Society
for
Neuroscience

PROGRAM and ABSTRACTS

Fourth Annual Meeting

October 20-24, 1974
St. Louis, Missouri

Sustaining Associate Members

The Society for Neuroscience wishes to acknowledge the invaluable contribution of unrestricted funds from its Sustaining Associate Members:

Hoffmann-La Roche Inc., Nutley, New Jersey

David Kopf Instruments, Tujunga, California

Wyeth Laboratories, Research Division, Philadelphia, Pennsylvania

Grass Foundation

This year's Grass Foundation Lecture by Sir Bernard Katz, University College, London, is the third such Society for Neuroscience Annual Meeting highlight made possible by an award from the Grass Foundation. Participants at our previous meetings will recall the successful and impressive [illegible] lectures delivered by Stephen Kuffler (1972, Houston) and Arvid Carlsson (1973, San Diego).

We are further privileged to acknowledge the continuation of the Grass Foundation Travelling Scientist. Funds for this program, now in its second year, enable the national organization to send eminent neuroscientists to tour a circuit of local chapters, speaking to their particular interests. To date, 10 speakers have visited 18 chapters, and many more tours are scheduled. This program has been enthusiastically received, and the Society is pleased to extend its thanks to the lecturers for their dedication, and to the Grass Foundation for the award that makes this service possible.

Grant Foundation

Once again this year the Society for Neuroscience has enjoyed the generous support of the Grant Foundation. Their award was used toward the production of our latest membership directory, and facilitated the expansion of the Committee on Chapters and the new Committee on Public Information.

It is most pertinent to express here the appreciation of the 1973-74 Program Committee. Their freedom and power to generate another successful Society for Neuroscience Annual Meeting was due in large part to the infusion of Grant Foundation funds.

Contents

General Information

REGISTRATION

Regency Foyer, Chase-Park Plaza Hotel

Hours

Sunday, October 20	10:00 AM– 6:00 PM
Monday, October 21	7:30 AM– 5:00 PM
Tuesday, October 22	8:00 AM– 5:00 PM
Wednesday, October 23	8:00 AM– 5:00 PM
Thursday, October 24	8:00 AM–11:00 AM

Fees

	In Advance	*At the Meeting*
Members	$25.00	$30.00
Nonmembers	$35.00	$40.00
Graduate Students	$ 5.00	$ 5.00

(Any student working toward a degree in neuroscience or an allied field. Post-doctoral fellows, hospital residents, interns and laboratory technicians, even though they may be in a training program, do not qualify for reduced student rate.)

Social Registrants	$ 3.00	$ 3.00

(Nonscientist family members of registrants.)

Advance registration will be accepted until September 24. Mail appropriate fee to: Neuroscience Annual Meeting Office, Room 200, 9650 Rockville Pike, Bethesda, Maryland 20014.

The official badge must be worn at all times for admission to scientific sessions, exhibits and social events.

INFORMATION/TICKET DESK

Regency Foyer, Chase-Park Plaza Hotel

Open during registration hours. For information of any kind, consult the Information Desk in the registration area. Important notices about Annual Meeting events will be posted on bulletin boards near the Information Desk.

Tickets for the Special Interest Dinners scheduled for Tuesday evening are available at the Information/Ticket Desk. See page 10 for list of dinners, locations, and ticket prices. *Ticket sales for Special Interest Dinners close at 5:00 PM on Monday.*

Tickets for the Wednesday evening dinner at the Missouri Botanical Gardens are $12.50 per person, which includes transportation to and from the Chase-Park Plaza Hotel. See page 11 for further information. *Tickets must be purchased by 1:00 PM on Tuesday.* All tickets for events planned primarily for social registrants will be sold in the Guest Hospitality Room, Chase-Park Plaza Hotel, Georgian Room.

VISIBLE DIRECTORY OF REGISTRANTS AND MESSAGE CENTER

Lindell Foyer, Chase-Park Plaza Hotel

Registration cards are filed in the Visible Directory, located in the Lindell Foyer, adjacent to the registration area. The Directory may be consulted for the hotel address of any registrant. Each advance registrant should check his convention address for accuracy.

Message boxes will be located adjacent to the Visible Directory for delivery of messages to other registrants. Message boxes should be checked daily for mail, notes and telephone messages. Please suggest that callers who wish to reach you during the day ask the hotel operator (314 361-2500) for the Neuroscience Information Desk.

PROGRAM AND ABSTRACTS VOLUME

A Program, which contains the abstracts, was mailed to each Society member and nonmember advance registrant. Those who received a copy of the Program/Abstracts Volume in advance but who did not bring it to the meeting may purchase another for $5.00 at the Annual Meeting Office.

ANNUAL MEETING AND SOCIETY OFFICE

Lido Room, Chase-Park Plaza Hotel

The Annual Meeting and Society Office is located in the Lido Room, adjacent to the Registration area, Regency Foyer. Offices will be open on Sunday, October 20 from 9:00 to 6:30 PM, and daily thereafter from 8:00 AM to 5:30 PM. Registrants requiring assistance with housing, presentation of papers, etc., should consult the Annual Meeting and Society Office.

LOST AND FOUND

Inquiries concerning lost articles should be made to the Annual Meeting and Society Office. Slides left in session rooms will be delivered by projection operators to this office.

PRESS ROOM

Pony Express Room, Chase-Park Plaza Hotel

Members of the press should register in the Pony Express Room. Hours are 2:00 PM to 5:00 PM on Sunday, and daily thereafter from 8:00 AM to 5:30 PM.

EXHIBITS

Exhibit Hall, Lower Level of the Chase-Park Plaza Hotel

Exhibits of pertinent laboratory equipment, books and journals, will be on display in the Exhibit Hall during the following hours:

Monday, October 21 ..... 8:00 AM–5:00 PM
Tuesday, October 22 ..... 8:30 AM–5:00 PM
Wednesday, October 23 ..... 8:30 AM–12 NOON

For exhibit floor plan and alphabetical list of exhibitors, see page 518–520.

COFFEE AND DISCUSSION LOUNGE

Exhibit Hall, Lower Level of the Chase-Park Plaza Hotel

The Coffee and Discussion Lounge will be open during exhibit hours, Monday to Wednesday. Coffee will be served without charge from 9:30 AM to 10:30 AM, Monday to Wednesday, and 2:30 PM to 3:30 PM, Monday and Tuesday.

Projection facilities for 2" x 2" slides will be available on a first-come, first-served basis in the Discussion Lounge.

PLACEMENT INFORMATION

Exhibit Hall, Lower Level, Chase-Park Plaza Hotel

As a service to registrants, a Placement Information Board will be located near the Coffee/Discussion Lounge in the Exhibit Hall. Employers and Candidates are urged to prepare 5" x 7" cards describing positions available and positions desired for posting at the meeting. Cards may be mailed to the Society Office, 9650 Rockville Pike, Bethesda, Maryland 20014, prior to October 10.

A small interview area will be available near the Discussion Lounge.

INFORMAL GROUP DISCUSSIONS

Limited space is available on a first-come, first-served basis for informal discussions by small groups. Apply for room assignment to the Annual Meeting Office, Lido Room.

SOCIAL REGISTRANTS

The Guest Hospitality Room, for family members and guests of scientists, is located in the Georgian Room of the Chase-Park Plaza Hotel, and is open to all social registrants from 1:00 to 5:00 PM on Sunday, October 20; 9:00 AM to 5:00 PM, Monday to Wednesday; and until Noon on Thursday. Complimentary coffee will be provided. Hostesses will be on hand to greet guests and offer assistance as needed. *All tickets to social registrant events will be sold in the Georgian Room and will not be available in the registration area.* Badges for social registrants who registered prior to September 24 have been placed in the registration packet of the sponsoring scientist.

In addition to the Opening Reception on Sunday and the Botanical Gardens Dinner on Wednesday, social registrants are invited to participate in the following activities:

The Historic Riverfront—Monday, 11 AM–4 PM

Ride to the top of the Gateway Arch, visit the Old Courthouse, Cathedral and Cathedral Museum. Luncheon on the Lt. Robert E. Lee, a 19th century sternwheeler, permanently moored on the Mississippi River. Transportation, entrance fees and lunch $9.00. Tickets must be purchased by 5:00 PM on Sunday.

Anheuser-Busch Brewery and Carriage House Luncheon—Tuesday, 10 AM–3:30 PM

Tour of the Chatillon-DeMenil Mansion in old South St. Louis and a visit to the Anheuser-Busch Brewery. Luncheon in the Carriage House adjoining the DeMenil Mansion. Transportation, entrance fees and lunch $8.50. Tickets must be purchased by 1:00 PM on Monday.

Forest Park—Wednesday, 10 AM–3:30 PM

The 1376-acre park, scene of the 1904 World's Fair, includes the Jewel Box, Municipal Opera, McDonnell Planetarium, Jefferson Memorial with its Lindbergh trophies, costume and toy rooms, St. Louis Art Museum and the Zoo. Lunch on your own in the Art Museum Dining Room. Transportation $4.00. Tickets must be purchased by 1:00 PM on Tuesday.

Further details, including bus departure hours, are included in the social registrant Program, available in the Guest Hospitality Room.

AIRLINES RESERVATIONS AND TICKETS

A Transportation Desk is located in the Chase-Park Plaza Hotel lobby.

CHASE-PARK PLAZA DINING FACILITIES AND LOUNGES

Restaurants

Tack Room Coffee Shop, open 24 hours a day, Main Floor, moderate prices
Hunt Room, breakfast, lunch and dinner, Main Floor, moderate prices
Tenderloin Room, lunch and dinner, Main Floor, jacket and tie required
Sea Chase, lunch and dinner, Main Floor, jacket required for dinner
Mr. Sam's, dinner only, 3rd Floor, jacket and tie required

Cocktail Lounges

Steeple Chase, Main Floor
Marty's Make Believe Ballroom, Park Plaza lower level
Sea Chase Bar, Main Floor
Tenderloin Room Bar, Main Floor

HOTEL CHECK-OUT HOUR AND LUGGAGE STORAGE

The check-out hour is 1:00 PM. Registrants with early afternoon flights on Thursday may wish to check out that morning and store their luggage in the Annual Meeting Office, Lido Room. Baggage must be claimed by 1:00 PM.

Program Information

SCIENTIFIC SESSIONS

The scientific program begins at 1:30 PM on Sunday, October 20, and continues through 3:00 PM on Thursday, October 24.

Morning sessions begin at 8:30 AM; afternoon sessions begin at 1:00 PM and at 3:30 PM. All sessions are scheduled in the Chase-Park Plaza Hotel. See the hotel floor plan, inside front cover, for the location of session rooms.

A chart showing the five-day schedule is on pages 12 and 13.

PRESIDENTIAL SYMPOSIUM

Sunday, 4:30 PM, Khorassan C
In honor of Ralph Waldo Gerard, Honorary President 1969-1974.

Topic: Neuroscience Today: Whence and Whither

Moderator: **T. H. BULLOCK**, President, Society for Neuroscience

Panelists: **HALLOWELL DAVIS**, *Central Institute for the Deaf*; **BENJAMIN LIBET**, *University of California, San Francisco*; **JAMES L. McGAUGH**, *University of California, Irvine*; **FRANCIS O. SCHMITT**, *Neuroscience Research Program, MIT.*

Open to all registrants

SOCIETY BUSINESS MEETINGS

Monday and Wednesday, 5:00 PM, Khorassan C

Open to all members of the Society for Neuroscience

GRASS FOUNDATION LECTURE

Monday, 8:30 PM, Khorassan C

Topic: Molecular Components of Neuromuscular Transmission

Speaker: **SIR BERNARD KATZ**, *University College, London*

PUBLIC LECTURE

Tuesday, 5:00 PM, Khorassan C
Topic: Convergent Sensory Processing in the Mammalian Forebrain

Speaker: **WALLE J. H. NAUTA**, *Department of Psychology, MIT*

SOCIAL EVENTS AND SPECIAL FUNCTIONS

Saturday, October 19

International Society for Developmental Psychobiology

1:00 PM–4:30 PM, *Tiara Lounge South.* Round Table Symposium on Endocrine Determinants in Psychobiological Research, followed by Business Meeting at 4:30 PM.

5:30 PM–8:30 PM, *Tiara Lounge North.* No-host cocktails and dinner, followed by Presidential Address, "Chaos and Constancy, or What, Where, When and . . . Wow!," **SAMUEL EIDUSON**, ISDP President. Film program follows address.

Sunday, October 20

International Society for Developmental Psychobiology

9:00 AM–12:30 PM, *Tiara Lounge South.* Continuation of Saturday meeting.

Society for Neuroscience Chapters Officers and Representatives

9:00 AM–NOON, *Coach Room.* To encourage participation of the chapters in society activities and provide a direct means of obtaining expressions of chapters opinions and needs.

Opening Reception

6:30 PM–8:00 PM, *Chase Club Room.* No-host cocktails. All registrants and their guests are cordially invited to attend.

Society for Neuroscience Committee on Social Issues Workshops

7:30 PM–9:00 PM, *location to be announced.* Concurrent workshops focused on specific types of preventable brain damage emphasizing the neuroscience content and an epidemiological estimate of the magnitude of the problem. Tentative topics: Traumatic Brain Damage, Damage Due to Drug Use, Malnutrition and Malnourishment, Environmental Neurotoxins, Genetic Defects, Insufficient Early Stimulation and Sensory Deprivation. Details available at Information Desk.

Society for Neuroscience Committee on Social Issues Plenary Session

9:00 PM–10:30 PM, *location to be announced.* An overview of the topic Preventable Brain Damage will be given, followed by discussion of the avenues by which neuroscientists can initiate appropriate social responses to the problems outlined in the preceding Workshops. Details available at Information Desk.

Monday, October 21

State Dependent Learning Discussion Group

5:00 PM–7:30 PM, *Chippendale Room.* No-host cocktails, followed by informal meeting on "Newer Aspects." Speakers: **J. A. ROSECRANS, D. OVERTON, H. BARRY III, H. A. TILSON.**

Tuesday, October 22

Special Interest Dinners

6:30 PM–10:00 PM. No-host cocktails followed by dinner meetings of groups sharing common scientific interests. Tickets, available at the Information/ Ticket Desk, *must be purchased by* 5:00 PM *on Monday.*

Tissue Culture, Balabans Restaurant, 405 N. Euclid. **R. P. BUNGE,** *Chairman.* Ticket $10.00

Recent Developments in Neuroanatomical Methodology, Coach Room. **W. M. COWAN,** *Chairman.* Ticket and price at Information

Neuroendocrinology, Georgian Room. **W. H. DAUGHADAY,** *Chairman.* Ticket $8.50

Audition, Tiara Lounge North. **H. H. DAVIS,** *Chairman.* Ticket $8.25

Vision, Palladian Room. **N. W. DAW,** *Chairman.* Ticket $8.50

EEG and Clinical Neurophysiology, Chippendale Room. **S. GOLDRING,** *Chairman.* Ticket $9.50

Brain Stimulation and Motivation, Lucas Room. **R. GOLDSTEIN,** *Chairman.* Ticket $8.50

Developmental Neurobiology, Regency Room. **V. HAMBURGER,** *Chairman.* Ticket $8.50

Psychopharmacology: Studies on Addiction, English Room. **B. K. HARTMAN,** *Chairman.* Ticket $8.50

General Neurophysiology, Stockholm Room. **C. C. HUNT,** *Chairman.* Ticket $7.75

Sensorimotor Integration and Motor Control, Whittemore House (Washington Univ. Faculty Club). **W. M. LANDAU,** *Chairman.* Ticket $8.00 chicken or $11.00 beef. Transportation included.

Neurochemistry, Park Room. **O. H. LOWRY,** *Chairman.* Ticket $7.75

Memory, Learning and Neural Plasticity, Zodiac Room. **J. L. McGAUGH,** *Chairman.* Ticket $8.50

Neuronal Modeling, Colonial Room. **C. E. MOLNAR,** *Chairman.* Ticket and price at Information

Invertebrate Neurophysiology, Empire Room. **P. STEIN,** *Chairman.* Ticket $7.75

Special Interest Dinners General Chairman, **E. V. EVARTS**

Chemical Senses Informal Discussion Group

7:30 PM–11:00 PM, *Tiara Lounge South.* No-host cocktails followed by an informal meeting of neuroscientists interested in the chemical senses. **BRUCE OAKLEY,** *Department of Zoology, University of Michigan, Chairman.*

Wednesday, October 23

Missouri Botanical Gardens Dinner

7:00 PM–11:00 PM. *Buses will depart from the Lindell Boulevard entrance of the Chase-Park Plaza at 7:00* PM. *Loading begins at 6:45* PM. No-host cocktails in the geodesic-dome Climatron, followed by dinner in the Lehman Building. The Missouri Botanical Gardens, also known as Shaw's Garden, is one of the most unusual botanical gardens in the world with more than 70 acres in the heart of St. Louis devoted to outdoor exhibits, conservatories and horticultural displays. The Climatron, the first geodesic-dome greenhouse ever built, houses a wide variety of natural tropical settings including a Hawaiian waterfall, a jungle pond and an aquatunnel for underwater viewing. The Lehman Building is the heart of the research center. Other attractions include the Floral Display House, Rose Gardens, Water Lily display, Herbarium, Desert House and the Camellia House.

Dinner tickets are $12.50 per person which includes transportation to and from the Chase-Park Plaza and admission fees. Tickets, available at the Information/Ticket Desk in the registration area, *must be purchased by 1:00* PM *on Tuesday.*

* Events planned primarily for Social Registrants

	SUNDAY OCTOBER 20	MONDAY OCTOBER 21
MORNING	10 AM–6 PM Registration and Information	7:30 AM–5 PM Registration and Information 8 AM–5 PM Exhibits 8:30–11:30 AM Symposia and Volunteer Paper Sessions *11 AM–4 PM Historic Riverfront Tour
AFTERNOON	1:30–4 PM Volunteer Paper Sessions 4:30–6 PM Presidential Symposium	1–3 PM Symposia and Volunteer Paper Sessions 3:30–5 PM Volunteer Paper Sessions
EVENING	6:30–8 PM Opening Reception	5–6:30 PM Society Business Meeting 8:30 PM Grass Foundation Lecture

CALENDAR

TUESDAY OCTOBER 22	WEDNESDAY OCTOBER 23	THURSDAY OCTOBER 24
8 AM–5 PM Registration and Information	8 AM–5 PM Registration and Information	8 AM–11 AM Registration and Information
8:30 AM–5 PM Exhibits	8:30 AM–12 Noon Exhibits	8:30 AM–11:30 AM Symposia and Volunteer Paper Sessions
8:30–11:30 AM Symposia and Volunteer Paper Sessions	8:30–11:30 AM Symposia and Volunteer Paper Sessions	
*10 AM–3:30 PM Anheuser-Busch and DeMenil Mansion Tour	*10 AM–3:30 PM Forest Park Tour	
1–3 PM Symposia and Volunteer Paper Sessions	1–3 PM Symposia and Volunteer Paper Sessions	1–3 PM Volunteer Paper Sessions
3:30–5 PM Volunteer Paper Sessions	3:30–5 PM Volunteer Paper Sessions	
5–6:30 PM Public Lecture	5–6:30 PM Society Business Meeting	
6:30–10 PM Special Interest Group Dinners	7–11 PM Missouri Botanical Gardens Dinner	

SYMPOSIUM

1. Computer Applications in Neuroscience: A Symposium Presented by the Computer Systems Laboratory, Washington University School of Medicine

1:30 PM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **C. E. MOLNAR**

Computer applications in neuroanatomy: analysis of Golgi-impregnated neurons in mouse cerebral cortex. **T. A. WOOLSEY,** *Department of Anatomy;* **M. L. DIERKER,** *Department of Electrical Engineering;* and **D. F. WANN,** *Department of Electrical Engineering.*

Computer applications in transaxial tomography of the brain. **M. PHELPS,** *Department of Radiology;* **E. HOFFMAN,** *Department of Radiology;* **N. MULLANI,** *Biomedical Computer Laboratory;* and **T. TER-POGOSSIAN,** *Department of Radiology.*

Computer applications in auditory physiology: fast Fourier transform analysis of cochlear microphonic and period histograms of cochlear nerve fiber discharges. **C. E. MOLNAR,** *Computer Systems Laboratory;* **D. ELDREDGE,** *Department of Otolaryngology and Central Institute for the Deaf;* **R. R. PFEIFFER,** *Department of Electrical Engineering* and *Department of Physiology and Biophysics;* and **D. A. RONKEN,** *Central Institute for the Deaf.*

Computer applications in experiments on bat sonar. **J. A. SIMMONS,** *Department of Psychology;* **W. A. LAVENDER,** *Department of Psychology;* and **B. A. LAVENDER,** *Department of Psychology.*

Visits to participating laboratories may be arranged during the week. Details available at Registration/Information Desk.

VOLUNTEER PAPERS

2. Neurotransmitters: Receptors

1:30 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **J. A. HOBSON**

1:30 Gamma-aminobutyric acid binding sites in nerves and muscle membranes and bicuculline inhibition. **R. W. OLSEN.** *Univ. of California, Riverside, CA.*

1:45 Selective drug effects on motor and sensory nerves: a "Dale's principle" for receptors. **H. C. SABELLI, J. DeFOE-MAY** and **M. BULAT.** *Chicago Med. Sch. and Mt. Sinai Hosp., Chicago, IL.*

2:00 Neurotransmitter receptors in CNS axons: a nonsynaptic target for neurotropic drugs. **A. J. VAZQUEZ** and **H. C. SABELLI.** *Chicago Med. Sch., Chicago, IL.*

2:15 Interaction of L-proline and glutamate upon neurons in the central nervous system of the cat. **P. ZARZECKI, P. BLUM** and **G. SOMJEN.** *Duke Univ., Durham, NC.*

2:30 Pharmacology of acidic amino acids studied on isolated frog spinal cord. **A. L. PADJEN.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

2:45 Chemical sensitivity of the dorsal spinocerebellar tract neurons in relation to various sensory inputs. **N. R. MYSLINSKI, M. RANDIC** and **M. E. LEDGERE.** *Tufts Univ. Sch. of Med., Boston, MA.*

3:00 Transmembrane changes in hippocampal neurons: hyperpolarizing actions of norepinephrine, cyclic AMP, and locus ceruleus. **A. P. OLIVER** and **M. SEGAL.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

3:15 Neuroleptic antagonism of catecholamine inhibitions in rat cerebellum and caudate. **R. FREEDMAN, B. J. HOFFER** and **G. R. SIGGINS.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

3:30 Responses of squirrel monkey auditory cortex neurons to vocalizations: changes produced by microiontophoresis of putative neurotransmitters. **S. L. FOOTE, R. FREEDMAN** and **A. P. OLIVER.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

3:45 Cholinergic enhancement and suppression of desynchronized sleep. **T. AMATRUDA, T. McKENNA, D. BLACK, R. W. McCARLEY** and **J. A. HOBSON.** *Harvard Med. Sch., Boston, MA.*

Abstracts of volunteer papers are arranged in alphabetical order by first author, starting on page 109.

VOLUNTEER PAPERS

3. Neurochemistry: Energy Metabolism

1:30 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **J. V. PASSONNEAU**

1:30 Activity related 2-deoxy-D-glucose uptake in the central nervous system of the rat. **F. R. SHARP.** *NIH, Bethesda, MD.*

1:45 Whole brain blood flow and oxygen metabolism in the rat. **A. GJEDDE, J. CARONNA, B. HINDFELDT** and **F. PLUM.** *Cornell Univ. Med. Col., New York, NY.*

2:00 Brain energy metabolism: local and regional recordings of NADH fluorescence. **B. CHANCE, A. MAYEVSKY** and **B. STUART.** *Johnson Res. Fndn., Univ. of Pennsylvania, Philadelphia, PA.*

2:15 Levels of potassium, NADH and extracellular potential in the cerebral cortex during electrical stimulation, seizures and spreading depression. **E. LOTHMAN, J. LaMANNA, G. CORDINGLEY, M. ROSENTHAL** and **G. SOMJEN.** *Duke Univ., Durham, NC.*

2:30 Oxidation of reduced nicotinamide adenine dinucleotide in dorsal root ganglion neurons after topical application of adenine nucleotide. **C. RODRIGUEZ-ESTRADA.** *Univ. Central de Venezuela, Caracas, Venezuela.*

2:45 Requirement for carbon dioxide to maintain metabolic responses of rat cerebral cortex slices to stimulation. **R. J. BULL.** *Natl. Environ. Res. Ctr., EPA, Cincinnati, OH.*

3:00 Energy metabolism and nerve function in cockroaches (*Periplaneta americana*) during hypoxia. **D. C. WALTER** and **S .R. NELSON.** *Univ. of Kansas Med. Sch., Kansas City, KS.*

3:15 Distribution and regulation of phosphoribosylpyrophosphate synthetase in rat brain. **F. C. KAUFFMAN** and **R. GHOSH.** *Univ. of Maryland Sch. of Med., Baltimore, MD.*

3:30 Congenital lactic acidosis: complete absence of pyruvate decarboxylase in brain and liver. **D. F. FARRELL, A. F. CLARK, C. R. SCOTT** and **R. P. WENNBERG.** *Univ. of Washington Sch. of Med., Seattle, WA.*

3:45 Leucine incorporation into protein by brain slices from ischemic gerbils. **K. PATEL-MANDLIK, J. F. HARTMANN** and **M. M. COHEN.** *Rush-Presbyterian St. Luke's Med. Ctr., Chicago, IL.*

VOLUNTEER PAPERS

4. Membrane Structure and Function

1:30 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **R. W. ALBERS**

1:30 Further in vitro studies of skeletal muscle sarcolemma: phosphorylation of membrane protein. **N. B. REDDY, R. TSUKUI, W. K. ENGEL** and **B. W. FESTOFF.** *NIH, Bethesda, MD.*

1:45 Uptake of choline by the neurons of the chick ciliary ganglion. **R. L. BEACH, J. B. SUSZKIW** and **G. PILAR.** *Univ. of Connecticut, Storrs, CT.*

2:00 Immunochemical properties of the subunits of Lubrol solubilized ($Na^+ + K^+$)-ATPase from electric eel. **D. H. JEAN, R. W. ALBERS** and **G. J. KOVAL.** *NIH, Bethesda, MD.*

2:15 A negative electrogenic pump in frog muscle. **D. GEDULDIG** and **D. R. LIVENGOOD.** *Univ. of Maryland Sch. of Med., Baltimore, MD, and AFRRI, Bethesda, MD.*

2:30 Analysis of the decaying postsynaptic current in the squid giant synapse. **D. L. GILBERT** and **R. S. MANALIS.** *NIH, Bethesda, MD, Univ. of Cincinnati, Cincinnati, OH, and Marine Biol. Lab., Woods Hole, MA.*

2:45 Effects of organic anions on neuronal membrane permeability. **H. LEVITAN** and **J. L. BARKER.** *Univ. of Maryland, College Park, and NIH, Bethesda, MD.*

3:00 Selective blockade of the inhibitory postsynaptic response by mercurial compounds, observed in *Aplysia* ganglion cells. **M. SATO** and **M. SAWADA.** *Univ. of Oregon Med. Sch., Portland, OR.*

3:15 A sodium pump induced chloride conductance decrease in frog muscle. **D. R. LIVENGOOD** and **D. GEDULDIG.** *AFRRI, Bethesda, MD, and Univ. of Maryland, Baltimore, MD.*

3:30 Current source in a weakly electric mormyrid fish. **J. C. BRADBURY** and **C. C. BELL.** *Good Samaritan Hosp. and Med. Ctr., Portland, OR.*

3:45 Characteristic length as a function of frequency: a white noise analysis. **H. L. BRYANT** and **J. P. SEGUNDO.** *UCLA, Los Angeles, CA.*

VOLUNTEER PAPERS

5. Muscle

1:30 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **S. R. MAX**

1:30 Conversion of cross-reinnervated skeletal muscles. **D. A. RILEY.** *UCSF, San Francisco, CA.*

1:45 Contractile, histochemical, biochemical and morphological properties of guinea pig hindlimb muscles restrained from contracting isotonically. **A. MAIER, J. L. CROCKETT, D. R. SIMPSON** and **V. R. EDGERTON.** *UCLA, Los Angeles, CA.*

2:00 Compensatory hypertrophy studied in individual motor units. **J. V. WALSH, R. E. BURKE, W. Z. RYMER** and **P. TSAIRIS.** *NIH, Bethesda, MD, and Cornell Univ. Med. Col., New York, NY.*

2:15 Oxidative metabolism of skeletal muscle in steroid atrophy. **C. L. KOSKI, D. H. RIFENBERICK** and **S. R. MAX.** *Univ. of Maryland Sch. of Med., Baltimore, MD.*

2:30 Membrane electrical constants of innervated and denervated, normal and dystrophic chicken muscles. **F. J. LEBEDA** and **E. X. ALBUQUERQUE.** *Univ. of Maryland Sch. of Med., Baltimore, MD.*

2:45 Rat skeletal muscle necrosis following amine uptake blockers or pargyline plus serotonin. **H. Y. MELTZER** and **S. L. RASTOGI.** *Univ. of Chicago Pritzker Sch. of Med., Chicago, IL.*

3:00 Muscle pathology following brain lesions in rats. **M. I. KANNER** and **H. Y. MELTZER.** *Univ. of Chicago Pritzker Sch. of Med., Chicago, IL.*

3:15 Ultrastructural observations on myogenesis from *Drosophila* gastrulae in vitro. **I. GERSON, R. L. TEPLITZ** and **R. L. SEECOF.** *City of Hope Natl. Med. Ctr., Duarte, CA.*

3:30 Response of muscle cholinesterase to endurance training. **V. R. EDGERTON, J. L. CROCKETT** and **R. J. BARNARD.** *UCLA, Los Angeles, CA.*

3:45 Effect of dynamic mechanical loading on frog sciatic nerve. **A. K. OMMAYA, T. A. GENNARELLI** and **L. THIBAULT.** *NIH, Bethesda, MD.*

VOLUNTEER PAPERS

6. Neurochemistry: Behavioral Correlates

1:30 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **L. G. SHARPE**

1:30 Origin of homovanillic acid in the lumbar fluid. **M. BULAT, M. JAKUPČEVIĆ** and **Z. LACKOVIĆ.** *Inst. "Ruder Boskovic," Zagreb, Yugoslavia, and Chicago Med. Sch., Chicago, IL.*

1:45 Changes in amino acid levels in brain areas of rats during drug-induced behavioral excitation. **W. J. McBRIDE, J. N. HINGTGEN** and **M. H. APRISON.** *Indiana Univ. Med. Ctr., Indianapolis, IN.*

2:00 Caffeine effects on spontaneous activity of reticular formation neurons. **K. HIRSH, J. FORDE** and **M. PINZONE.** *General Foods Corp. Tech. Ctr., Tarrytown, NY.*

2:15 Induction of female sexual behavior by intracranial catecholamine administration. **F. P. ZEMLAN.** *Univ. of Pennsylvania, Philadelphia, PA.*

2:30 Disruption of long term memory in goldfish by inhibition of cerebral monoamine oxidase. **S. M. STAHL** and **E. A. ZELLER.** *Northwestern Univ. Med. Sch., Chicago, IL.*

2:45 Correlation of hypothalamic obesity with brain amine levels in rats. **D. V. COSCINA, D. D. GODSE** and **H. C. STANCER.** *Clarke Inst. of Psychiatry, Toronto, Canada.*

3:00 Elevated piperidine and cadaverine contents in the brain of dormant mice. **H. DOLEZALOVA** and **M. STEPITA-KLAUCO.** *Univ. of Connecticut, Storrs, CT.*

3:15 Effects of light and darkness on dopamine and norepinephrine levels in the rat brain. **U. G. WHITWORTH, J. O. OWASOYO** and **C. A. WALKER.** *Sch. of Vet. Med., Tuskegee Inst., Tuskegee, AL.*

3:30 Cholinergic effects of methylphenidate hydrochloride on selective sensory information processing. **T-M. SHIH, Z. S. KHACHATURIAN, K. L. REISLER** and **I. HANIN.** *Univ. of Pittsburgh Sch. of Med., Pittsburgh, PA.*

3:45 Thermal responses following intracranial microinjections of angiotensin II, carbachol and putative neurotransmitters in the brain stem of rabbits. **L. G. SHARPE, J. E. GARNETT** and **N. S. OLSEN.** *Washington Univ. Sch. of Med., St. Louis, MO.*

SUNDAY AFTERNOON

PRESIDENTIAL SYMPOSIUM

7. Neuroscience Today: Whence and Whither

4:30 PM—*Khorassan C, Chase-Park Plaza Hotel*

In honor of Ralph Waldo Gerard
Honorary President, 1969-1974

Insights from recent history involving Gerard and projections into the future: a panel discussion

H. DAVIS, B. LIBET, J. L. McGAUGH, F. O. SCHMITT

Moderated by **T. H. BULLOCK**
President, Society for Neuroscience, 1973-1974

MONDAY MORNING

SYMPOSIUM

8. Biochemical Neuroanatomy

8:30 AM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **P. L. McGEER**

Comparison of various assay techniques for biogenic amines in terms of their sensitivity, specificity, and convenience. **R. E. McCAMAN.** *City of Hope Med. Ctr., Duarte, CA.*

Histochemistry of biogenic amines. **R. Y. MOORE.** *UCSD, San Diego, CA.*

Localization of neurotransmitter synthetic enzymes by immunohistochemistry. **T. HÖKFELT.** *Karolinska Inst., Stockholm, Sweden.*

Some consequences of axonal lesions on neurotransmitters and their biosynthetic enzymes. **D. J. REIS.** *Cornell Univ., New York, NY.*

Axoplasmic flow of neurotransmitters. **H. C. FIBIGER.** *Univ. of British Columbia, Vancouver, Canada.*

Co-sponsored by the Society for Neuroscience and the American Society for Neurochemistry.

SYMPOSIUM

9. Neurophysiological Applications of Input-Output Analysis

8:30 AM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: **R. E. POPPELE**

Analysis of neuronal systems using Gaussian white noise. **P. MARMARELIS, G. McCANN** and **K. NAKA**. *Carnegie-Mellon Univ., Pittsburgh, PA, and California Inst. of Technol., Pasadena, CA.*

Response of neuronal systems to random pulse trains. **C. KNOX** and **R. POPPELE**. *Univ. of Minnesota, Minneapolis, MN.*

White noise analysis of spike generation in nerve cells. **H. BRYANT** and **J. SEGUNDO**. *UCLA, Los Angeles, CA.*

Analysis of muscle properties using noise input. **A. MANNARD, R. STEIN** and **T. BAWA**. *McGill Univ., Montreal, Quebec, and Univ. of Alberta, Edmonton, Alberta, Canada.*

VOLUNTEER PAPERS

10. Vision: Central Organization—I (Receptive Fields)

8:30 AM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **S. M. SHERMAN**

8:30 Topography of ocular dominance columns in monkey striate cortex. **S. LeVAY, D. H. HUBEL** and **T. N. WIESEL**. *Harvard Med. Sch., Boston, MA.*

8:45 Reorganization of ocular dominance columns in monkey striate cortex. **T. N. WIESEL** and **D. H. HUBEL**. *Harvard Med. Sch., Boston, MA.*

9:00 Visual-field representation in layer IV C of monkey striate cortex. **D. H. HUBEL, T. N. WIESEL** and **S. LeVAY**. *Harvard Med. Sch., Boston, MA.*

9:15 Activity of cortical visual neurons of the alert macaque during presentation of square-wave gratings. **G. F. POGGIO, R. W. DOTY** and **W. H. TALBOT.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

9:30 Activity of prestriate neurons in behaving monkey. **J. S. BAIZER** and **D. L. ROBINSON.** *NIMH, Bethesda, MD.*

9:45 Receptive field characteristics in cat striate cortex: changes with visual field eccentricity. **J. R. WILSON** and **S. M. SHERMAN.** *Univ. of Virginia, Charlottesville, VA.*

10:00 Receptive field characteristics and topographic organization of single neurons in the lateral suprasylvian visual area of the cat. **P. D. SPEAR.** *Kansas State Univ., Manhattan, KS.*

10:15 Supragranular laminar lesions of cat striate cortex: effects on visual receptive fields. **D. W. WATKINS, A. B. BUTLER, S. M. SHERMAN** and **J. A. JANE.** *Univ. of Virginia Sch. of Med., Charlottesville, VA.*

10:30 Receptive fields and topographic representation in mouse visual cortex. **U. DRAGER.** *Harvard Med. Sch., Boston, MA.*

10:45 Alteration of visual receptive field characteristics of neurons in dorsal lateral geniculate nucleus and lateral posterior nucleus following complete or partial neonatal striatectomy. **D. BIRT** and **D. STEWART.** *Indiana Univ., Bloomington, IN.*

11:00 Relation between visual and somatic organization in the cat superior colliculus. **B. E. STEIN, B. MAGALHAES-CASTRO** and **L. KRUGER.** *UCLA Sch. of Med., Los Angeles, CA.*

11:15 Form discrimination and localization performance in cats with superior colliculus ablations. **J. E. TUNKL** and **M. A. BERKLEY.** *Florida State Univ., Tallahassee, FL.*

VOLUNTEER PAPERS

11. Motor Systems I

8:30 AM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **J. C. HOUK**

8:30 Respiratory reaction times in man: estimation of central delays in the initiation of voluntary breathing movements. **R. W. LANSING** and **J. E. THOMAS.** *Univ. of Arizona, Tucson, AZ.*

8:45 The frequency of human postural sway. **A. W. MONSTER** and **H. CHAN.** *Temple Univ. Hlth. Sci. Ctr., Philadelphia, PA.*

9:00 Function of ankle reflexes in human posture control. **L. M. NASHNER.** *Good Samaritan Hosp. and Med. Ctr., Portland, OR.*

9:15 The influence of angular position and velocity of the elbow on the discharge rates of interpositus neurons (cat). **N. ONODA** and **J. E. BURTON.** *City of Hope Natl. Med. Ctr., Duarte, CA.*

9:30 EMG and mechanical responses to load perturbations applied to the human arm. **P. CRAGO, Z. HASAN** and **J. C. HOUK.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

9:45 Effects of single hindlimb deafferentation upon treadmill locomotion in cats. **M. C. WETZEL, A. E. ATWATER, J. V. WAIT** and **D. G. STUART.** *Univ. of Arizona Col. of Med., Tucson, AZ.*

10:00 Advanced development of prosthetic arm control by pattern recognition. **F. R. FINLEY, R. W. WIRTA** and **D. R. TAYLOR, JR.** *Temple Univ. Hlth. Sci. Ctr., Philadelphia, PA.*

10:15 An indirect technique to estimate the size distribution and the number of motor units in human skeletal muscle. **H. CHAN** and **A. W. MONSTER.** *Temple Univ. Hlth. Sci. Ctr., Philadelphia, PA.*

10:30 Mechanisms involved in the prolonged motor inhibition produced by impulses from type J pulmonary receptors. **M. KALIA** and **H. P. KOEPCHEN.** *Univ. of Pennsylvania Sch. of Med., Philadelphia, PA, and Physiologishes Institut der Freien Universitat Berlin, Berlin, Germany.*

10:45 Control of single forelimb muscles by input-output linkages in motor cortex. **J. T. MURPHY, Y-C. WONG** and **H. C. KWAN.** *Univ. of Toronto, Toronto, Ontario, Canada.*

11:00 The consequences of intrafusal-extrafusal coactivation in amphibian muscles. **K. S. K. MURTHY** and **A. TAYLOR.** *Univ. of Arizona Col. of Med., Tucson, AZ.*

11:15 Control of swimming in the turtle by electrical stimulation of the spinal cord. **P. R. LENNARD** and **P. S. G. STEIN.** *Washington Univ., St. Louis, MO.*

MONDAY MORNING

VOLUNTEER PAPERS

12. Trophic Functions

8:30 AM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **M. J. COHEN**

8:30 Effect of brain extract on chick embryo muscle cells in culture. **T. H. OH.** *NIH, Bethesda, MD.*

8:45 Myogenic origin of inherited muscular dystrophy of the chicken. **T. A. LINKHART, G. W. YEE** and **B. W. WILSON.** *Univ. of California, Davis, CA.*

9:00 Trophic relationships of nerve and muscle in regenerating legs of an insect. **E. SHAPIRO** and **M. J. COHEN.** *Yale Univ., New Haven, CT.*

9:15 Evidence for dual neurotrophic effects on the metabolism of specific muscle proteins. **B. BERESFORD, M. P. RATHBONE** and **D. M. LOGAN.** *McMaster Univ., Hamilton, Canada, and York Univ., Downsview, Ontario, Canada.*

9:30 Comparison of supersensitivity to acetylcholine and carbachol in chronically denervated rat diaphragm. **M. G. McCONNELL.** *Columbia Univ., New York, NY.*

9:45 Distribution of (^{3}H) colchicine in nerves and muscles of rats. **J. E. WARNICK, E. X. ALBUQUERQUE** and **F. C. KAUFFMAN.** *Univ. of Maryland Sch. of Med., Baltimore, MD.*

10:00 Electrophysiological properties of the membrane and cholinergic receptor in developing rat myotubes. **A. K. RITCHIE** and **D. M. FAMBROUGH.** *Carnegie Inst. of Washington, Baltimore, MD.*

10:15 In vivo recovery of neuromuscular response after α-bungarotoxin binding. **H. C. FERTUCK, W. WOODWARD** and **M. M. SALPETER.** *Cornell Univ., Ithaca, NY.*

10:30 A study of the equilibrium inhibition of the binding of α-bungarotoxin to the acetylcholine receptor by serum IgG from myasthenia gravis patients. **R. R. ALMON, C. G. ANDREW** and **S. H. APPEL.** *Duke Univ. Med. Ctr., Durham, NC.*

10:45 Effect of atropine on the acetylcholine receptor-ionic conductance modulator complex of the frog sartorius muscle. **M. ADLER** and **E. X. ALBUQUERQUE.** *Univ. of Maryland Sch. of Med., Baltimore, MD.*

11:00 Effect of mercury on the electrophysiology of neuromuscular transmission in the frog. **R. S. MANALIS** and **G. P. COOPER.** *Univ. of Cincinnati, Cincinnati, OH.*

11:15 Therapy of anticholinesterase intoxication using compounds with veratrine-like action and the role of calcium. **O. L. WOLTHUIS** and **V. J. NICKOLSON.** *Med. Biol. Lab. TNO, Rijswijk Z.H., The Netherlands.*

VOLUNTEER PAPERS

13. Limbic System I: Hippocampus

8:30 AM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **D. B. LINDSLEY**

8:30 A new "extrarhinal" source of afferents to the hippocampus in the squirrel monkey. **G. R. LEICHNETZ** and **J. ASTRUC.** *Med. Col., Virginia Commonwealth Univ., Richmond, VA.*

8:45 Projections of the hippocampus in the squirrel monkey. **A. SIEGEL, S. OHGAMI** and **H. M. EDINGER.** *New Jersey Med. Sch., Newark, NJ.*

9:00 Anatomical and behavioral analysis of hippocampal cell fields. **L. E. JARRARD.** *Washington and Lee Univ., Lexington, VA.*

9:15 Multiple origins of the hippocampal theta rhythm. **L. K. GERBRANDT, J. C. LAWRENCE, J. R. FOWLER** and **T. G. WEYAND.** *California State Univ., Northridge, CA.*

9:30 Patterns of dorsal hippocampal unit activity. **C. E. OLMSTEAD** and **P. J. BEST.** *NPI, UCLA, Los Angeles, CA, and Univ. of Virginia, Charlottesville, VA.*

9:45 Responses of hippocampal units to tonal stimuli in awake and sleeping rats. **L. E. MAYS** and **P. J. BEST.** *Univ. of Virginia, Charlottesville, VA.*

10:00 Hippocampal EEG activity and motor behavior in the rat. **C. J. FREDERICKSON** and **K. ASIN.** *Carnegie-Mellon Univ., Pittsburgh, PA.*

10:15 Effects of hypothalamic stimulation upon septal pacemaker mechanisms influencing hippocampal theta thythm. **C. L. WILSON** and **D. B. LINDSLEY.** *UCLA, Los Angeles, CA.*

10:30 Effects of locus ceruleus stimulation on hippocampal unit activity and on behavior in unrestrained rats. **M. SEGAL** and **F. E. BLOOM.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

10:45 Hippocampal and neocortical EEG changes during free and operant behavior. **J. R. COLEMAN** and **D. B. LINDSLEY.** *UCLA, Los Angeles, CA.*

11:00 Minicomputer monitoring of social behavior patterns in colonies of hippocampal-lesioned CBA mice. **D. L. ELY** and **E. G. GREENE.** *USC, Los Angeles, CA.*

11:15 Hippocampal and pituitary-adrenal influences on activity and avoidance learning in rats. **J. J. JASO.** *Univ. of Oklahoma Hlth. Sci. Ctr., Oklahoma City, OK.*

MONDAY MORNING

VOLUNTEER PAPERS

14. Psychopharmacology

8:30 AM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **R. W. FULLER**

8:30 Tranquilizer-blockade of dopamine release from stimulated striatal slices. **P. SEEMAN** and **T. LEE.** *Univ. of Toronto, Toronto, Canada.*

8:45 Studies on the antinociceptive properties of haloperidol and diazepam. **T. L. YAKSH** and **T. A. RUDY.** *Univ. of Wisconsin, Madison, WI.*

9:00 Antipsychotic drugs: possible mechanisms for differing incidences of extrapyramidal side effects. **B. S. BUNNEY** and **G. K. AGHAJANIAN.** *Yale Univ. Sch. of Med., New Haven, CT.*

9:15 Effects of amphetamine isomers on spontaneous neuronal activity in the caudate nucleus and reticular formation. **G. V. REBEC** and **P. M. GROVES.** *Univ. of Colorado, Boulder, CO.*

9:30 Regional accumulation and metabolism of intraventricular ^{3}H-3-methoxytyramine in the cat brain. **J. H. GORDON** and **M. K. SHELLENBERGER.** *Kansas Univ. Med. Col., Kansas City, KS.*

9:45 Prevention and reversal of 4-chloroamphetamine action by inhibiting its uptake into serotoninergic neurons: evidence for reversible and irreversible phases of brain serotonin depletion. **R. W. FULLER, K. W. PERRY** and **B. B. MOLLOY.** *Lilly Res. Labs., Indianapolis, IN.*

10:00 Excitatory effects of certain indoleamines in the hippocampus of the cat. **J. F. DeFRANCE** and **H. YOSHIHARA.** *Wayne State Univ., Detroit, MI.*

10:15 A comparison of various doses of lithium in the treatment of acute mania. **P. E. STOKES** and **J. H. KOCSIS.** *New York Hosp.-Cornell Univ. Med. Ctr., New York, NY.*

10:30 Effects of lithium carbonate pretreatment of ethanol induced depression and hypothermia in mice; comparative study with DH-524 and other drugs. **A. H. ABDALLAH** and **D. M. ROBY.** *Dow Chemical Co., Midland, MI.*

10:45 Reinforcement contingencies affecting amphetamine, pentobarbital discriminative control and the development of response-specific behavioral tolerance. **D. W. RICHARDS III, C. MEYER** and **B. CONNELLY.** *Texas Res. Inst. of Ment. Sci., Houston, TX.*

11:00 Acute effects of tetraethyl lead on avoidance and weight in weanling rats. **M. I. GAGE** and **D. A. FOX.** *EPA and Univ. of Cincinnati, Cincinnati, OH.*

11:15 A new, chronic experimental procedure for electrographic study of neuropharmacological mechanisms. **W. R. KLEMM.** *Texas A&M Univ., College Station, TX.*

VOLUNTEER PAPERS

15. Sleep

8:30 AM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **C. D. KING**

8:30 Research and clinical applications of the somnogram. **R. G. BICKFORD, K. HANSON, T. JONES** and **K. BURCHIEL.** *UCSD Sch. of Med., La Jolla, CA.*

8:45 Discharge patterns of pontine units during desynchronized sleep. **R. W. McCARLEY** and **J. A. HOBSON.** *Harvard Med. Sch., Boston, MA.*

9:00 Basal forebrain unit activity during sleep and waking in behaving cats. **R. Y. WANG** and **J. SIEGEL.** *Univ. of Delaware, Newark, DE.*

9:15 Cholinergic perfusion of the cat's locus ceruleus: effect on respiration and sleep. **J. M. MASSERANO** and **C. D. KING.** *Univ. of Tennessee Med. Units, Memphis, TN.*

9:30 Effects of marijuana on cat sleep-wakefulness stages following pretreatment with *p*-chloro-phenylalanine and 5-hydroxytryptophan. **P. M. ADAMS** and **E. S. BARRATT.** *Univ. of Texas Med. Br., Galveston, TX.*

9:45 The effects of nicotinamide and L-methionine on mouse sleep-wake cycles. **J. M. BEATON, R. J. BRADLEY, G. V. PEGRAM** and **J. R. SMYTHIES.** *Univ. of Alabama, Birmingham, AL.*

10:00 Insomnia induced by *meta*-chlorotyrosine in cats. **C. D. KING.** *Univ. of Tennessee Med. Units, Memphis, TN.*

10:15 Biochemical analysis of perfusates taken from the MRF of conscious cats during sleep and wakefulness. **C. W. SPANIS, R. R. DRUCKER-COLIN, C. W. COTMAN** and **J. L. McGAUGH.** *Univ. of California, Irvine, CA.*

10:30 Nocturnal myoclonus and 5HTP. **C. GUILLEMINAULT, J. MONTPLAISIR** and **W. C. DEMENT.** *Stanford Med. Ctr., Stanford, CA.*

10:45 Facial units and lid closure in sleep. **J. OREM, J. Y. MONTPLAISIR** and **W. C. DEMENT.** *Stanford Med. Ctr., Stanford, CA.*

11:00 Effect of REM sleep deprivation (on a treadmill) following socialization, on adult reactivity in CBA mice. **F. M. C. WATSON, J. P. HENRY** and **G. C. HALTMEYER.** *USC Sch. of Med., Los Angeles, CA.*

11:15 Age-related changes in brain functioning: relationship of sleep variables to longitudinal changes in intellectual function. **P. N. PRINZ, G. R. MARSH** and **L. W. THOMPSON.** *Duke Univ., Durham, NC.*

11:30 Secretion of a possible reticular neurotransmitter during electrocortical arousal. **M. VELASCO, F. VELASCO, X. LOZOYA** and **F. ESTRADA-VILLANUEVA.** *Natl. Med. Ctr., Mexico, D.F.*

MONDAY AFTERNOON

SYMPOSIUM

16. Monoamine Neurotoxins: Are They Specific?

1:00 PM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **F. E. BLOOM**

The chemical nature of monoaminergic neurotoxins and metabolites. **G. JONSSON.** *Karolinska Inst., Stockholm, Sweden.*

Selective destruction of catecholaminergic neurons; 6-OHDA versus electrolytic lesions. **F. JAVOY.** *Col. de France, Paris, France.*

Structural and behavioral correlates of the selective degeneration induced by 6-OHDA on central catechol neurons. **T. HOKFELT** and **U. UNGERSTEDT.** *Karolinska Inst., Stockholm, Sweden.*

Failure of 6-OHDA to produce selective neuronal degeneration after punctate injections into the brain. **L. BUTCHER.** *UCLA, Los Angeles, CA.*

Discussants:

C. SACHS, *Sweden*
L. POIRIER, *Canada*
S. HICKS, *USA*

SYMPOSIUM

17. Recent Advances in Experimental Epilepsy

1:00 PM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: **W. A. SPENCER**

Introductory remarks. **W. A. SPENCER.** *Columbia Univ., New York, NY.*

Invertebrate models of epilepsy. **G. AYALA.** *Univ. of Minnesota, Minneapolis, MN.*

Control of focal epileptogenic discharge. **D. A. PRINCE.** *Stanford Univ. Med. Ctr., Stanford, CA.*

The contribution of glia to slow potential shifts seen during seizure activity. **B. R. RANSOM.** *NIH, Bethesda, MD.*

Monitoring of the rate of oxygen utilization during seizures. **D. V. LEWIS.** *NIH, Bethesda, MD.*

Discussion.

VOLUNTEER PAPERS

18. Memory and Learning I

1:00 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **J. L. McGAUGH**

1:00 Discrete manipulations of hippocampal subfields of the mouse: effects on memory. **S. F. ZORNETZER** and **C. A. BOAST.** *Univ. of Florida Col. of Med., Gainesville, FL.*

1:15 Modulating influences of hormones on time-dependent memory-storage processes. **R. B. VAN BUSKIRK** and **P. E. GOLD.** *Univ. of California, Irvine, CA.*

1:30 Retrograde facilitation of inhibitory avoidance learning with post-trial intraventricular injections of norepinephrine and dopamine. **J. W. HAYCOCK, R. B. VAN BUSKIRK, J. R. RYAN** and **J. L. McGAUGH.** *Univ. of California, Irvine, CA.*

1:45 Cycloheximide-induced amnesia: possible involvement of brain catecholamines. **A. S. BLOOM, E. E. QUINTON** and **L. A. CARR.** *Univ. of Louisville, Louisville, KY.*

2:00 Proline injection may impair discrimination ability of the chick. **A. CHERKIN.** *VA Hosp., Sepulveda, and UCLA Sch. of Med., Los Angeles, CA.*

2:15 Inhibition of protein synthesis impairs long-term habituation. **L. R. SQUIRE** and **C. BECKER.** *VA Hosp., San Diego, and UCSD Sch. of Med., La Jolla, CA.*

2:30 Effectiveness of biochemical transfer as a function of dosage and injection-testing interval. **P. V. LAIRD** and **W. G. BRAUD.** *Univ. of Houston, Houston, TX.*

2:45 Stimulus specific effect of scotophobin on mouse plasma corticoids. **D. H. MALIN, G. J. RADCLIFFE, JR., D. M. OSTERMAN** and **B. S. KEENAN.** *Baylor Col. of Med., Houston, TX.*

3:00 Dissociation of shock-motivated compartment avoidance and drug-induced flavor aversions following selective olfactory system lesions. **R. L. ELKINS** and **S. H. HOBBS.** *VA Hosp., Augusta, GA.*

VOLUNTEER PAPERS

19. Motor Systems II

1:00 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **J. B. PRESTON**

1:00 Short-latency responses to load changes in human masseter muscles. **J. P. LUND** and **Y. LAMARRE.** *Univ. of Montreal, Montreal, Canada.*

1:15 The function of muscle spindles in normal jaw movements of unrestrained cats. **A. TAYLOR, F. W. J. CODY** and **L. HARRISON.** *Univ. of Arizona Col. of Med., Tucson, AZ.*

1:30 Response patterns of precentral neurons to ramp stretch of some hindlimb muscles in the baboon. **J. HORE, J. B. PRESTON, R. G. DURKOVIC** and **P. D. CHENEY.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

1:45 Effects of sinusoidal stretching of forearm muscles on precentral neurones in monkeys. **M. WIESENDANGER, G. LUCIER** and **D. RUEGG.** *Univ. of Western Ontario, London, Ontario, Canada.*

2:00 Nerve fiber activity during normal movements. **J-A. HOFFER, W. B. MARKS** and **W. Z. RYMER.** *Johns Hopkins Univ., Baltimore, and NIH, Bethesda, MD.*

2:15 The discharge of spindle afferents from jaw closing muscles during chewing in alert monkeys. **E. S. LUSCHEI** and **G. M. GOODWIN.** *Univ. of Washington Med. Ctr., Seattle, WA.*

2:30 Effects of slow muscle stretch on group I EPSP's in cat extensor motoneurons. **W. Z. RYMER** and **J. V. WALSH.** *NIH, Bethesda, MD.*

2:45 Responses of tendon organs to ramp changes of active in-series motor unit force. **E. K. STAUFFER** and **J. A. STEPHENS.** *Univ. of Arizona Col. of Med., Tucson, AZ.*

MONDAY AFTERNOON

VOLUNTEER PAPERS

20. Plasticity I

1:00 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **C. W. COTMAN**

1:00 Reorganization of the retino-tectal projection in goldfish. **J. T. SCHMIDT, C. M. CICERONE** and **S. S. EASTER, JR.** *Univ. of Michigan, Ann Arbor, MI.*

1:15 Pattern of thalamic projections to the neocortex of normal and reeler mutant mice. **D. O. FROST** and **V. S. CAVINESS.** *MIT, Cambridge, and E. K. Shriver Inst., Harvard Med. Sch., Waltham, MA.*

1:30 A normally laminated afferent projection to an abnormally laminated cortex: olfactory connections in the reeler mouse. **M. DEVOR, V. S. CAVINESS, JR.** and **P. DERER.** *MIT, Cambridge, and E. K. Shriver Inst., Harvard Med. Sch., Waltham, MA.*

1:45 Selectivity in the pattern of new synapse formation with denervated dentate granule cells. **O. STEWARD, C. W. COTMAN** and **G. LYNCH.** *Univ. of California, Irvine, CA.*

2:00 Electron microscopic analysis of post-lesion synaptic growth. **D. A. MATTEWS, J. R. McWILLIAMS, C. W. COTMAN** and **G. S. LYNCH.** *Univ. of California, Irvine, CA.*

2:15 In vitro neurophysiological studies of the deafferented hippocampus. **S. DEADWYLER, G. LYNCH, E. STANFORD, G. ROSE** and **C. COTMAN.** *Univ. of California, Irvine, CA.*

2:30 A neurophysiological time course of axon sprouting. **J. R. WEST, S. A. DEADWYLER, C. W. COTMAN** and **G. S. LYNCH.** *Univ. of California, Irvine, CA.*

VOLUNTEER PAPERS

21. Narcotics and Drugs of Abuse I

1:00 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **H. AKIL**

1:00 Analgesia produced by electrical stimulation of midline structures of the rostral mesencephalon and caudal diencephalon in the rat. **D. L. RHODES** and **J. C. LIEBESKIND.** *UCLA, Los Angeles, CA.*

1:15 Electrophysiological correlates of stimulation-produced analgesia, morphine analgesia, and their blockade by naloxone. **H. AKIL** and **D. E. RICHARDSON.** *Tulane Univ. Sch. of Med., New Orleans, LA.*

1:30 Regional studies of the consequences of acute and chronic intercerebral morphine injection. **K. A. BONNET** and **J. ROGERS.** *Stanford Res. Inst., Menlo Park, CA.*

1:45 Effects of morphine and naloxone on catecholamine and calcium uptake in rat striatal slices. **S. L. MILLER** and **J. HARRIS.** *Barrow Neurolog. Inst., Phoenix, AZ.*

2:00 Blockade of ovulation by methadone in the rat. **J. H. JOHNSON, M. W. ETKIN** and **J. A. ROSECRANS.** *Virginia Commonwealth Univ., Med. Col. of Virginia, Richmond, VA.*

2:15 Development of tolerance to morphine following intracerebral injection in the periaqueductal gray of the rat. **Y. F. JACQUET** and **A. LAJTHA.** *New York State Res. Inst. for Neurochem. and Drug Addiction, Ward's Island, NY.*

2:30 Morphine neuron membrane effects in the cat pericruciate cortex. **C. C. HUANG** and **A. S. MARRAZZI.** *Univ. of Missouri Inst. of Psychiat., St. Louis, MO.*

2:45 Morphine as a reinforcer: influence of central norepinephrine depletion and cholinergic blockade. **W. M. DAVIS** and **S. G. SMITH.** *Univ. of Mississippi Sch. of Pharm., University, MS.*

3:00 Effects of morphine on pain evoked potentials in the unanesthetized rhesus monkey. **C. T. BENNETT, A. PERT** and **T. L. YAKSH.** *Edgewood Arsenal Biomed. Lab., Edgewood Arsenal, MD.*

3:15 Opiate induced facilitation of self-stimulation behavior in the rat. **A. PERT** and **R. C. HULSEBUS.** *Edgewood Arsenal Biomed. Lab., Edgewood Arsenal, MD.*

3:30 Catecholamine metabolism in methadone withdrawal. **H. DEKIRMENJIAN, J. M. DAVIS, D. L. GARVER, F. D. JONES, G. N. PANDEY, I. INWANG** and **R. WATKINS.** *Illinois State Psychiat. Inst. and Univ. of Chicago, Chicago, IL.*

3:45 Morphine selectively blocks the rapid IPSPs in cholinergic synapses of *Aplysia.* **R. WAZIRI.** *Univ. of Iowa Col. of Med., Iowa City, IA.*

4:00 Morphine as a discriminative stimulus to behavior: strain variability. **M. W. ETKIN, J. H. JOHNSON** and **J. A. ROSECRANS.** *Virginia Commonwealth Univ., Richmond, VA.*

4:15 Genetic factors modulating the actions of morphine in mice. **E. EIDELBERG** and **R. ERSPAMER.** *Barrow Neurolog. Inst., Phoenix, AZ.*

4:30 Physicochemical, quantum chemical and other theoretical studies for the understanding of the mechanism of action of CNS agents: psychotropic drugs, narcotics and narcotic antagonists and anesthetics. **J. J. KAUFMAN** and **W. S. KOSKI.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

VOLUNTEER PAPERS

22. Somatosensory: Thalamus and Cortex

1:00 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: L. KRUGER

1:00 The pattern of ventrobasal neuron projections to rat somatosensory cortex studied by retrograde axonal transport of horseradish peroxidase. S. SAPORTA and L. KRUGER. *UCLA, Los Angeles, CA.*

1:15 Origins of periodic firing of somatosensory thalamic neurons. H. J. WALLER and L. T. ANDREWS. *Med. Col. of Ohio, Toledo, OH.*

1:30 Vestibular input to somatosensory thalamic nuclei in the squirrel monkey. D. W. F. SCHWARZ, C. LIEDGREN, J. H. YOUNG, A. RUBIN, R. D. TOMLINSON and A. C. MILNE. *Univ. of Toronto, Toronto, Canada.*

1:45 Bradykinin elicited responses of ventrobasal thalamic neurons. G. KRAUTHAMER and L. GOTTESMAN. *Rutgers Med. Sch., Piscataway, NJ.*

2:00 The somatosensory cortex: what is a stellate cell? E. G. JONES. *Washington Univ. Sch. of Med., St. Louis, MO.*

2:15 Response of somatosensory cortical neurons to moving tactile stimuli. B. L. WHITSEL, P. R. LOE and R. C. SCHREINER. *Univ. of North Carolina, Chapel Hill, NC.*

2:30 Population response properties of neurons in hindlimb sensorimotor cortex of the cat. G. S. DOETSCH. *Med. Col. of Georgia, Augusta, GA.*

2:45 Response of primary somatic sensory neocortical neurons to paired mechanical pulses applied to the raccoon's forepaw. L. M. PUBOLS, R. F. LEROY and B. H. PUBOLS, JR. *Hershey Med. Ctr., Pennsylvania State Univ., Hershey, PA.*

3:00 Peripheral receptive fields of barrels in SmI of the rat. C. WELKER. *Central Wisconsin Colony, Madison, WI.*

VOLUNTEER PAPERS

23. Synaptic Transmission

1:00 PM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **F. F. WEIGHT**

1:00 Serotonin effects on the depression, frequency facilitation and posttetanic potentiation at a cholinergic synapse in *Aplysia californica*. **J. P. TREMBLAY, P. B. J. WOODSON, W. T. SCHLAPFER** and **S. H. BARONDES**. *UCSD and VA Hosp., San Diego, CA.*

1:15 Actions of catecholamines and related compounds on plastic cholinergic synaptic transmission in the abdominal ganglia of *Aplysia californica*. **P. B. J. WOODSON, J. P. TREMBLAY, W. T. SCHLAPFER** and **S. H. BARONDES**. *UCSD and VA Hosp., San Diego, CA.*

1:30 Voltage-clamp analysis of the conductance change underlying a cholinergic IPSP in *Aplysia*. **D. GARDNER** and **C. F. STEVENS**. *Cornell Univ. Med. Col., New York, NY, and Univ. of Washington, Seattle, WA.*

1:45 Manganese can block lateral and self-inhibition in the *Limulus* eye. **R. L. PURPLE** and **J. P. EAGLES**. *Univ. of Minnesota Med. Sch., Minneapolis, MN.*

2:00 Depression of transmitter release and accumulation of extracellular potassium at the squid giant synapse. **S. D. ERULKAR** and **F. F. WEIGHT**. *Univ. of Pennsylvania, Philadelphia, PA, and NIMH, Washington, DC.*

2:15 Increased levels of cyclic GMP and cyclic AMP associated with synaptic transmission in frog sympathetic ganglion. **F. WEIGHT, G. PETZOLD** and **P. GREENGARD**. *NIMH, Washington, DC, and Yale Univ., New Haven, CT.*

2:30 The mechanism of generation of passive hyperpolarizing potentials in goldfish medulla. **D. S. FABER** and **H. KORN**. *Univ. of Cincinnati, Cincinnati, OH, and CHU, Pitie-Salpetriere, Paris, France.*

2:45 Myelofugal unit activity in lumbar primary afferent neurons. **G. K. MATHESON** and **R. D. WURSTER**. *Stritch Sch. of Med., Loyola Univ. of Chicago, Maywood, IL.*

VOLUNTEER PAPERS

24. Epilepsy I

3:30 PM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: S. GOLDRING

3:30 Effects of spinal, mesencephalic and diencephalic lesions on metrazol induced multiple unit discharges. **F. VELASCO, M. VELASCO** and **J. P. MACHADO.** *Natl. Med. Ctr., Mexico, D.F.*

3:45 Action of diphenylhydantoin on cortical postsynaptic inhibition. **W. RAABE** and **G. F. AYALA.** *St. Paul-Ramsey Hosp. and Univ. of Minnesota, St. Paul, MN.*

4:00 Pharmacologic prophylaxis of posttraumatic epilepsy in monkey model. **J. S. LOCKARD, W. C. CONGDON, L. L. DuCHARME** and **B. J. HUNTSMAN.** *Univ. of Washington Sch. of Med., Seattle, WA.*

4:15 Effects of pentylenetetrazol and picrotoxin on hippocampal slices in vitro. **N. HORI** and **N. KATSUDA.** *Kyushu Univ., Japan.*

4:30 An electrographic analysis of convulsions during alcohol withdrawal in the rat. **B. E. HUNTER, D. W. WALKER, J. N. RILEY, C. A. BOAST, S. F. ZORNETZER** and **G. FREUND.** *Univ. of Florida Col. of Med. and VA Hosp., Gainesville, FL.*

4:45 Activation of "kindled" seizures during alcohol withdrawal in the rat. **C. A. BOAST, B. E. HUNTER, D. W. WALKER, J. N. RILEY** and **S. F. ZORNETZER.** *Univ. of Florida Col. of Med. and VA Hosp., Gainesville, FL.*

VOLUNTEER PAPERS

25. Memory and Learning II

3:30 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **A. CHERKIN**

3:30 Multiple retention deficits in appetitive learning. **R. A. WANSLEY** and **F. A. HOLLOWAY.** *Univ. of Oklahoma Hlth. Sci. Ctr., Oklahoma City, OK.*

3:45 Linguistic deficits in right hemisphere lesions. **H. K. ULATOWSKA** and **T. BAKER.** *Univ. of Texas Hlth. Sci. Ctr. and Univ. of Texas, Dallas, TX.*

4:00 Evoked potential correlates of human short-term memory. **R. W. THATCHER.** *New York Med. Col., New York, NY.*

4:15 Recurrent recognition measures detect an early labile phase in human memory. **W. H. RIEGE.** *VA Hosp., Sepulveda, and UCLA Sch. of Med., Los Angeles, CA.*

4:30 Storage and retrieval stages in memory and learning by children and adults. **H. BUSCHKE.** *Albert Einstein Col. of Med., Bronx, NY.*

4:45 Diaschisis as bilateral cerebral dysfunction following lateralized cerebral lesions. **A. SMITH.** *Univ. of Michigan Med. Sch., Ann Arbor, MI.*

VOLUNTEER PAPERS

26. Cerebellum I

3:30 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **D. A. ROBINSON**

3:30 Activity in cat cerebellar Purkinje cells evoked by passive forepaw movements. **W. J. ROBERTS** and **D. S. RUSHMER.** *Good Samaritan Hosp. and Med. Ctr., Portland, OR.*

3:45 A functional interpretation of the climbing fiber responses evoked by forepaw movements in the cat. **D. S. RUSHMER** and **W. J. ROBERTS.** *Good Samaritan Hosp. and Med. Ctr., Portland, OR.*

4:00 Regional differences in the behavioral and anatomical effects of deep cerebellar lesions in the rat. **R. H. BAISDEN, M. L. WOODRUFF, B. SCHNEIDERMAN** and **A. O. ALDERMAN.** *SUNY Upstate Med. Ctr., Syracuse, NY, and Univ. of Florida, Gainesville, FL.*

4:15 Dentate follower neurons. **L. T. ROBERTSON** and **R. J. GRIMM.** *Good Samaritan Hosp. and Med. Ctr., Portland, OR.*

4:30 Cerebellar cortical and nuclear activity during paroxysmal cerebral discharges. **J. MITRA** and **R. S. SNIDER.** *Univ. of Rochester Med. Sch., Rochester, NY.*

4:45 Cerebellar adaptation of the vestibulo-ocular reflex to modified visual input. **D. A. ROBINSON.** *Johns Hopkins Univ., Baltimore, MD.*

VOLUNTEER PAPERS

27. Plasticity II

3:30 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **L. E. WESTRUM**

3:30 A lack of dorsal root sprouting found after spinal hemisection in neonatal or weanling rats. **D. J. STELZNER** and **E. WEBER.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

3:45 Effect of olfactory bulb removal in newborn rats on resultant axon patterns in olfactory cortex. **L. E. WESTRUM.** *Univ. of Washington, Seattle, WA.*

4:00 Effect of intracerebral NGF injections in newborn rodents. **R. LEVI-MONTALCINI, M. G. M. CHEN** and **J. S. CHEN.** *Washington Univ., St. Louis, MO, and CNR, Rome, Italy.*

4:15 Spinal cord transection: results of implanting cultured embryonic spinal cord at the transection site. **M. I. OLSON** and **R. P. BUNGE.** *Washington Univ. Sch. of Med., St. Louis, MO.*

4:30 Plastic changes in the visual cortex induced by light and monocular deprivation. **E. FIFKOVA.** *California Inst. of Technol., Pasadena, CA.*

4:45 Regeneration of axonal fibers after neonatal corpus callosum section in rats. **J. A. SECHZER.** *New York Hosp.—Cornell Med. Ctr., White Plains, NY.*

MONDAY AFTERNOON

VOLUNTEER PAPERS

28. Membrane Structure

3:30 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **J. G. WOOD**

3:30 Carbohydrate composition and binding properties of synaptic junctional complex and postsynaptic density fractions. **L. CHURCHILL** and **C. W. COTMAN.** *Univ. of California, Irvine, CA.*

3:45 The visualization of concanavalin A binding sites in Purkinje cells of rat cerebellum. **J. G. WOOD** and **B. J. McLAUGHLIN.** *City of Hope Med. Ctr., Duarte, CA, and Univ. of Tennessee Med. Ctr., Memphis, TN.*

4:00 Structure of cerebellar cortex prepared for freeze-fracturing by rapid freezing. **T. S. REESE** and **D. M. D. LANDIS.** *NIH, Bethesda, MD.*

4:15 Scanning and transmission electron microscopy of isolated neuronal and glial perikarya. **B. D. TRAPP, B. DWYER** and **J. BERNSOHN.** *VA Hosp., Hines, IL, and Loyola Univ. Sch. of Med., Maywood, IL.*

4:30 The distribution, activity, and function of cilia in the frog brain. **D. J. NELSON, E. M. WRIGHT** and **J. S. FRANK.** *UCLA Sch. of Med., Los Angeles, CA.*

4:45 Growth cone vesicles: analogy to the amoeba contractile vacuole. **J. A. McKANNA.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

VOLUNTEER PAPERS

29. Synaptosomes

3:30 PM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **B. HABER**

3:30 Studies on the demonstration and purification of a synaptic membrane glutamate binding macromolecule. **E. K. MICHAELIS.** *Univ. of Kansas, Lawrence, KS.*

3:45 Interrelations of stimulus secretion coupling and transport of γ-aminobutyric acid in isolated synaptosomes. **D. A. REDBURN** and **C. W. COTMAN.** *Univ. of California, Irvine, CA.*

4:00 Sedimentation characteristics of catecholamine synaptosomes in sucrose density gradients. **G. JONSSON** and **C. PYCOCK.** *Karolinska Inst., Stockholm, Sweden.*

4:15 Inhibition of synaptosomal biogenic amine uptake by sympathomimetic amines. **R. ASHKENAZI** and **B. HABER.** *Univ. of Texas Med. Br., Galveston, TX.*

4:30 Chlorpromazine selectively inhibits monoamine uptake by squid synaptosomes. **H. B. POLLARD** and **J. L. BARKER.** *NIH, Bethesda, MD.*

4:45 Effect of fighting and diphenylhydantoin on uptake of ^{3}H-*l*-norepinephrine in retired male breeding mice. **M. G. HADFIELD, M. L. POWELL** and **N. E. WEBER.** *Med. Col. of Virginia, Richmond, VA.*

SYMPOSIUM

30. Motor Programs and Feedback in Control of Movement

8:30 AM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **E. V. EVARTS**

Introductory remarks. **E. V. EVARTS.** *NIMH, Bethesda, MD.*

Roles for feedback in arthropod locomotion and escape. **D. KENNEDY.** *Stanford Univ., Stanford, CA.*

Servoassistance of centrally programmed head movements in monkeys. **E. BIZZI.** *MIT, Cambridge, MA.*

Differences and similarities of stretch reflexes in humans and decerebrate animals. **J. HOUK.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

Discussion.

SYMPOSIUM

31. Sensory Mechanisms in Vertebrate Homing and Migration: Show Me The Way To Go Home

8:30 AM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: **D. R. GRIFFIN**

Introductory remarks. **D. R. GRIFFIN.** *Rockefeller Univ., New York, NY.*

Olfactory imprinting in migrating salmon. **A. D. HASLER.** *Univ. of Wisconsin, Madison, WI.*

Visual mechanisms in pigeon homing. **C. WALCOTT.** *SUNY, Stony Brook, NY.*

Nonvisual mechanisms in pigeon homing. **W. KEETON.** *Cornell Univ., Ithaca, NY.*

The orientation of migrating birds. **D. R. GRIFFIN.** *Rockefeller Univ., New York, NY.*

Discussion.

VOLUNTEER PAPERS

32. Vision: Central Organization II

8:30 AM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **M. MISHKIN**

8:30 Organization of primary optic projections in heterochromic rats. **D. J. CREEL** and **R. A. GIOLLI.** *VA Hosp., Phoenix, AZ, and Univ. of California Sch. of Med., Irvine, CA.*

8:45 Presynaptic inhibition in the rat optic tectum. **J. A. FREEMAN** and **T. J. CUNNINGHAM.** *Vanderbilt Univ., Nashville, TN.*

9:00 Studies of the population of unitary sensory responses in the posterior thalamic association nuclei of the cats. **C. C. HUANG.** *Univ. of Missouri Inst. of Psychiat., St. Louis, MO.*

9:15 Visually evoked responses in pulvinar, lateral geniculate and visual cortex to patterned and unpatterned stimuli in squirrel monkey. **K. M. PERRYMAN** and **D. B. LINDSLEY.** *UCLA, Los Angeles, CA.*

9:30 Permanent perceptual and neurophysiological effects of visual deprivation in the cat. **L. GANZ** and **M. E. HAFFNER.** *Stanford Univ., Stanford, CA.*

9:45 Pattern discrimination thresholds after visual cortical lesions in monkeys. **L. BLAKE, C. JARVIS** and **M. MISHKIN.** *NIMH, Bethesda, MD.*

10:00 Physiological and anatomical correlates of visual and auditory modalities in the inferior convexity of orbital cortex in rhesus monkey. **J. H. FALLON** and **L. A. BENEVENTO.** *Univ. of Illinois Col. of Med., Chicago, IL.*

10:15 Formation of myelin in the optic nerve and tract of normal and dark reared cats. **C. L. MOORE, R. E. KALIL** and **W. A. RICHARDS.** *MIT, Cambridge, MA, and Univ. of Wisconsin, Madison, WI.*

10:30 Luminous flux, wavelength and stripe orientation discrimination in ground squirrels (*Citellus tridecemlineatus*) after posterior neocortical lesions. **E. KICLITER, M. S. LOOP** and **J. A. JANE.** *Univ. of Virginia Sch. of Med., Charlottesville, VA.*

10:45 Modification of striate cortex by brief periods of monocular visual experience. **C. K. PECK** and **C. BLAKEMORE.** *Pomona Col., Claremont, CA, and Physiological Lab., Cambridge, England.*

11:00 Evidence for efferent activity in the fish optic nerve and its effect on retinal ganglion cells. **N. P. ROSENTHAL** and **D. E. SANDEMAN.** *UCLA Sch. of Med., Los Angeles, CA, and Australian Natl. Univ., Canberra, Australia.*

11:15 Functional role of efferents to the avian retina. **A. L. PEARLMAN** and **C. P. HUGHES.** *Washington Univ. Sch. of Med., St. Louis, MO.*

TUESDAY MORNING

VOLUNTEER PAPERS

33. Neuroendocrinology I

8:30 AM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **B. R. KOMISARUK**

8:30 Localization of LH-RH in the hypothalamus of rats using radioimmunoassay. **J. C. KING, A. ARIMURA** and **T. H. WILLIAMS.** *Univ. of Iowa, Iowa City, IA, and VA Hosp., New Orleans, LA.*

8:45 Ultrastructural localization of luteinizing hormone-releasing hormone in the rat hypothalamus. **P. C. GOLDSMITH** and **W. F. GANONG.** *UCSF Sch. of Med., San Francisco, CA.*

9:00 Antidromic and orthodromic activation of basomedial and periventricular hypothalamic neurons. **L. P. RENAUD** and **J. B. MARTIN.** *McGill Univ., Montreal Gen. Hosp., Montreal, Quebec, Canada.*

9:15 A comparison of microfluorometric and biochemical estimates of catecholamine content in rat median eminence. **N. G. BACOPOULOS, R. K. BHATNAGAR, W. J. SCHNUTE** and **L. S. VAN ORDEN III.** *Univ. of Iowa, Iowa City, IA.*

9:30 Membrane changes induced by secretagogues in adenohypophysial cells grown in tissue culture. **D. H. YORK.** *Queen's Univ., Kingston, Ontario, Canada.*

9:45 Sensory field of the pudendal nerve in female rats: changes over the estrous cycle. **N. T. ADLER, B. R. KOMISARUK** and **P. DAVIS.** *Univ. of Pennsylvania, Philadelphia, PA, and Rutgers Univ., Newark and New Brunswick, NJ.*

10:00 Effects of medial hypothalamic lesions on the lordosis response in female hamsters. **L-M. KOW, C. W. MALSBURY** and **D. W. PFAFF.** *Rockefeller Univ., New York, NY.*

10:15 Effect of gonadal steroids on activities of enzymes in male and female rat brains. **V. N. LUINE, R. I. KHYLCHEVSKAYA** and **B. S. McEWEN.** *Rockefeller Univ., New York, NY.*

10:30 Intracerebral progesterone: effects on sexual behavior in female mice. **N. R. HALL** and **W. G. LUTTGE.** *Univ. of Florida Col. of Med., Gainesville, FL.*

10:45 Changes in multi-unit spike activity in the preoptic area induced by midbrain stimulation. **H. F. CARRER** and **C. H. SAWYER.** *UCLA Sch. of Med., Los Angeles, CA.*

11:00 Changes in the electrical activity of the medial preoptic area in response to intraventricular norepinephrine. **R. J. KRIEG** and **C. H. SAWYER.** *UCLA Sch. of Med., Los Angeles, CA.*

11:15 Role of brain catecholamines in release of gonadotropin before proestrus in the cycling rat. **E. TERASAWA, W. E. BRIDSON, J. W. DAVENPORT** and **R. W. GOY.** *Wisconsin Primate Res. Ctr., Univ. of Wisconsin, Madison, WI.*

VOLUNTEER PAPERS

34. Neurotransmitters: Synthetic Enzymes

8:30 AM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **E. McGEER**

8:30 Immunohistochemical localization of tyrosine hydroxylase by light and electron microscopy. **V. M. PICKEL, T. H. JOH** and **D. J. REIS.** *Cornell Univ. Med. Col., New York, NY.*

8:45 Immunocytochemical localization of dopamine-β-hydroxylase in peripheral adrenergic neurons at the ultrastructural level. **K. E. RYBARCZYK, J. A. REDICK** and **L. S. VAN ORDEN III.** *Univ. of Iowa, Iowa City, IA.*

9:00 A systematic immunofluorescence study of the central dopamine-β-hydroxylase neurons and the distribution of their processes in the rat. **L. W. SWANSON** and **B. K. HARTMAN.** *Washington Univ., St. Louis, MO.*

9:15 The nature of the slow decline of dopamine-β-hydroxylase activity during anterograde degeneration of central noradrenergic neurons. **D. J. REIS, R. A. ROSS, T. H. JOH** and **P. M. FIELD.** *Cornell Univ. Med. Col., New York, NY.*

9:30 Fine structural localization of glutamate decarboxylase in synaptic terminals of rat spinal cord. **B. J. McLAUGHLIN, R. BARBER, K. SAITO** and **E. ROBERTS.** *City of Hope Med. Ctr., Duarte, CA.*

9:45 Light microscopic localization of glutamate decarboxylase in boutons of rat spinal cord before and after dorsal rhizotomy. **R. BARBER, B. J. McLAUGHLIN, K. SAITO** and **E. ROBERTS.** *City of Hope Med. Ctr., Duarte, CA.*

10:00 Stimulation of striatal tyrosine hydroxylase activity by derivatives of adenosine 3',5'-cyclic phosphate. **J. E. HARRIS, S. WHEELER** and **R. J. BALDESSARINI.** *Emory Univ., Atlanta, GA, and Harvard Med. Sch., Massachusetts Gen. Hosp., Boston, MA.*

10:15 Ontogeny of the reserpine-elicited induction of tyrosine hydroxylase in rat superior cervical ganglion, adrenal and locus ceruleus. **I. B. BLACK** and **D. J. REIS.** *Cornell Univ. Med. Col., New York, NY.*

10:30 Effects of stress on catecholamines and tyrosine hydroxylase activity in specific hypothalamic nuclei. **R. M. KOBAYASHI, M. PALKOVITS, J. S. KIZER, D. M. JACOBOWITZ** and **I. J. KOPIN.** *NIMH, Bethesda, MD.*

10:45 The rate of synthesis of tyrosine hydroxylase after cold exposure in rat adrenal medulla. **D. CHUANG** and **E. COSTA.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

11:00 Circadian rhythm for plasma choline, brain choline, acetylcholine, choline kinase and choline acetyltransferase. **T. J. CHIPPENDALE, F-L. WANG** and **D. R. HAUBRICH.** *Princeton Univ., Princeton, NJ, and Squibb Inst. for Med. Res., Princeton, NJ.*

11:15 The distribution in human postmortem brain tissue of enzymes concerned with neurotransmitter metabolism. **E. G. McGEER, P. L. McGEER** and **H. C. FIBIGER.** *Univ. of British Columbia, Vancouver, Canada.*

VOLUNTEER PAPERS

35. Limbic System II: Amygdala, Septum and Cortex

8:30 AM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **W. I. WELKER**

8:30 Facilitation of two-bar ratio performance by external cues in septal rats but not in normal rats. **J. C. MITCHELL** and **K. E. KRATZ.** *Kansas State Univ., Manhattan, KS.*

8:45 Fornix lesions block the increased light aversion usually observed after septal lesions. **D. S. OLTON, P. G. JENKO** and **F. H. GAGE III.** *Johns Hopkins Univ., Baltimore, MD.*

9:00 Septal lesions and behavior: effects of presurgical rearing and strain of mouse. **P. J. DONOVICK, R. G. BURRIGHT, J. L. FULLER** and **P. R. BRANSON.** *SUNY, Binghamton, NY.*

9:15 Amygdaloid lesions, behavioral arousal and habituation. **I. LOURIE** and **M. M. KRIEGER.** *Norristown State Hosp., Norristown, PA.*

9:30 Effects of posttrial amygdala stimulation on retention of avoidance training. **P. E. GOLD, M. HANDWERKER, R. ROSE, C. W. SPANIS** and **J. L. McGAUGH.** *Univ. of California, Irvine, CA.*

9:45 Passive avoidance learning deficits produced by amygdala lesions: relationship with pituitary-adrenal system. **B. S. KAPP, N. J. RUSSO II** and **R. E. MUSTY.** *Univ. of Vermont, Burlington, VT.*

10:00 Connections of the posterior cingulate cortex in the cat. **K. KALIL.** *Univ. of Wisconsin, Madison, WI.*

10:15 Effects of localized cholinomimetics in the amygdala on retention of one-trial passive avoidance. **J. W. TODD** and **R. P. KESNER.** *Univ. of Utah, Salt Lake City, UT.*

10:30 Comparing the effects of amygdala and temporal neocortex lesions on emotionality and visual performance of the monkey. **J. A. HOREL, E. G. KEATING** and **L. J. MISANTONE.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

10:45 Effects of electrical stimulation of the lateral aspect of the prefrontal cortex upon attack behavior in cats. **H. M. EDINGER, A. SIEGEL** and **M. DOTTO.** *New Jersey Med. Sch., Newark, NJ.*

11:00 Connections of the accumbens nucleus in the squirrel monkey. **E. W. POWELL** and **R. B. LEMAN.** *Univ. of Arkansas Med. Col., Little Rock, AK.*

11:15 Effect of bilateral lesions in the cingulum bundle on the behavior and neurophysiology of the squirrel monkey. **E. S. BARRATT, P. M. ADAMS** and **J. T. O'NEAL.** *Univ. of Texas Med. Br., Galveston, TX.*

TUESDAY MORNING

VOLUNTEER PAPERS

36. Chemical Senses: Taste and Smell

8:30 AM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **M. M. MOZELL**

8:30 Physicochemical parameters related to olfactory quality. **S. S. SCHIFFMAN.** *Duke Univ., Durham, NC.*

8:45 A model for odorant movement based on the chromatographic theory of olfactory discrimination. **D. P. BASHOR** and **W. M. COOKE.** *Univ. of North Carolina, Charlotte, NC.*

9:00 The distribution of odorant molecules across the olfactory mucosa. **D. E. HORNUNG** and **M. M. MOZELL.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

9:15 Electrophysiological evidence for a topographical projection of the nasal mucosa onto the olfactory bulb of the frog. **R. M. COSTANZO** and **M. M. MOZELL.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

9:30 Denervation of the primary olfactory pathway: specific biochemical changes. **F. L. MARGOLIS, N. ROBERTS, J. FELDMAN** and **D. FERRIERO.** *Roche Inst. of Molec. Biol., Nutley, NJ.*

9:45 Development of olfactory guided behavior in the golden hamster. **E. H. GREGORY.** *California State Univ., Los Angeles, CA.*

10:00 Neural responses telemetered from the olfactory bulbs of rats involved in an odor discrimination task. **S. J. GOLDBERG.** *Med. Col. of Virginia, Virginia Commonweath Univ., Richmond, VA.*

10:15 Optimum stimuli for cat tongue chemoreceptors. **J. C. BOUDREAU, T. E. NELSON** and **J. ORAVEC.** *Univ. of Texas, Houston, TX.*

10:30 Taste preferences of the cat for neurophysiologically active substances. **T. D. WHITE** and **J. C. BOUDREAU**. *Univ. of Texas, Houston, TX.*

10:45 Direct gustatory projections to ventral forebrain in rats. **R. NORGREN**. *Rockefeller Univ., New York, NY.*

11:00 Recovery of taste function. **M. L. CHEAL** and **B. OAKLEY**. *Univ. of Michigan, Ann Arbor, MI.*

11:15 Response of the antennal chemoreceptors of the mosquito, *Aedes aegypti*, to L(+) lactic acid. **E. E. DAVIS** and **P. G. SOKOLOVE**. *Stanford Res. Inst., Menlo Park, CA.*

VOLUNTEER PAPERS

37. Epilepsy II

8:30 AM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **A. A. WARD**

8:30 Selective alumina exposure in experimental epilepsy. **A. B. HARRIS**. *Univ. of Washington Sch. of Med., Seattle, WA.*

8:45 Role of scar formation in the development of an epileptogenic focus. **T. J. HOEPPNER** and **F. MORRELL**. *Rush-Presbyterian-St. Luke's Med. Ctr., Chicago, IL.*

9:00 On the mechanism of regularity of periodic interictal discharge in experimental penicillin epilepsy. **R. M. LEBOVITZ**. *Univ. of Texas Southwestern Med. Sch., Dallas, TX.*

9:15 Evidence for a cortical estrogenic involvement in experimental petit mal epilepsy. **R. M. JULIEN, S. C. LANGE** and **G. W. FOWLER**. *Univ. of California, Irvine, CA.*

9:30 Altered neuronal excitability accompanying experimental prevention of supersensitivity in undercut cortex. **T. E. ANDERSON, L. T. RUTLEDGE** and **R. S. DYER**. *Univ. of Michigan, Ann Arbor, MI.*

9:45 A regulatory mechanism related to cortical stability and epileptiform activity in the thalamocortical motor system of the cat. **R. N. JOHNSON** and **G. R. HANNA**. *Univ. of Virginia Sch. of Med., Charlottesville, VA.*

10:00 Stereotyped doublet and burst firing patterns of neurons in normal lateral cuneate nucleus: a normal substrate for "epileptic" firing patterns? **W. H. CALVIN** and **J. D. LOESER.** *Univ. of Washington, Seattle, WA.*

10:15 Seizures induced by cerebellar stimulation in freely moving primates. **J. W. McSHERRY** and **J. J. HABLITZ.** *Methodist Hosp. and Baylor Col. of Med., Houston, TX.*

10:30 Cortical depth penetration of radioactive acetylcholine at seizure onset. **J. H. FERGUSON, D. R. CORNBLATH** and **P. A. HAVRE.** *Case Western Reserve Univ., Cleveland, OH.*

10:45 Enhanced seizure susceptibility in rats following protein malnutrition during development. **W. C. STERN, W. B. FORBES, O. RESNICK** and **P. J. MORGANE.** *Worcester Fndn. for Exp. Biol., Shrewsbury, MA.*

11:00 Changes in $(K^+)_o$ during neocortical propagated seizures. **G. W. SYPERT** and **A. A. WARD, JR.** *Univ. of Washington, Seattle, WA.*

11:15 Differential effects of intravenous diazepam on the spontaneous EEG recorded from the limbic system and cortex of the more epileptogenic hemisphere in temporal lobe epileptics. **J. P. LIEB** and **P. H. CRANDALL.** *UCLA, Los Angeles, CA.*

TUESDAY MORNING

VOLUNTEER PAPERS

38. Neurochemistry I

8:30 AM—*Park Room, Chase-Park Plaza Hotel*

Chairman: **M. M. RAPPORT**

8:30 Mechanism of S-100-basic protein interaction: metal binding and fluorescence studies. **A. S. PERUMAL** and **S. P. MAHADIK.** *New York State Psychiat. Inst., New York, NY.*

8:45 Protein synthesis and the sensory induction of susceptibility to audiogenic seizures in C57BL/6 mice. **S. C. MAXSON, P. Y. SZE** and **A. TOWLE.** *Univ. of Connecticut, Storrs, CT.*

9:00 Metabolic studies on myelin—evidence for a precursor-role for myelin subfractions. **J. L. TROTTER, H. C. AGRAWAL, R. M. BURTON** and **R. F. MITCHELL.** *Washington Univ. Sch. of Med., St. Louis, MO.*

9:15 Turnover in vivo of glucose carbon in glycosphingolipids of adult rat brain. **A. BARKAI, A. KISIC** and **M. M. RAPPORT.** *New York State Psychiat. Inst. and Columbia Univ., New York, NY.*

9:30 The effect of acute ethanol ingestion on brain lipid metabolism in vivo. **G. Y. SUN** and **A. Y. SUN.** *Univ. of Missouri, Kansas City, MO.*

9:45 Distribution of homocarnosine-carnosine synthetase in rat brain and organs of various species. **F. D. MARSHALL, JR.** and **R. H. NG.** *Univ. of South Dakota Sch. of Med., Vermillion, SD.*

10:00 Levels of folate and *S*-adenosyl-L-methionine in tissues of adult and developing mice following folic acid deprivation. **J. W. ZEMP, L. A. BLACKWELL, L. D. MIDDAUGH, W. TURNER** and **E. GUNTER.** *Med. Univ. of South Carolina, Charleston, SC, and CDC, Atlanta, GA.*

10:15 Neurochemical examination of a leukodystrophy with accompanying adrenal insufficiency. **R. B. RAMSEY, N. L. BANIK** and **A. N. DAVISON.** *St. Louis Univ., St. Louis, MO, and Inst. of Neurology, London, England.*

10:30 Interrelated properties of multiple forms of brain monoamine oxidase. **J. C. SHIH** and **S. EIDUSON.** *UCLA, Los Angeles, CA.*

10:45 Properties of synaptic membranous and mitochondrial monoamine oxidase of thalamic area of bovine brain. **R. C. ARORA, C. VUGRINCIC, F. UNGAR** and **S. G. A. ALIVISATOS.** *Chicago Med. Sch., Chicago, IL.*

11:00 Species differences in the adenyl cyclase responsiveness to neurotransmitters in the superior cervical ganglion. **A. C. BLACK, JR., R. C. BHALLA** and **T. H. WILLIAMS.** *Univ. of Iowa Col. of Med., Iowa City, IA.*

11:15 Chemical alteration of subcortical evoked resistance shifts. **K. A. KLIVINGTON.** *UCSD, San Diego, CA.*

SYMPOSIUM

39. Molecular and Cellular Aspects of Neurogenesis

1:00 PM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **J. B. ANGEVINE, JR.**

Intrinsic and extrinsic factors in shaping neurons. **P. RAKIC.** *Harvard Med. Sch. and Children's Hosp. Med. Ctr., Boston, MA.*

When and where can cytodifferentiation of neurons be first detected? **J. W. SECHRIST.** *Univ. of Arizona Col. of Med., Tucson, AZ.*

Development of oligodendroglia. **G. McKHANN.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

Differential gene expression in neural cells and tissue. **R. B. CHURCH.** *Univ. of Calgary, Alberta, Canada.*

TUESDAY AFTERNOON

SYMPOSIUM

40. Neural and Endocrine Mechanisms of Thirst

1:00 PM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: **A. N. EPSTEIN**

Introductory remarks. **A. N. EPSTEIN.** *Univ. of Pennsylvania, Philadelphia, PA.*

The role of the ventricles in angiotensin thirst. **A. K. JOHNSON.** *Univ. of Iowa, Iowa City, IA.*

The subfornical organ as dipsogenic receptor for angiotensin. **J. B. SIMPSON.** *Univ. of Pennsylvania, Philadelphia, PA.*

Neurotransmitters, hormones and thirst. **P. SETLER.** *Smith, Kline and French Labs., Philadelphia, PA.*

Some factors inhibiting extracellular thirst. **E. BLASS.** *Johns Hopkins Univ., Baltimore, MD.*

Discussion.

VOLUNTEER PAPERS

41. Vision: Receptors and Perception I

1:00 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **L. G. BISHOP**

1:00 Physiological responsivity shifts of *Drosophila* visual system. **W. S. STARK.** *Johns Hopkins Univ., Baltimore, MD.*

1:15 "White noise analysis" of cells in the visual pathway of flies: a quantitative description of nonlinear transfer characteristics. **H. ECKERT** and **L. G. BISHOP.** *California Inst. of Technol., Pasadena, and USC, Los Angeles, CA.*

1:30 An ultraviolet photoreceptor in a dipteran compound eye and a reinvestigation of the two-peaked spectral sensitivity of dipteran photoreceptors. **L. G. BISHOP** and **H. E. A. ECKERT.** *USC, Los Angeles, CA.*

1:45 Light adaptation in the ventral photoreceptor of *Limulus.* **M. M. BEHBEHANI** and **R. SREBRO.** *SUNY, Buffalo, NY.*

2:00 Cyclic nucleotide phosphodiesterase activity in photoreceptor cells of degenerative retinae of rats and mice. **D. B. FARBER** and **R. N. LOLLEY.** *VA Hosp., Sepulveda, and UCLA Sch. of Med., Los Angeles, CA.*

2:15 Effect of continuous illumination on the electroretinogram and the visual evoked response in the rat. **J. G. PARNAVELAS, R. F. SPENCER** and **P. D. COLEMAN.** *Univ. of Rochester Sch. of Med. and Dent., Rochester, NY.*

2:30 Psychophysical evidence for a short-wavelength cone mechanism in the pigeon retina. **D. YAGER** and **M. ROMESKIE.** *State Col. of Optometry, New York, NY, and Brown Univ., Providence, RI.*

2:45 Metabolic participation in receptor current generation in rat and rabbit retinas. **B. S. WINKLER.** *Oakland Univ., Rochester, MI.*

3:00 Sodium aspartate-isolated second order processes at the photoreceptor level in primates. **W. S. BARON** and **R. M. BOYNTON.** *Univ. of Rochester, Rochester, NY.*

VOLUNTEER PAPERS

42. Motor Systems III

1:00 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **V. E. AMASSIAN**

1:00 Short latency jaw movement produced by intracortical microstimulation of the precentral face area in monkeys. **R. W. CLARK** and **E. S. LUSCHEI.** *Univ. of Washington Sch. of Med., Seattle, WA.*

1:15 The role of thalamic N. VA-VL in aversive conditioning of contact placing. **V. E. AMASSIAN, C. T. WERTENBAKER** and **H. REISINE.** *SUNY Downstate Med. Ctr., New York, NY.*

1:30 Activity of neurons in the ventrolateral nucleus of the thalamus in relation to learned movement in the monkey. **P. L. STRICK.** *NIMH, Bethesda, MD.*

1:45 Input-output relations of the feline red nucleus. **C. GHEZ.** *Rockefeller Univ., New York, NY.*

2:00 What are the neurons in VL telling the motor cortex? **H. ASANUMA** and **R. W. HUNSPERGER.** *Rockefeller Univ., New York, NY.*

2:15 Unilateral periarcuate lesions cause loss of motor habit. **R. DEUEL.** *Univ. of Chicago Sch. of Med., Chicago, IL.*

2:30 Cortical cell discharge patterns during different loading conditions. **E. M. SCHMIDT, R. G. JOST** and **K. K. DAVIS.** *NIH, Bethesda, MD.*

2:45 Responses of precentral "motor" cortex cells during passive and active joint movements. **E. E. FETZ, D. V. FINOCCHIO, M. A. BAKER** and **M. J. SOSO.** *Regional Primate Res. Ctr., Univ. of Washington, Seattle, WA.*

VOLUNTEER PAPERS

43. Comparative Neurobiology I

1:00 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: R. G. NORTHCUTT

1:00 Degeneration in the nucleus of origin of preganglionic fibers to the ciliary ganglion following ciliary ganglionectomy in the chick. C. H. NARAYANAN. *Louisiana State Univ. Med. Sch., New Orleans, LA.*

1:15 The mesencephalic nucleus of the fifth nerve in the selachian brain. P. WITKOVSKY and B. L. ROBERTS. *Columbia Univ., New York, NY, and Marine Biol. Lab., Plymouth, England.*

1:30 The inferior olivary complex—a comparison between marsupial and placental mammals. C. R. R. WATSON and P. HERRON. *Univ. N.S.W., Australia, and Michigan State Univ., East Lansing, MI.*

1:45 Retinal projections in the longnose gar. R. G. NORTHCUTT and A. B. BUTLER. *Univ. of Michigan, Ann Arbor, MI, and George Washington Univ., Washington, DC.*

2:00 The visual connections of the adult flatfish, *Achirus lineatus.* R. L. GULLEY, S. O. E. EBBESSON and M. COCHRAN. *Univ. of Miami Sch. of Med., Miami, FL, and Univ. of Virginia, Charlottesville, VA.*

2:15 Cytoarchitecture of anterior dorsal ventricular ridge in snakes. P. S. ULINSKI. *Loyola Univ., Maywood, IL.*

2:30 Projections of dorsal cortex in the side necked turtle (*Podocnemis unifilis*). C. B. WARE. *SUNY Downstate Med. Ctr., Brooklyn, NY.*

2:45 An experimental demonstration of the fornix system in a snake. M. HALPERN. *SUNY Downstate Med. Ctr., Brooklyn, NY.*

VOLUNTEER PAPERS

44. Indoleamines and Behavior I

1:00 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **J. D. BARCHAS**

1:00 Behavioral and neurochemical changes in pigeons following L-tryptophan administration. **J. E. SMITH, J. D. LANE, J. N. HINGTGEN** and **M. H. APRISON.** *Indiana Univ. Med. Ctr., Indianapolis, IN.*

1:15 Differential behavioral and neurochemical effects following lesions of the dorsal or median raphe nuclei in rats. **B. L. JACOBS, W. D. WISE** and **K. M. TAYLOR.** *Princeton Univ. and Squibb Inst. of Med. Res., Princeton, NJ.*

1:30 Direct and prostaglandin-mediated components of the hyperthermia evoked by intrahypothalamic injection of 5-hydroxytryptamine in the cat. **H. L. KOMISKEY** and **T. A. RUDY.** *Univ. of Wisconsin Sch. of Pharm., Madison, WI.*

1:45 Retention deficit for one-trial passive avoidance in mice produced by 6-methoxy-1,2,3,4-tetrahydro-β-carboline. **N. S. BUCKHOLTZ.** *Med. Univ. of South Carolina, Charleston, SC.*

2:00 Enhancement of serotonin binding to a specific soluble protein by Fe^{2+}. **H. TAMIR** and **M. M. RAPPORT.** *New York State Psychiat. Inst., New York, NY.*

2:15 Possible structural specificity for the neurotoxic actions of 5,6-dihydroxytryptamine. **A. C. DONELSON, T. R. BOSIN** and **R. P. MAICKEL.** *Indiana Univ., Bloomington, IN.*

2:30 Penetration of phenylacetic acid across the blood-cerebrospinal fluid barrier. **W. PEDEMONTE, M. BULAT** and **A. D. MOSNAIM.** *Chicago Med. Sch., Chicago, IL.*

2:45 Convulsion producing properties of glycopeptides derived from brain glycoproteins. **L. G. DAVIS, J. I. JAVAID, M. RADULOVACKI** and **E. G. BRUNNGRABER.** *Univ. of Illinois Med. Ctr. and Illinois State Psychiat. Inst., Chicago, IL.*

VOLUNTEER PAPERS

45. Invertebrate Neurophysiology

1:00 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: I. KUPFERMANN

1:00 Electrophysiological effects of tetraethylammonium chloride on leech Retzius cells. A. L. KLEINHAUS and J. W. PRICHARD. *Yale Med. Sch., New Haven, CT.*

1:15 Acetylcholine: an excitatory neuromuscular transmitter in the lobster stomatogastric system. E. MARDER. *UCSD, La Jolla, CA.*

1:30 Organization of synaptic interactions between identified motor neurons in lobster stomatogastric ganglion. D. G. KING. *UCSD, La Jolla, CA.*

1:45 Genetic control of flight motor function in *Drosophila melanogaster.* P. T. WONG, K. IKEDA and W. D. KAPLAN. *City of Hope Natl. Med. Ctr., Duarte, CA.*

2:00 Control of centrally programmed feeding in *Helisoma trivolvis.* C. R. S. KANEKO, S. B. KATER and R. L. FOUNTAIN. *Univ. of Iowa, Iowa City, IA.*

2:15 Integration of sensory information in the crayfish optomotor system. W. B. STERN. *Rice Univ., Houston, TX.*

2:30 Electrophysiological analysis of input to a multimodal command interneuron in the crayfish. J. J. WINE, R. GAUTHIER and J. E. MITTENTHAL. *Stanford Univ., Stanford, CA, and Purdue Univ., West Lafayette, IN.*

2:45 Visual activity of the supraesophageal ganglion of the crayfish. H. L. WOOD and R. M. GLANTZ. *Rice Univ., Houston, TX.*

3:00 Further analysis of the synaptic decrement underlying habituation of the gill-withdrawal reflex in *Aplysia.* V. CASTELLUCCI and E. R. KANDEL. *NYU Med. Sch. and Publ. Hlth. Res. Inst., New York, NY.*

3:15 Quantitative aspects of the sensory component of the gill-withdrawal reflex in *Aplysia.* J. BYRNE, V. CASTELLUCCI and E. R. KANDEL. *NYU Med. Sch., Publ. Hlth. Res. Inst., and New York State Psychiat. Inst., New York, NY.*

3:30 Peptide regulation of bursting pacemaker activity in a molluscan neuron. **J. L. BARKER, H. GAINER** and **M. IFSHIN.** *MIH, Bethesda, MD.*

3:45 A technique for voltage clamping with a single microelectrode. **W. A. WILSON** and **M. M. GOLDNER.** *VA Hosp. and Duke Univ. Med. Ctr., Durham, NC.*

4:00 Pattern generator for rhythmic motor output in *Melibe.* **S. H. THOMPSON.** *Univ. of Washington, Seattle, WA.*

4:15 Identification of large cells in *Aplysia* abdominal ganglion by means of extracellular waveform properties. **R. FEINSTEIN** and **H. PINSKER.** *Univ. of Texas Med. Br., Galveston, TX.*

4:30 Functional studies on the metacerebral cells of *Aplysia.* **I. KUPFERMANN** and **K. R. WEISS.** *Columbia Univ., New York State Psychiat. Inst., and Publ. Hlth. Res. Inst., New York, NY.*

4:45 Homology of giant cerebral cells in *Aplysia* to the metacerebral cells of pulmonate molluscs. **K. R. WEISS** and **I. KUPFERMANN.** *Columbia Univ., New York State Psychiat. Inst., and Publ. Hlth. Res. Inst., New York, NY.*

TUESDAY AFTERNOON

VOLUNTEER PAPERS

46. Somatosensory: Spinal Cord

1:00 PM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **W. D. WILLIS**

1:00 Multimodal responsiveness of individual spinothalamic tract neurons in the monkey. **R. D. FOREMAN, R. A. MAUNZ, A. E. APPLEBAUM, J. E. BEALL** and **W. D. WILLIS.** *Marine Biomed. Inst., and Univ. of Texas Med. Br., Galveston, TX.*

1:15 Parametric analysis of physiological properties of cat dorsal horn cells responding to light touch. **P. B. BROWN, J. L. FUCHS** and **D. N. TAPPER.** *Boston State Hosp., Boston, MA, and Cornell Univ., Ithaca, NY.*

1:30 Viscerosomatic convergence onto spinothalamic tract cells. **M. B. HANCOCK, R. D. FOREMAN** and **W. D. WILLIS.** *Marine Biomed. Inst., and Univ. of Texas Med. Br., Galveston, TX.*

1:45 Effects of stimulation of medullary reticular formation on activity of interneurons in lumbosacral spinal cord of the cat. **L. H. HABER** and **I. H. WAGMAN.** *Univ. of California, Davis, CA.*

2:00 A neurophysiological analysis of the anterolateral spinal cord neurons contributing to pain perception in man. **D. J. MAYER, D. D. PRICE** and **D. P. BECKER.** *Med. Col. of Virginia, Richmond, VA.*

2:15 A neurophysiological analysis of anterolateral quadrant neurons subserving pain in *M. mulatta.* **D. D. PRICE** and **D. J. MAYER.** *Med. Col. of Virginia, Richmond, VA.*

2:30 Supraspinal influences on spinal interneuron characteristics in chronically prepared cats. **N. G. PITTS** and **I. H. WAGMAN.** *Univ. of California, Davis, CA.*

2:45 Signal detection analysis of pain responsivity in rhesis monkeys. **A. T. KULICS** and **C. G. LINEBERRY.** *Univ. of Pittsburgh Sch. of Med., Pittsburgh, PA.*

3:00 Signal detection analysis of morphine analgesia in the rhesus monkey. **C. G. LINEBERRY** and **A. T. KULICS.** *Univ. of Pittsburgh Sch. of Med., Pittsburgh, PA.*

VOLUNTEER PAPERS

47. Neuropathology

1:00 PM—*Park Room, Chase-Park Plaza Hotel*

Chairman: **H. deF. WEBSTER**

1:00 Effects of the space flight environment during the Apollo 17 mission to the moon on the brain of the pocket mouse. **J. M. ORDY, K. R. BRIZZEE** and **W. A. HAYMAKER.** *Delta Reg. Primate Res. Ctr., Covington, LA, and Ames Res. Ctr., NASA, Moffett Field, CA.*

1:15 Whole mounts of tadpole optic nerves examined by differential interference microscopy: a simple method for quantitative morphological studies of CNS demyelination. **H. deF. WEBSTER, P. J. REIER, M. W. KIES** and **M. F. O'CONNELL.** *NIH, Bethesda, MD.*

1:30 Inhibited myelination and neuronal cytoplasmic inclusions produced by cholesterol synthesis inhibitor AY 9944 in organotypic CNS cultures. **S. U. KIM.** *Univ. of Pennsylvania, Philadelphia, PA.*

1:45 Chemical induction of graded cerebellar pathology in a carnivore. **R. K. HADDAD.** *New York State Inst. for Basic Res. in Mental Retardation, Staten Island, NY.*

2:00 Ultrastructural responses of cerebral tissue following periods of ischemic insult. **R. F. DODSON** and **Y. TAGASHIRA.** *Baylor Col. of Med., Houston, TX.*

2:15 Effect of intracerebral herpes virus injection in cats. **R. S. POZOS, R. J. ZIEGLER, M. HARTMANN** and **J. LYONS.** *Univ. of Minnesota Med. Sch., Duluth, MN.*

2:30 A new program for investigating adult human skeletal muscle grown aneurally in tissue culture. **V. ASKANAS** and **W. K. ENGEL.** *NYU Med. Ctr., New York, NY, and NIH, Bethesda, MD.*

2:45 Drugs modifying presumed ischemic damage of skeletal muscle. **W. K. ENGEL** and **E. C. DERRER.** *NIH, Bethesda, MD.*

TUESDAY AFTERNOON

VOLUNTEER PAPERS

48. Feeding and Drinking

3:30 PM—*Chase Club Room, Chase-Park Plaza Hotel*

Chairman: **R. D. MYERS**

3:30 Norepinephrine-elicited eating: involvement of neuroendocrine system of the paraventricular nucleus. **S. F. LEIBOWITZ.** *Rockefeller Univ., New York, NY.*

3:45 Chlorpromazine induced hyperphagia. **R. G. ROBINSON, B. J. HOFFER** and **F. E. BLOOM.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

4:00 Aphagia and adipsia in rats produced by knife cuts ventral to the globus pallidus. **G. F. ALHEID** and **S. P. GROSSMAN.** *Univ. of Chicago, Chicago, IL.*

4:15 Effects of zona incerta lesions and knife cuts on water intake following cellular and extracellular dehydration. **L. L. WALSH** and **S. P. GROSSMAN.** *Univ. of Chicago, Chicago, IL.*

4:30 The cerebral release of catecholamines during feeding in the rat. **G. E. MARTIN** and **R. D. MYERS.** *Purdue Univ., Lafayette, IN.*

4:45 Entry of angiotensin into cerebral ventricles and circumventricular structures. **E. E. SHRAGER, A. K. JOHNSON, A. N. EPSTEIN** and **M. J. OSBORNE.** *Univ. of Pennsylvania, Philadelphia, PA.*

VOLUNTEER PAPERS

49. Vision: Receptors and Perception II

3:30 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **R. H. WURTZ**

3:30 Visual recognition and reaction time: laterality differences in response to verbal stimuli. **R. RUTSCHMANN, L. WEEKS** and **C. BERRY.** *Queens Col., CUNY, New York, NY.*

3:45 Does the Muller-Lyer illusion have lateralizing significance? **S. KUMAR** and **J. E. BOGEN.** *Ross-Loos Med. Group, Los Angeles, CA.*

4:00 Color and orientation specificity of spatial pattern detectors in the human visual system. **C. R. SHARPE** and **G. MANDL.** *McGill Univ., Montreal, Canada.*

4:15 Distribution of sensitivity of rod and cone systems of the rhesus monkey. **M. L. J. CRAWFORD** and **R. KELLY.** *Univ. of Texas Grad. Sch. of Biomed. Sci., Houston, TX.*

4:30 Electrophysiological investigation of visual units in the cat: a revised conception of receptive fields. **E. E. SUTTER.** *Stanford Univ., Stanford, CA.*

4:45 Modification of single unit responses in the cat's visual cortex by electrical stimulation of the brain. **R. W. PHELPS** and **K. H. PRIBRAM.** *Stanford Univ., Stanford, CA.*

VOLUNTEER PAPERS

50. Cerebellum II

3:30 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **F. E. BLOOM**

3:30 The lateral reticular nucleus—afferent projections to cerebellar cortex in the cat. **M. A. CLENDENIN, C-F. EKEROT, O. OSCARSSON** and **I. ROSEN.** *Univ. of Lund, Lund, Sweden.*

3:45 Brain stem afferents to the vestibulo-cerebellum as mapped with horseradish peroxidase tracers. **K. E. ALLEY, R. BAKER** and **J. I. SIMPSON.** *Univ. of Iowa, Iowa City, IA.*

4:00 Cerebral inputs to dentate neurons in primates. **G. I. ALLEN, P. F. C. GILBERT** and **T. C. T. YIN.** *SUNY, Buffalo, NY.*

4:15 Effects of laser irradiation on the spontaneous electrical activity of unstained cerebellar cells in culture. **W. SCHIMMERLING, J. OLSON, A. M. MAMOON, C. A. TOBIAS** and **B. GAHWILER.** *Univ. of California, Berkeley, CA, and Biomed. Res. Labs., SANDOZ A.G., Basel, Switzerland.*

4:30 Fluorescence and electron microscopic analysis of catecholamine-containing fibers in mutant mouse cerebellum. **S. C. LANDIS** and **F. E. BLOOM.** *NIMH, Washington, DC.*

4:45 γ-Aminobutyric acid selectively blocks parallel fiber-Purkinje cell synaptic transmission in the frog cerebellum. **J. T. HACKETT.** *Univ. of Virginia, Charlottesville, VA.*

VOLUNTEER PAPERS

51. Comparative Neurobiology II

3:30 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **R. G. NORTHCUTT**

3:30 Hormones from the eye of *Aplysia*? Effect of cutting the optic nerve on the circadian rhythm of behavioral activity. **M. E. LICKEY, G. K. AUGTER, G. D. BLOCK** and **J. A. WOZNIAK.** *Univ. of Oregon, Eugene, OR.*

3:45 Effects of satiation on the biting reflex of *Aplysia.* **A. J. SUSSWEIN** and **I. KUPFERMANN.** *Columbia Univ., New York State Psychiat. Inst., and Publ. Hlth. Res. Inst., New York, NY.*

4:00 The goldfish brain and optokinetic nystagmus. **S. S. EASTER, JR., G. E. LANDRETH** and **R. G. NORTHCUTT.** *Univ. of Michigan, Ann Arbor, MI.*

4:15 Binocular vision and prey-catching behavior in the leopard frog, *Rana pipiens.* **K. V. FITE** and **M. REGO.** *Univ. of Massachusetts, Amherst, MA.*

4:30 Effects of preoptic, hypothalamic and ventromedial telencephalic lesions on behavioral thermoregulation in the lizard, *Dipsosaurus dorsalis.* **M. L. BERK** and **J. E. HEATH.** *Univ. of Illinois, Urbana, IL.*

4:45 The contribution of prefrontal neocortex to delayed alternation in a prosimian primate. **C. SKEEN** and **B. MASTERTON.** *Florida State Univ., Tallahassee, FL.*

VOLUNTEER PAPERS

52. Indoleamines and Behavior II

3:30 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **J. C. GILLIN**

3:30 Effects of *N,N*-dimethyltryptamine alone and after pretreatment with methiothepin, chlorpromazine or haloperidol on evoked potentials in the visual system of the cat. **R. H. MOORE, K. HATADA** and **E. F. DOMINO.** *Lafayette Clin., Detroit, MI, and Univ. of Michigan, Ann Arbor, MI.*

3:45 Effects of *N,N*-dimethyltryptamine on shuttlebox escape/avoidance in rats. **D. M. STOFF, D. A. GORELICK, T. R. BOZEWICZ, J. C. GILLIN** and **W. H. BRIDGER.** *NIMH, St. Elizabeths Hosp., Washington, DC, and Albert Einstein Col. of Med., Bronx, NY.*

4:00 Behavioral tolerance to *N,N*-dimethyltryptamine. **S. R. MITCHELL, J. M. BEATON, R. J. BRADLEY, J. R. SMYTHIES, F. BENINGTON** and **R. D. MORIN.** *Univ. of Alabama, Birmingham, AL.*

4:15 Studies in rat and rabbit of the tissue distribution of intraperitoneally administered *N,N*-dimethylated tryptamines. **N. NARASIMHACHARI, D. A. CALLISON** and **R-L. LIN.** *Galesburg State Res. Hosp., Galesburg, IL.*

4:30 Regional distribution of aromatic alkylamine *N*-methyltransferase in rat brain. **L. L. HSU** and **A. J. MANDELL.** *UCSD Sch. of Med., La Jolla, CA.*

4:45 Methyltetrahydrofolic acid- and *S*-adenosylmethionine-dependent indolethylamine *N*-methyltransferases: two distinct enzymes. **R-L. LIN** and **N. NARASIMHACHARI.** *Galesburg State Res. Hosp., Galesburg, IL.*

VOLUNTEER PAPERS

53. Basal Ganglia I

3:30 PM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **R. E. DILL**

3:30 Dissimilar effects of cyclic AMP and cyclic GMP on cholinergic stimulation of the rat neostriatum. **R. E. DILL, W. L. DAVIS** and **I. THONNARD-PHILLIPS.** *Baylor Univ. Grad. Sch., Dallas, TX.*

3:45 Dystonias elicited by an antipsychotic agent in relation of plasma and red blood cell levels of butaperazine. **D. L. GARVER, H. DEKIRMENJIAN, J. M. DAVIS** and **F. D. JONES.** *Illinois State Psychiat. Inst. and Univ. of Chicago, Chicago, IL.*

4:00 Ontogeny of acetylcholinesterase in the neostriatum of rats. **L. L. BUTCHER** and **G. K. HODGE.** *UCLA, Los Angeles, CA.*

4:15 Catecholamine synthetic enzyme changes associated with neuronal activity. **C. J. SCHLEHUBER, D. S. SEGAL** and **C. E. SPOONER.** *UCSD Sch. of Med., La Jolla, CA.*

4:30 Interrelationship between dopaminergic and cholinergic neurons in the rat striatum. **F. JAVOY, P. GUYENET, J-C. BEAUJOUAN, J. GLOWINSKI** and **Y. AGID.** *College de France, Paris, France.*

4:45 Biochemical, neuroendocrinological and clinical findings in manganese workers. **J. P. CONOMY, H. MARS, H. RODMAN** and **H. RABINOVITCH.** *University Hosp., Cleveland, OH.*

SYMPOSIUM

54. New Varieties of Synaptic Interaction

8:30 AM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **G. M. SHEPHERD**

Dendrodendritic synaptic interactions in the central nervous system. **G. M. SHEPHERD.** *Yale Univ. Sch. of Med., New Haven, CT.*

Dendrodendritic synapses in the peripheral nervous system. **D. M. McDONALD.** *UCSF Sch. of Med., San Francisco, CA.*

Electrical synaptic interactions in the mammalian central nervous system. **R. LLINAS.** *Univ. of Iowa, Iowa City, IA.*

Membrane structure at chemical and electrical synapses. **T. S. REESE.** *NIH, Bethesda, MD.*

SYMPOSIUM

55. Biochemical and Pharmacological Aspects of Psychiatric Disorders

8:30 AM—*Chase Club, Chase-Park Plaza Hotel*

Co-Chairmen: **R. WYATT**
J. D. BARCHAS

Aspects of clinical and biological factors in manic-depressive illnesses. **E. ROBINS.** *Washington Univ. Sch. of Med., St. Louis, MO.*

Biological aspects of neurological and neuroleptic drugs. **R. BALDESSARINI.** *Harvard Med. Sch., Boston, MA.*

The development of drugs which block psychomimetic agents. **E. DOMINO.** *Univ. of Michigan, Ann Arbor, MI.*

Clinical pharmacology and theories of psychosis. **J. DAVIS.** *Univ. of Chicago, Chicago, IL.*

The dopamine hypothesis of schizophrenia. **S. MATTHYSSE.** *Harvard Med. Sch., Boston, MA.*

VOLUNTEER PAPERS

56. Vision: Organization, Central Interconnections

8:30 AM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **J. H. KAAS**

8:30 Bilateral branching of single ganglion cells. **T. J. CUNNINGHAM** and **J. A. FREEMAN.** *Vanderbilt Univ., Nashville, TN.*

8:45 Intracellular recording and staining of optomotor neurons in fly optic lobe. **D. R. DVORAK, L. G. BISHOP** and **H. E. ECKERT.** *USC, Los Angeles, CA.*

9:00 Behavioral study of descending pathways from the deep layers of superior colliculus in *Tupaia glis.* **D. RACZKOWSKI, I. T. DIAMOND** and **V. A. CASAGRANDE.** *Duke Univ., Durham, NC, and Univ. of Wisconsin, Madison, WI.*

9:15 The connections of the pulvinar nucleus in the grey squirrel (*Sciurus carolinensis*). **J. A. ROBSON, E. C. MARSH** and **W. C. HALL.** *Duke Univ., Durham, NC.*

9:30 Afferent connections of the pulvinar nucleus in the tree shrew. **J. K. HARTING** and **V. A. CASAGRANDE.** *Univ. of Wisconsin, Madison, WI.*

9:45 Projections of individual laminae of the lateral geniculate nucleus in the prosimian. **K. K. GLENDENNING** and **E. A. KOFRON.** *Duke Univ., Durham, NC.*

10:00 Demonstration of geniculocortical relay cells in the squirrel monkey by means of retrograde transport of horseradish peroxidase. **M. WONG-RILEY.** *UCSF, San Francisco, CA.*

10:15 Some cortical projections of the dorsomedial visual area in the owl monkey (*Aotus trivirgatus*). **C. S. LIN, E. WAGOR** and **J. H. KAAS.** *Vanderbilt Univ., Nashville, TN.*

10:30 The identification of relay neurons in the dorsal lateral geniculate nucleus of primates by the method of retrograde transport of horseradish peroxidase. **J. J. NORDEN.** *Vanderbilt Univ., Nashville, TN.*

10:45 Cells in area 17 of monkey (*Macaca mulatta*) which give rise to corticotectal and corticogeniculate pathways. **R. D. LUND, J. S. LUND, A. H. BUNT, A. E. HENDRICKSON** and **A. F. FUCHS.** *Univ. of Washington Sch. of Med., Seattle, WA.*

11:00 Demonstration of retinal ganglion cell projections to the lateral geniculate nucleus and superior colliculus of the monkey with horseradish peroxidase. **A. H. BUNT, A. E. HENDRICKSON, J. S. LUND, R. D. LUND** and **A. F. FUCHS.** *Univ. of Washington, Seattle, WA.*

11:15 The use of peroxidase transport to study the connections of the cat's visual system. **C. GILBERT** and **J. P. KELLY.** *Harvard Med. Sch., Boston, MA.*

WEDNESDAY MORNING

VOLUNTEER PAPERS

57. Motor Neurons

8:30 AM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **R. E. COGGESHALL**

8:30 A histochemical study of cervical motor neurons and the posterior latissimus dorsi muscle in normal and dystrophic chickens. **F. M. SANSONE** and **F. J. LEBEDA.** *SUNY, Buffalo, NY.*

8:45 Compartmentalization of motor unit innervation territories: implications for motor nucleus organization. **W. D. LETBETTER.** *Emory Univ., Atlanta, GA.*

9:00 Unmyelinated fibers in human ventral roots. **R. E. COGGESHALL, T. B. STUBBS III** and **M. T. SYKES.** *Univ. of Texas Med. Br., Galveston, TX.*

9:15 Unmyelinated fibers in frog ventral roots. **W. H. VANCE, R. E. COGGESHALL** and **W. D. WILLIS.** *Marine Biomed. Inst., Univ. of Texas Med. Br., Galveston, TX.*

9:30 Functional changes following motoneuron axotomy. **J. G. SCOTT, J. B. MUNSON** and **L. M. MENDELL.** *Duke Med. Ctr., Durham, NC.*

9:45 Stability of monosynaptic connections following peripheral nerve cross union. **L. M. MENDELL** and **J. G. SCOTT.** *Duke Med. Ctr., Durham, NC.*

10:00 Input-output relations in a heterogeneous population of motor units: synaptic efficacy and tension production. **R. E. BURKE, W. Z. RYMER** and **J. V. WALSH, JR.** *NIH, Bethesda, MD.*

10:15 Tension output from mammalian motor units to nonrepetitive pulse trains. **F. E. ZAJAC** and **J. YOUNG.** *Univ. of Maryland, College Park, MD.*

10:30 Firing patterns of motoneurons and their significance. **D. A. HARRIS** and **E. HENNEMAN.** *Harvard Med. Sch., Boston, MA.*

10:45 Differences in proximal and distal conduction velocities of medial gastrocnemius nerve fibers. **P. COPACK, E. FELMAN, J. LIEBERMAN** and **S. GILMAN.** *Columbia Univ. Col. of P. and S., New York, NY.*

11:00 Relationship between size and excitability in spinal motoneurons. **H. P. CLAMANN.** *Med. Col. of Virginia, Richmond, VA.*

11:15 Effects of eserine (physostigmine) on alpha motoneurons. **M. C. HICKEY** and **C. D. BARNES.** *Indiana State Univ., Terre Haute, IN.*

VOLUNTEER PAPERS

58. Developmental Neurobiology I

8:30 AM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **S. M. CRAIN**

8:30 Early formation of synaptic networks in cultures of fetal mouse cerebral neocortex and hippocampus. **S. M. CRAIN, M. B. BORNSTEIN** and **C. S. RAINE.** *Albert Einstein Col. of Med., Bronx, NY.*

8:45 A quantitative study of synaptogenesis in the spinal cord of the chick embryo. **I-W. CHU-WANG, R. W. OPPENHEIM** and **R. F. FOELIX.** *Dept. of Ment. Hlth., Raleigh, NC.*

9:00 Formation of cockroach interganglionic connectives: an in vitro analysis. **R. R. PROVINE, L. ALOE** and **K. R. SESHAN.** *Washington Univ., St. Louis, MO.*

9:15 Origin and development of sensory neurons in an insect antenna. **J. R. SANES** and **J. G. HILDEBRAND.** *Harvard Med. Sch., Boston, MA.*

9:30 Membrane electrical properties associated with morphogenesis in L cells: relationship between divalent cations, cyclic nucleotides, and prostaglandin E_1 (PGE_1). **P. NELSON, M. HENKART** and **B. RANSOM.** *NIH, Bethesda, MD.*

9:45 Time lapse and electron microscope studies of process formation in L cells: a model for morphogenesis of process-bearing cells. **M. HENKART, A BREUER** and **P. NELSON.** *NIH, Bethesda, MD.*

10:00 Delay of oligodendrocyte differentiation by bromodeoxyuridine. **L. H. YOUNKIN** and **D. H. SILBERBERG.** *Univ. of Pennsylvania Sch. of Med., Philadelphia, PA.*

10:15 Hormonal regulation of cerebellar thymidine kinase activity and DNA biosynthesis during early development: cortisol and thyroxine. **M. E. WEICHSEL, JR.** *Michigan State Univ., East Lansing, MI.*

10:30 Differential labeling of growth cone vesicles by electron dense tracers. **M. DEL CERRO.** *Univ. of Rochester Med. Sch., Rochester, NY.*

10:45 Neuronal localization of S-100 in neonatal and adult rat brain. **M. M. RAPPORT, H. LAEV, S. MAHADIK** and **L. GRAF.** *New York State Psychiat. Inst., New York, NY.*

11:00 Myelin deficiency in the CNS of dwarf (Snell's) mice. **P. J. REIER, J-M. MATTHIEU** and **K. S. BROWN.** *NIH, Bethesda, MD.*

11:15 Precursor dependent turnover measures of proteins in myelin and myelinlike material during development. **C. A. FISCHER** and **P. MORELL.** *Albert Einstein Col. of Med., Bronx, NY, and Univ. of North Carolina, Chapel Hill, NC.*

WEDNESDAY MORNING

VOLUNTEER PAPERS

59. Neuroendocrinology II

8:30 AM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **B. McEWEN**

8:30 Corticosterone, cortisol, and estradiol bind differentially to specific cell groups in rhesus monkey brain and pituitary. **J. L. GERLACH, B. S. McEWEN, D. W. PFAFF, S. MOSKOVITZ, M. FERIN, P. W. CARMEL** and **E. A. ZIMMERMAN.** *Rockefeller Univ., New York, NY, and Columbia Univ. Col. of P. and S., New York, NY.*

8:45 Stress responsiveness is a function of the circadian rhythm of adrenocortical activity. **W. E. ENGELAND, M. F. DALLMAN, J. SHINSAKO, C. M. WINGET** and **J. VERNIKOS-DANELLIS.** *UCSF, San Francisco, CA, and NASA-Ames Res. Ctr., Moffett Field, CA.*

9:00 Dexamethasone termination of stress-induced pituitary-adrenal responses in the rat. **E. ZIMMERMAN, B. BRANCH, C. N. PANG** and **A. N. TAYLOR.** *UCLA Sch. of Med., Los Angeles, CA.*

9:15 Mediation of the release of ACTH by the medial dorsal hypothalamus. **W. E. GRIZZLE, L. P. SCHRAMM** and **D. S. GANN.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

9:30 The role of the limbic system in the hypersecretion of ACTH following adrenalectomy in the rat. **J. P. ALLEN** and **C. F. ALLEN.** *Sch. of Aerospace Med., Brooks AFB, TX, and Southwest Fndn. for Res. and Ed., San Antonio, TX.*

9:45 Effect of septal lesions on stress response patterns of plasma growth hormone and prolactin as compared with adrenal stress responses. **J. A. SEGGIE** and **G. M. BROWN.** *Clarke Inst. of Psychiat., Toronto, Canada.*

10:00 Sedative effects on adrenocortical function. **P. E. STOKES** and **P. STOLL.** *Payne Whitney Clin., New York, NY.*

10:15 Effects of adrenal glucocorticoids on synaptosomal uptake of L-tryptophan. **L. NECKERS** and **P. Y. SZE.** *Univ. of Connecticut, Storrs, CT.*

10:30 Midbrain raphe neurons: sensitivity to corticosteroids. **S. S. MOSKO** and **B. L. JACOBS.** *Princeton Univ., Princeton, NJ.*

10:45 Laminar cell counts of neuron density and glia/neuron ratio in cortical area 3 of rats given corticosterone neonatally. **K. R. BRIZZEE** and **E. HOWARD.** *Delta Regional Primate Res. Ctr., Covington, LA, Tulane Univ. Sch. of Med., New Orleans, LA, and Johns Hopkins Med. Sch., Baltimore, MD.*

11:00 A second site for binding of thyrotropin releasing hormone in rat brain. **D. R. BURT** and **S. H. SNYDER.** *Johns Hopkins Univ. Med. Sch., Baltimore, MD.*

11:15 The role of thyrotropin releasing factor and cyclic AMP in the duration of amobarbital-induced narcosis. **M. L. COHN** and **M. COHN.** *Univ. of Pittsburgh, Pittsburgh, PA.*

VOLUNTEER PAPERS

60. Brain Stimulation and Behavior

8:30 AM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **D. C. GERMAN**

8:30 Dopamine mediation of intracranial stimulation and amphetamine reward in the rat. **R. A. YOKEL, R. PANTEL** and **R. WISE.** *Sir George Williams Univ., Montreal, Canada.*

8:45 Are central dopaminergic neurons substrates for intracranial self-stimulation? **D. CARTER, A. G. PHILLIPS** and **H. C. FIBIGER.** *Univ. of British Columbia, Vancouver, Canada.*

9:00 Concurrent self-stimulation in the MFB, ventral tegmentum, and locus ceruleus: the effects of D-amphetamine. **G. F. KOOB, G. D. WINGER, J. L. MEYERHOFF** and **Z. ANNAU.** *Johns Hopkins Univ., Baltimore, MD, and Walter Reed Army Inst. of Res., Washington, DC.*

9:15 Monoamines in aversive midbrain stimulation. **R. S. KISER, JR.** and **R. M. LEBOVITZ.** *Univ. of Texas Hlth. Sci. Ctr., Dallas, TX.*

9:30 Self-stimulation of the dorsal midbrain as a function of the interval between conditioning and testing pulses. **R. H. THALMANN.** *Baylor Col. of Med., Houston, TX.*

9:45 Activity of locus ceruleus units responsive to stimulation at reinforcing sites in alert monkey. **D. C. GERMAN** and **E. E. FETZ.** *Univ. of Washington, Seattle, WA.*

10:00 Effect of sucrose application of lateral hypothalamic self-stimulation in rats. **T. R. SCOTT** and **M. LEMAISTRE.** *Univ. of Delaware, Newark, DE.*

10:15 Negative contrast effects were absent when reinforcing lateral hypothalamic brain stimulation was switched to the contralateral electrode. **B. L. BROMLEY** and **D. K. TRANBERG.** *Moorhead State Col., Moorhead, MN.*

10:30 Prolonged changes in cortical unit activity following reinforcing brain stimulation. **P. I. RIVERA-DIAZ** and **J. J. KEENE.** *Univ. of Puerto Rico Sch. of Med., San Juan, PR.*

10:45 Cortical synchronous activity mediated by nucleus reticularis thalami. **C. D. YINGLING, G. L. KING** and **J. E. SKINNER.** *Rice Univ., Texas A. & M. Univ., Baylor Col. of Med., and Methodist Hosp., Houston, TX.*

11:00 Eating, grooming, threat, and escape induced by medullary stimulation in the cat. **G. G. BERNTSON** and **H. C. HUGHES.** *Ohio State Univ., Columbus, OH.*

11:15 Enhanced verbal performance following human thalamic stimulation. **G. A. OJEMANN.** *Univ. of Washington, Seattle, WA.*

VOLUNTEER PAPERS

61. Neuronal Modeling

8:30 AM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **P. H. HARTLINE**

8:30 A statistical analysis of the spontaneous activity from single units in the anterior semicircular canal of the pigeon. **J. P. LANDOLT** and **M. J. CORREIA.** *Def. and Civil Inst. of Environ. Med., Downsview, Canada, and Univ. of Texas Med. Br., Galveston, TX.*

8:45 Analysis of spike train data. **G. D. LANGE** and **P. H. HARTLINE.** *UCSD Sch. of Med., San Diego, CA.*

9:00 A computer model for quantitative trigger-zone simulation. **D. K. HARTLINE** *UCSD, La Jolla, CA.*

9:15 A network model of the pyloric rhythm in the lobster stomatogastric ganglion. **H. S. WARSHAW** and **D. K. HARTLINE.** *UCSD, La Jolla, CA.*

9:30 Evidence for a time varying process that determined membrane conductance in the interspike interval. **J. FOHLMEISTER, R. E. POPPELE** and **R. L. PURPLE.** *Univ. of Minnesota, Minneapolis, MN.*

9:45 A self organizing feature detecting neuronal net. **W. B. MARKS.** *NIH, Bethesda, MD.*

10:00 Medullary discharge patterns and the control of breathing. **I. STAW, S. KATZ** and **A. D. HORRES.** *Med. Univ. of South Carolina, Charleston, SC.*

10:15 The neurophysiological basis of "distinctive features." **J. A. ANDERSON.** *Brown Univ., Providence, RI.*

10:30 A model for myotatic reflex control of upright stance in man. **E. BARAN** and **R. HERMAN.** *Temple Univ. Hlth. Sci. Ctr., Philadelphia, PA.*

10:45 Phase-shift theory of neural information processing in the cortex: theoretical considerations and physiological evidence. **W. SCHNEIDER.** *Indiana Univ., Bloomington, IN.*

11:00 A programmable electronic array for brain modeling. **L. D. WITTIE.** *SUNY at Buffalo, Amherst, NY.*

11:15 A family of simple models relating reflex amplitude, variability and intercorrelation to stimulus intensity. **K. H. REID.** *Univ. of Louisville Sch. of Med., Louisville, KY.*

WEDNESDAY MORNING

VOLUNTEER PAPERS

62. Clinical Neurophysiology and EEG

8:30 AM—*Park Room, Chase-Park Plaza Hotel*

Chairman: **J. S. BARLOW**

8:30 EEG potentials time-locked to saccadic eye movements of reading and optokinetic nystagmus: form, topography, and differential attention aspects. **J. S. BARLOW.** *Massachusetts Gen. Hosp., Boston, MA.*

8:45 Evoked potential and reaction time correlates in monkeys during a simultaneous visual discrimination task. **L. M. CHALUPA, J. ROHRBAUGH, J. E. GOULD** and **D. B. LINDSLEY.** *UCLA, Los Angeles, CA.*

9:00 Short and long latency components of the visual evoked response in acquired childhood cortical blindness. **M. S. DUCHOWNY, I. P. WEISS** and **A. B. BARNET.** *NIH, Bethesda, MD, and Children's Hosp., Washington, DC.*

9:15 The effects of cocaine and D-amphetamine on simian electroencephalographic responses to photic driving. **H. L. ALTSHULER, N. R. BURCH, P. E. PHILLIPS** and **R. G. DOSSETT.** *Texas Res. Inst. of Ment. Sci., and Baylor Col. of Med., Houston, TX.*

9:30 Firing of human temporal lobe neurons during smell testing. **E. HALGREN, R. RAUSCH, T. L. BABB** and **P. H. CRANDALL.** *UCLA, Los Angeles, CA.*

9:45 Evoked potential correlates of phonologic information processing. **D. FRIEDMAN, R. SIMSON, W. RITTER** and **I. RAPIN.** *Albert Einstein Col. of Med., Bronx, NY.*

10:00 On the question of the use of electroconvulsive therapy. **R. J. GRIMM.** *Good Samaritan Hosp., Portland, OR.*

10:15 Ultrastructure of neurons in turtle brainstem reticular formation. **D. B. NEWMAN.** *Stritch Sch. of Med., Loyola Univ., Maywood, IL.*

10:30 Hippocampal responses to fimbrial and commissural stimulation. **P. J. BEST** and **C. E. OLMSTEAD.** *Univ. of Virginia, Charlottesville, VA, and UCLA, Los Angeles, CA.*

10:45 Behavioral and electrophysiological measures of arousal in garter snakes. **M. L. ANDRY** and **M. W. LUTTGES.** *Univ. of Colorado, Boulder, CO.*

11:00 Exploratory sniffing and the hippocampal theta rhythm in the Syrian golden hamster. **F. MACRIDES.** *Worcester Fndn. for Exp. Biol., Shrewsbury, MA.*

11:15 EEG sensory evoked responses in early infancy malnutrition. **A. B. BARNET, M. VICENTINI** and **M. CAMPOS S.** *Children's Hosp. Natl. Med. Ctr., Washington, DC.*

WEDNESDAY AFTERNOON

SYMPOSIUM

63. Hypothalamic Hormones

1:00 PM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **W. F. GANONG**

Introductory remarks. **W. F. GANONG.** *UCSF, San Francisco, CA.*

Chemical nature. **W. VALE.** *The Salk Inst., La Jolla, CA.*

Relation to prolactin secretion. **J. CLEMENS.** *Eli Lilly and Co., Indianapolis, IN.*

Localization. **E. A. ZIMMERMAN.** *Col. of P. and S., Columbia Univ., New York, NY.*

Regulation of aminergic neurons. **W. F. GANONG.** *UCSF, San Francisco, CA.*

Physiological effects and clinical use in man. **L. S. JACOBS.** *Washington Univ. Sch. of Med., St. Louis, MO.*

Discussion.

WEDNESDAY AFTERNOON

SYMPOSIUM

64. Comparative Aspects of Forebrain Organization

1:00 PM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: **S. O. E. EBBESSON**

Comparative studies of thalamocortical organization. **I. T. DIAMOND.** *Duke Univ., Durham, NC.*

Parallels in organization between reptilian and mammalian cortex. **F. E. EBNER.** *Brown Univ., Providence, RI.*

On the organization of the avian forebrain. **H. J. KARTEN.** *SUNY, Stony Brook, NY.*

Anatomical and functional organization of the nurse shark telencephalon. **J. A. JANE.** *Univ. of Virginia, Charlottesville, VA.*

Variation in telencephalic organization of anamniotes. **R. G. NORTHCUTT.** *Univ. of Michigan, Ann Arbor, MI.*

VOLUNTEER PAPERS

65. Axonal Transport I

1:00 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **B. GRAFSTEIN**

1:00 Intraaxonal transport of horseradish peroxidase following intravitreal injections in chicks. **J. LaVAIL** and **M. LaVAIL**. *Harvard Med. Sch. and Children's Hosp. Med. Ctr., Boston, MA.*

1:15 Organelles involved in retrograde axonal transport in chick retinal ganglion cells. **M. LaVAIL** and **J. LaVAIL**. *Harvard Med. Sch. and Children's Hosp. Med. Ctr., Boston, MA.*

1:30 Dendritic transport of horseradish peroxidase in vivo and in vitro. **R. SMITH, C. GALL, S. DEADWYLER** and **G. LYNCH**. *Univ. of California, Irvine, CA.*

1:45 Circulation of synaptic vesicle membrane in neurons of spinal cord explants. **S. TEICHBERG, E. HOLTZMAN, S. M. CRAIN** and **E. R. PETERSON**. *North Shore Univ. Hosp., Manhasset, NY, Cornell Univ. Med. Col., New York, NY, Columbia Univ., New York, NY, and Albert Einstein Col. of Med., Bronx, NY.*

2:00 Demonstration of calcium-induced "tight junctions" between cholinergic synaptic vesicles and the nerve terminal membrane: implications for the vesicle hypothesis. **A. F. BOYNE**. *Univ. of Iowa, Iowa City, IA.*

2:15 Axonal transport of serotonin and membrane glycoproteins in metacerebral neurons of *Aplysia californica*. **J. E. GOLDMAN, R. T. AMBRON** and **J. H. SCHWARTZ**. *Publ. Hlth. Res. Inst. and NYU Med. Sch., New York, NY.*

2:30 Glutamate and glutamine proximo-distal flow in the dorsal sensory neuron. **J. L. JOHNSON**. *Univ. of South Dakota Sch. of Med., Vermillion, SD.*

2:45 Axoplasmic transport of GABA from the cerebellar cortex to the deep cerebellar nuclei of the rat. **T. HATTORI, E. G. McGEER** and **P. L. McGEER**. *Univ. of British Columbia, Vancouver, Canada.*

VOLUNTEER PAPERS

66. Vestibular System I

1:00 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **B. W. PETERSON**

1:00 Influence of dynamic stimuli on the multivalued relation between maintained head position and rate of guitar-fish utricular afferents. **O. MACADAR, G. E. WOLFE** and **J. P. SEGUNDO.** *UCLA Sch. of Med., Los Angeles, CA.*

1:15 Modification of the activity of vestibular units by visual input. **V. S. HENN, L. R. YOUNG** and **C. FINLEY.** *MIT, Cambridge, MA.*

1:30 Eye movements and postural changes evoked by electrical stimulation of the fish brain. **L. S. DEMSKI** and **D. G. BAUER.** *Univ. of New Mexico Sch. of Med., Albuquerque, NM.*

1:45 The influence of vestibular receptors on visual motor control. **C. H. MARKHAM, M. S. ESTES** and **R. H. I. BLANKS.** *UCLA Sch. of Med., Los Angeles, CA.*

2:00 Labyrinthine control of cat forelimb motoneurons. **R. A. MAUNZ, M. MAEDA** and **V. J. WILSON.** *Rockefeller Univ., New York, NY.*

2:15 Single unit firing patterns in the vestibular nuclei of alert rhesus monkeys associated with passive whole body rotation, eye movements, and attempted head movements. **J. H. FULLER** and **F. A. MILES.** *NIMH, Bethesda, MD.*

2:30 Vestibular connections to the reticular formation. **C. ABZUG** and **B. W. PETERSON.** *Rockefeller Univ., New York, NY.*

2:45 Fluid dynamics in models of the semicircular canals. **L. D. BENITEZ** and **A. M. MARTINEZ.** *Natl. Med. Ctr., Mexico. D.F.*

VOLUNTEER PAPERS

67. Developmental Neurobiology II

1:00 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **R. Y. MOORE**

1:00 The development of retinotectal connections in the chick. **W. J. CROSSLAND, W. M. COWAN** and **L. A. ROGERS.** *Washington Univ. Med. Sch., St. Louis, MO.*

1:15 The retinotectal projection in *Xenopus laevis* following left-right exchanges of the eye rudiment. **S. C. SHARMA** and **J. HOLLYFIELD.** *New York Med. Col. and Columbia Univ., New York, NY.*

1:30 Deprivation effects on time course of development of rabbit visual cortex. **P. GROBSTEIN, K. L. CHOW** and **P. C. FOX.** *Stanford Med. Ctr., Stanford, CA.*

1:45 Morphological changes in the tectal layers followed by reorganization of retinotectal projection in goldfish. **M. G. YOON.** *Dalhousie Univ., Halifax, Nova Scotia, Canada.*

2:00 Developmental analysis of the suprachiasmatic nucleus of the hypothalamus. **N. J. LENN, B. BEEBE** and **R. Y. MOORE.** *Univ. of Chicago, Chicago, IL.*

2:15 Evidence for directed growth of the optic tract in foreign nervous tissue. **M. C. PATON** and **R. R. CAPRANICA.** *Cornell Univ., Ithaca, NY.*

2:30 Siamese cat: receptive field position and anatomical distribution of fibers in the corpus callosum. **C. SHATZ.** *Harvard Med. Sch., Boston, MA.*

2:45 Aspects of the development of afferent projections to the olfactory cortex. **G. F. MOXLEY** and **J. L. PRICE.** *Washington Univ. Sch. of Med., St. Louis, MO.*

3:00 Changes in the development of central monoamine neurons following treatment with 6-hydroxydopamine and 5,7-dihydroxytryptamine at birth. **C. SACHS** and **G. JONSSON.** *Karolinska Inst., Stockholm, Sweden.*

3:15 Some effects on offspring produced by injecting pregnant mice with subanesthetic doses of phenobarbital. **L. D. MIDDAUGH, C. A. SANTOS III** and **J. W. ZEMP.** *Med. Univ. of South Carolina, Charleston, SC.*

3:30 The appearance of norepinephrine in the developing spinal cord of the chick. **M. CASERTA, E. JOHNSON** and **L. ROSS.** *Cornell Med. Col., New York, NY, and Med. Col. of Pennsylvania, Philadelphia, PA.*

3:45 The postnatal maturation of the serotonergic system in the olfactory bulb of the albino rat. **L. T. GRAHAM, JR.,** and **J. I. NURNBERGER.** *Indiana Univ. Med. Ctr., Indianapolis, IN.*

4:00 Synaptic reorganization of the rat cerebellum degranulated by postnatal X-irradiation. **D. G. PURO** and **D. J. WOODWARD.** *Univ. of Rochester Sch. of Med., Rochester, NY.*

4:15 Decreases in cerebellar DNA synthesis induced by short periods of postnatal malnutrition in rat pups. **W. S. T. GRIFFIN, D. J. WOODWARD** and **R. CHANDA.** *Univ. of Rochester, Rochester, NY.*

4:30 Spatiotemporal variations in macromolecular composition of membrane fractions from the trisected mesencephalon of the chick embryo. **H. CHEN** and **L. IRWIN.** *Wayne State Univ. Sch. of Med., Detroit, MI.*

WEDNESDAY AFTERNOON

VOLUNTEER PAPERS

68. Vision: Retinal Organization I

1:00 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **G. D. LANGE**

1:00 Mathematical consequences of delayed lateral inhibition in the *Limulus* retina. **B. D. COLEMAN** and **G. H. RENNINGER.** *Carnegie-Mellon Univ., Pittsburgh, PA, and Univ. of Guelph, Ontario, Canada.*

1:15 Patterned spike trains in *Limulus* optic nerve. **H. I. KRAUSZ** and **G. D. LANGE.** *UCSD, La Jolla, CA.*

1:30 Squid optic nerve responses. **P. H. HARTLINE** and **G. D. LANGE.** *UCSD, La Jolla, CA.*

1:45 Chloride sensitive pathways in the perfused retina eyecup preparation of the mudpuppy. **R. F. MILLER** and **R. F. DACHEUX.** *SUNY, Buffalo, NY.*

2:00 Laterally conducted signal and interactions occurring at light offset in the proximal retina of *Necturus*. **L. M. PROENZA.** *Univ. of Georgia, Athens, GA.*

2:15 A light microscopy analysis of anuran retinas, with special reference to the areae retinalis. **R. G. CAREY** and **K. V. FITE.** *Univ. of Massachusetts, Amherst, MA.*

2:30 Intraretinal measurement of light-induced changes in extracellular potassium. **B. OAKLEY** and **D. G. GREEN.** *Univ. of Michigan, Ann Arbor, MI.*

VOLUNTEER PAPERS

69. Narcotics and Drugs of Abuse II

1:00 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **J. M. DAVIS**

1:00 Dopamine β-hydroxylase activity after chronic administration of ethanol. **P. Y. SZE, R. BEACH** and **S. FERGIONE.** *Univ. of Connecticut, Storrs, CT.*

1:15 Mechanism of potentiation of the alcohol withdrawal reaction by drugs which inhibit norepinephrine synthesis. **H. R. MATTHEWS.** *Univ. of Texas Med. Sch., Houston, TX.*

1:30 Depletion of regional brain calcium by ethanol and salsolinol: selective antagonism by naloxone. **D. H. ROSS.** *Univ. of Texas Hlth. Sci. Ctr., San Antonio, TX.*

1:45 Morphine and ethanol: intragastric and intravenous self-administration. **S. G. SMITH, T. E. WERNER** and **W. M. DAVIS.** *Univ. of Mississippi Sch. of Med., University, MS.*

2:00 Effect of Δ^9-THC and alcohol on nucleic acids and proteins in the brain and liver of the chick embryo. **A. JAKUBOVIC** and **P. L. McGEER.** *Univ. of British Columbia, Vancouver, Canada.*

2:15 Marijuana extract and cannabidiol differentially affect operant performance as a function of deprivation. **R. E. MUSTY, R. SANDS** and **E. A. CARLINI.** *Escola Paulista de Medicina, Sao Paulo, Brazil.*

2:30 EEG correlates of barbiturate addiction in monkeys. **P. VRTUNSKI** and **L. R. WOLIN.** *Ohio MH & MR Res. Ctr., Cleveland, OH.*

2:45 Effects of long-term chronic exposure to delta-9-tetrahydrocannabinol in the rhesus monkey. **E. N. SASSENRATH, G. P. GOO, J. D. COWEN** and **L. F. CHAPMAN.** *Univ. of California Sch. of Med., Davis, CA, and California Primate Res. Ctr., Davis, CA.*

WEDNESDAY AFTERNOON

VOLUNTEER PAPERS

70. Neurotransmitters: Distribution I

1:00 PM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **M. J. KUHAR**

1:00 Epinephrine concentrations in discrete brain nuclei of the rat measured by mass fragmentography. **S. H. KOSLOW** and **M. SCHLUMPF.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

1:15 Concurrent measurement of picomole quantities of tryptophan, 5-hydroxytryptophan, serotonin, 5-hydroxyindoleacetic acid, tyrosine, dopamine and norepinephrine in the same sample from brain areas of rat and pigeon. **J. D. LANE, J. E. SMITH** and **M. H. APRISON.** *Indiana Univ. Med. Ctr., Indianapolis, IN.*

1:30 Identification of cytochemical products at reaction sites for biogenic amines. **J. G. WOOD** and **F. D. PRENTICE.** *Univ. of Texas Med. Sch., Houston, TX.*

1:45 Regional distribution of cyclic nucleotides in rat brain as determined after microwave fixation techniques. **R. H. LENOX, J. L. MEYERHOFF** and **H. L. WRAY.** *Walter Reed Army Inst. of Res., Washington, DC.*

2:00 Antibody to dopamine and tyramine. **G. M. BROWN** and **L. J. GROTA.** *Univ. of Toronto, Toronto, Canada, and Univ. of Rochester, Rochester, NY.*

2:15 Octopamine-containing neurons in the lobster nervous system. **B. G. WALLACE, B. R. TALAMO, P. D. EVANS** and **E. A. KRAVITZ.** *Harvard Med. Sch., Boston, MA.*

2:30 Tilt-analysis of pleomorphic vesicles in the superficial layers of the superior colliculus of two primate species. **M. TIGGES, J. TIGGES** and **R. H. LANGE.** *Emory Univ., Atlanta, GA, and Justus-Liebig Univ., Giessen, FRG.*

2:45 Light autoradiographic localization of cholinergic muscarinic sites in rat brain. **M. J. KUHAR** and **H. I. YAMAMURA.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

VOLUNTEER PAPERS

71. Central Autonomic Regulation

1:00 PM—*Park Room, Chase-Park Plaza Hotel*

Chairman: **M. A. NATHAN**

1:00 Prostaglandins in normal thermoregulation. **Q. J. PITTMAN, W. L. VEALE** and **K. E. COOPER.** *Univ. of Calgary, Calgary, Alberta, Canada.*

1:15 Mechanism of action on the hypothalamus of an antipyretic drug during the hyperthermia evoked by an endotoxin, a prostaglandin, 5-HT or 5,6-DHT. **M. B. WALLER** and **R. D. MYERS.** *Purdue Univ., Lafayette, IN.*

1:30 Hypertension of adrenomedullary origin from lesion of anterior hypothalamus in rat. **M. A. NATHAN** and **D. J. REIS.** *Cornell Univ. Med. Col., New York, NY.*

1:45 Hippocampectomy in rhesus monkeys: effects on plasma cortisol during two stressful conditions. **W. J. JACKSON** and **Q. R. REGESTEIN.** *Med. Col. of Georgia, Augusta, GA, and Peter Bent Brigham Hosp., Boston, MA.*

2:00 Ultrastructure of nucleus solitarius and parasolitarius in the rat. **J. E. JOHNSON, JR.,** and **W. R. MEHLER.** *Ames Res. Ctr., NASA, Moffett Field, CA.*

2:15 Effect of *beta*-adrenergic blocking agents on central regulation of blood pressure. **L. R. KLEVANS, J. L. KOVACS** and **R. KELLY.** *Hoffmann-La Roche Inc., Nutley, NJ.*

2:30 Autonomic nervous system involvement in cardiac dysfunction. **K. C. CORLEY** and **H. P. MAUCK.** *Med. Col. of Virginia, Richmond, VA.*

2:45 Effects of spinal cord injury on blood flow and cardiovascular function. **H. GOLDMAN, W. G. BINGHAM** and **S. J. FRIEDMAN.** *Ohio State Univ. Med. Sch., Columbus, OH.*

WEDNESDAY AFTERNOON

VOLUNTEER PAPERS

72. Axonal Transport II

3:30 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **S. OCHS**

3:30 Changes in goldfish retinal ganglion cells following intraocular injection of vincristine. **W. R. WHITE** and **B. GRAFSTEIN.** *Cornell Univ. Med. Col., New York, NY.*

3:45 Movements of organelles in frog axons studied by time-lapse cinemicrography and computer analysis. **D. S. FORMAN, A. L. PADJEN** and **G. R. SIGGINS.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

4:00 Biochemical and autoradiographic study of median and dorsal raphe projections and transport rate using radioactive proline. **E. C. AZMITIA, JR.** and **M. SEGAL.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

4:15 In vitro release of protein from axons during rapid axonal transport. **J. F. HINES, M. M. GARWOOD** and **L. A. FORSYTH.** *Texas Woman's Univ., Denton, TX.*

4:30 Fast axoplasmic transport in rats: a measurement of rate as a function of age. **I. NADELHAFT** and **F. RONCO.** *VA Hosp. and Univ. of Pittsburgh Sch. of Med., Pittsburgh, PA.*

4:45 "Routing" of fast transported materials in nerve fibers. **S. OCHS** and **J. ERDMAN.** *Indiana Univ. Sch. of Med., Indianapolis, IN.*

VOLUNTEER PAPERS

73. Vestibular Systems II

3:30 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **J. M. GOLDBERG**

3:30 Evidence concerning a vestibular contribution to spontaneous alternation in rats: a progress report. **L. ABRAHAM, M. POTEGAL** and **S. MANNING.** *Columbia Teachers Col., New York State Psychiat. Inst., and Hunter Col., CUNY, New York, NY.*

3:45 Innervation patterns of the horizontal semicircular canal in *Rhinobatos productus.* **R. F. DUNN, D. P. O'LEARY** and **V. HONRUBIA.** *UCLA, Los Angeles, CA.*

4:00 Diverse afferent responses from the horizontal semicircular canal in *Rhinobatos productus.* **D. P. O'LEARY, R. F. DUNN** and **V. HONRUBIA.** *UCLA Sch. of Med., Los Angeles, CA.*

4:15 Response characteristics of first-order semicircular canal neurons in the cat. **M. S. ESTES, R. H. I. BLANKS** and **C. H. MARKHAM.** *UCLA Sch. of Med., Los Angeles, CA.*

4:30 Response dynamics of peripheral otolith neurons in barbiturate anesthetized squirrel monkey. **J. M. GOLDBERG** and **C. FERNANDEZ.** *Univ. of Chicago, Chicago, IL.*

4:45 Hair cell types in goldfish vestibular maculae. **C. PLATT.** *Univ. of California, Berkeley, CA.*

5:00 Organization of the superior vestibular nucleus of the squirrel monkey. **W. K. ABEND.** *Univ. of Chicago, Chicago, IL.*

5:15 Responses of first and second order vestibular neurons in gerbil. **L. W. SCHNEIDER** and **D. J. ANDERSON.** *Univ. of Michigan, Ann Arbor, MI.*

VOLUNTEER PAPERS

74. Vision: Retinal Organization II

3:30 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **G. D. LANGE**

3:30 Lateral spread of light adaptation in the rat retina. **D. G. GREEN** and **L. TONG.** *Univ. of Michigan, Ann Arbor, MI.*

3:45 How to account for "hypercomplex" visual processing in peripheral directionally sensitive units. **H. J. WYATT** and **N. W. DAW.** *Washington Univ. Sch. of Med., St. Louis, MO.*

4:00 Quantitation of ganglion cell responses to multiple stimulus conditions in pigeon retina. **R. BINGGELI.** *USC Sch. of Med., Los Angeles, CA.*

4:15 Midget bipolar cells in the ground squirrel retina. **R. W. WEST.** *Memorial Univ. of Newfoundland, St. John's, Newfoundland.*

4:30 Geometry of receptive fields of cat retinal ganglion cells. **K. BEHREND** and **H. SCHARSTEIN.** *MPI f. Biophys. Chemie, Goettingen, and MPI f. Verhaltensphysiol., Seewiesen, West Germany.*

4:45 Development of receptive field properties during the critical developmental period in cats. **D. I. HAMASAKI** and **J. T. FLYNN.** *Bascom Palmer Eye Inst., Univ. of Miami, Miami, FL.*

WEDNESDAY AFTERNOON

VOLUNTEER PAPERS

75. Narcotics and Drugs of Abuse III

3:30 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **J. M. DAVIS**

3:30 Effects of amphetamine on avoidance behavior in enucleated BALB/cJ mice. **R. S. DYER** and **D. A. WELDON.** *Towson State Col., Baltimore, MD.*

3:45 Relative potencies of amphetamines and methylphenidate on mood and activation in man and stereotyped behavior and locomotor activity in rats. **R. C. SMITH, J. M. DAVIS** and **F. SCHLEMMER.** *Illinois State Psychiat. Inst. and Univ. of Chicago, Chicago, IL.*

4:00 Critical interval for loss of behavioral response to amphetamine after hypothalamic injections of 6-hydroxydopamine. **G. N. ERVIN, R. C. YOUNG** and **G. P. SMITH.** *Cornell Univ. Med. Col., New York, NY.*

4:15 Primary role of the nigro-striatal dopamine pathway in the mediation of amphetamine responses in the rat. **I. CREESE** and **S. D. IVERSEN.** *Cambridge Univ., England, and Johns Hopkins Univ. Med. Sch., Baltimore, MD.*

4:30 Neuropsychopharmacology of methaqualone. **W. O. BOGGAN.** *Med. Univ. of South Carolina, Charleston, SC.*

4:45 The role of serotonin in the discriminative stimulus properties of mescaline. **R. G. BROWNE** and **B. T. HO.** *Texas Res. Inst. of Ment. Sci., Houston, TX.*

WEDNESDAY AFTERNOON

VOLUNTEER PAPERS

76. Neurotransmitters: Distribution II

3:30 PM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **L. S. VAN ORDEN III**

3:30 Specific identification of serotoninergic axon terminals in rat cerebral cortex. **A. BEAUDET** and **L. DESCARRIES.** *Univ. of Montreal, Montreal, Quebec, Canada.*

3:45 Neurotransmitter identification in small, fluorescent cells of rat paracervical ganglia by microspectrofluorometry and immunohistochemistry. **H. A. BAKER, J. A. REDICK, W. J. SCHNUTE** and **L. S. VAN ORDEN III.** *Univ. of Iowa, Iowa City, IA.*

4:00 The distribution of catecholamine-containing perikarya in *Macaca speciosa.* **J. R. SLADEK, JR.** and **D. L. GARVER.** *Univ. of Rochester, Rochester, NY, and Illinois State Psychiat. Inst., Chicago, IL.*

4:15 Innervation of the cat spinal cord vasculature by the catecholamine containing fibers. **J. D. IRVIN, E. T. ANGELAKOS** and **J. L. OSTERHOLM.** *Hahnemann Med. Col., Philadelphia, PA.*

4:30 Acetylcholine levels after electrical stimulation of the cholinergic septal-hippocampal pathway. **H. ROMMELSPACHER** and **M. J. KUHAR.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

4:45 Catecholamine levels in traumatized spinal cord. **W. G. BINGHAM, R. RUFFOLO** and **S. J. FRIEDMAN.** *Ohio State Univ. Med. Sch., Columbus, OH.*

THURSDAY MORNING

SYMPOSIUM

77. Neuroscience Now: Education, Manpower, and Opportunities

8:30 AM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **E. M. SHOOTER**

The institutional base for education in neuroscience. **L. H. MARSHALL, J. A. RIVERA** and **H. W. MAGOUN.** *Natl. Res. Council, Washington, DC, and Society for Neuroscience, Bethesda, MD.*

Survey of manpower in research and teaching: concepts and issues. **E. M. SHOOTER.** *Stanford Univ., Stanford, CA.*

Characterization and demography of neuroscientists. **L. R. HARMON.** *Natl. Res. Council, Washington, DC.*

Support of education in neuroscience and opportunities for career employment: some dilemmas. **T. J. KENNEDY, JR.** *NIH, Bethesda, MD.*

VOLUNTEER PAPERS

78. Neural Pathways

8:30 AM—*Chase Club, Chase-Park Plaza Hotel*

Chairman: **F. W. L. KERR**

8:30 A computer system for use with the autoradiographic method for tracing axonal connections. **J. L. PRICE, D. F. WANN** and **W. M. COWAN.** *Washington Univ. Sch. of Med., St. Louis, MO.*

8:45 The use of tritiated leucine and proline to map efferent projections of cells in the cat dorsal column nuclei. **K. J. BERKLEY.** *Florida State Univ., Tallahassee, FL.*

9:00 Autoradiographic tracing of projections from preoptic area and anterior hypothalamus in the rat. **L. A. CONRAD** and **D. W. PFAFF.** *Rockefeller Univ., New York, NY.*

9:15 Differentiation of axon systems using a specific axon protein marker. **B. K. HARTMAN** and **R. LIM.** *Washington Univ. Sch. of Med., St. Louis, MO, and Univ. of Chicago, Chicago, IL.*

9:30 Immunohistochemical localization of choline acetyltransferase in certain structures of the central nervous system. **P. L. McGEER, E. G. McGEER** and **V. K. SINGH.** *Univ. of British Columbia, Vancouver, Canada.*

9:45 Raphe-reticular formation connections in the cat. **E. T. PIERCE.** *Harvard Med. Sch., Boston, MA.*

10:00 Does the nucleus raphe pontis have chemosensor or neuroendocrine functions? **M. E. SCHEIBEL** and **A. B. SCHEIBEL.** *UCLA, Los Angeles, CA.*

10:15 The afferent and efferent connections of the anterior olfactory nucleus in the rabbit as studied with the autoradiographic and horseradish peroxidase axon tracing methods. **R. BROADWELL.** *Univ. of Wisconsin, Madison, WI.*

10:30 Connections of the amygdala with the bad nucleus of the stria terminalis and the hypothalamus in the rat and cat. **J. E. KRETTEK** and **J. L. PRICE.** *Washington Univ. Sch. of Med., St. Louis, MO.*

10:45 Projections of the nonspecific thalamic nuclei in the rat. **M. A. HERKENHAM.** *Northeastern Univ., Boston, MA.*

11:00 Connectivity of body representation in the ventroposterior nucleus of the macaque thalamus. **P. R. LOE, B. L. WHITSEL** and **D. A. DREYER.** *Univ. of North Carolina, Chapel Hill, NC.*

11:15 Differential projections of two sectors of the inferotemporal cortex in the rhesus monkey. **M. MOSS.** *Northeastern Univ., Boston, MA.*

11:30 Ascending pathways in the posterolateral funiculus of the monkey spinal cord. **D. E. NIJENSOHN** and **F. W. L. KERR.** *Mayo Fndn., Rochester, MN.*

THURSDAY MORNING

VOLUNTEER PAPERS

79. Tissue Culture

8:30 AM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: **H. M. GELLER**

8:30 Rapid repair of abnormalities in the myelin sheath induced by glycerol treatment of cultured spinal ganglia. **R. YU** and **M. BUNGE.** *Univ. of Texas Med. Br., Galveston, TX, and Washington Univ. Sch. of Med., St. Louis, MO.*

8:45 Response of rat dorsal root and superior cervical ganglion cultures to congeners of chlorpromazine. **N. R. WEST.** *Washington Univ. Sch. of Med., St. Louis, MO.*

9:00 ^{3}H-3-*O*-Methyl-D-glucose uptake in organotypic cultures of cerebellum and meninges. **K. RENKAWEK, M. SPATZ, M. R. MURRAY** and **I. KLATZO.** *NIH, Bethesda, MD.*

9:15 Glial-endothelial interactions in vitro: release of cultured human endothelia topoinhibition by C6 astrocytoma conditioned media. **H. T. HUTCHISON, R. L. SUDDITH, P. J. KELLY, K. WERRBACH, T. COLMORE** and **B. HABER.** *Univ. of Texas Med. Br., Galveston, TX.*

9:30 Physiology and pharmacology of the tuberal hypothalamus in tissue culture. **H. M. GELLER, M. A. BROSTROM** and **B. McL. BRECKENRIDGE.** *CMDNJ-Rutgers Med. Sch., Piscataway, NJ.*

9:45 Primary explant cultures of rat brain regions: catecholamine production in brain stem cultures. **W. J. SHOEMAKER, M. SCHLUMPF, D. S. FORMAN, G. R. SIGGINS** and **F. E. BLOOM.** *NIMH, St. Elizabeths Hosp., Washington, DC.*

10:00 Differentiated neurons in cell cultures of fetal rat brain. **E. GODFREY, P. NELSON, A. BREUER** and **R. SCHRIER.** *NIH, Bethesda, MD.*

10:15 Chemosensitivity of mouse spinal cord neurons in cell culture. **B. RANSOM, E. GILLER** and **P. NELSON.** *NIH, Bethesda, MD.*

10:30 Regulation of electrical activity in mouse neuroblastoma clone N1E-115. **J. TUTTLE** and **E. RICHELSON.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

10:45 Reserpine sensitive uptake, synthesis and storage of catecholamines in adrenergic neuroblastoma cells. **X. O. BREAKEFIELD** and **M. W. NIRENBERG.** *NIH, Bethesda, MD.*

11:00 Dopamine uptake in the somatic cell hybrid line NX31. **P. R. MYERS** and **W. G. SHAIN.** *Armed Forces Radiobiol. Res. Inst., Bethesda, MD.*

11:15 Effects of superoxide dismutase and O_2 on the growth inhibitor action 6-hydroxydopamine on neuronal and nonneuronal cells in culture. **L. E. De BAULT.** *Univ. of Iowa Col. of Med., Iowa City, IA.*

VOLUNTEER PAPERS

80. Extraocular Movements

8:30 AM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **A. F. FUCHS**

8:30 Some afferent connections of the oculomotor complex in the cat. **A. M. GRAYBIEL.** *MIT, Cambridge, MA.*

8:45 Representation of direction of eye movement in activity of reticular formation neurons. **B. COHEN** and **V. HENN.** *Mt. Sinai Sch. of Med., CUNY, New York, NY.*

9:00 Monosynaptic reticulo-oculomotor projections in the cat. **S. M. HIGHSTEIN, B. COHEN** and **K. MATSUNAMI.** *Mt. Sinai Sch. of Med., CUNY, New York, NY.*

9:15 Role of striate cortex and superior colliculus in visual guidance of saccadic eye movements in monkey. **C. W. MOHLER** and **R. H. WURTZ.** *NIMH, Bethesda, MD.*

9:30 Activity of simian MLF fibers related to eye movement and adequate vestibular stimulation. **W. M. DAVIS-KING, S. G. LISBERGER, A. F. FUCHS** and **L. C. EVINGER.** *Univ. of Washington, Seattle, WA.*

9:45 Fastigial unit responses in alert monkeys to natural vestibular stimuli. **E. P. GARDNER** and **A. F. FUCHS.** *Univ. of Washington, Seattle, WA.*

10:00 Eye movement and vestibular fibers in monkey flocculus. **S. G. LISBERGER** and **A. F. FUCHS.** *Univ. of Washington, Seattle, WA.*

10:15 Effects of wearing telescopic spectacles on the vestibulo-ocular response of rhesus monkeys. **F. A. MILES** and **J. H. FULLER.** *NIMH, Bethesda, MD.*

10:30 MLF fiber activity in monkey during visually elicited and vestibular eye movement. **J. POLA.** *Johns Hopkins Univ., Baltimore, MD.*

10:45 Influence of head-position on excitation-patterns of oculomotor neurons during nystagmus. **D. L. MEYER, D. SCHOTT, U. BUTTNER** and **K.-P. SCHAEFER.** *UCSD, La Jolla, CA, and Univ. of Goettingen, Germany.*

11:00 Eye movements to the predictable aspects of randomized target motions. **P. E. HALLETT** and **A. D. LIGHTSTONE.** *Univ. of Toronto, Toronto, Ontario, Canada.*

11:15 Figure distortions elicited by visual tracking. **B. BRIDGEMAN, M. J. MAYER** and **L. GLEN.** *Univ. of California, Santa Cruz, CA.*

THURSDAY MORNING

VOLUNTEER PAPERS

81. Developmental Neurobiology III

8:30 AM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **S. P. HICKS**

8:30 Maturation of respiration and heart rate during sleep in kittens. **D. J. McGINTY, T. BAKER, S. HAMADA** and **M. STEVENSON.** *VA Hosp., Sepulveda, and UCLA, Los Angeles, CA.*

8:45 The ontogeny of supraspinal input to chick spinal cord: a behavioral study. **R. W. OPPENHEIM.** *Dept. of Ment. Hlth., Raleigh, N.C.*

9:00 Development of motoric activity in kittens. **M. S. LEVINE, C. D. HULL** and **N. A. BUCHWALD.** *Ment. Retardation Res. Ctr., UCLA, NPI, Los Angeles, CA.*

9:15 Interdependence of regions of motor-sensory cortex in developing locomotor placing responses in rats. **S. P. HICKS** and **C. J. D'AMATO.** *Univ. of Michigan Med. Ctr., Ann Arbor, MI.*

9:30 Patterned motor output in the 7-day chick embryo. **A. BEKOFF.** *Washington Univ., St. Louis, MO.*

9:45 Development of central regulation of habituation of the gill withdrawal reflex in *Aplysia.* **K. LUKOWIAK** and **B. PERETZ.** *Univ. of Kentucky Med. Ctr., Lexington, KY.*

10:00 Selective exposure does not quickly modify orientation selectivity of visual cortex in paralyzed, anesthetized kittens. **M. P. STRYKER.** *MIT, Cambridge, MA.*

10:15 Relative effects of visual deprivation and binocular competition on responses of striate cortex cells in the cat. **K. E. KRATZ** and **P. D. SPEAR.** *Kansas State Univ., Manhattan, KS.*

10:30 Postnatal development of visual acuity, cytoarchitectural and chemical organization of the striate cortex and growth of the brain, pituitary and adrenals in the squirrel monkey. **B. KAACK, J. M. ORDY** and **K. R. BRIZZEE.** *Delta Regional Primate Res. Ctr., Covington, LA.*

10:45 Disuse supersensitivity of auditory behavior and physiology. **K. R. HENRY** and **M. D. McGINN.** *Univ. of California, Davis, CA.*

11:00 Effect of chronic protein malnutrition on ontogeny of transcortical evoked potentials in rats. **W. B. FORBES, W. C. STERN, P. J. MORGANE, T. L. KEMPER, C. D. WEST** and **O. RESNICK.** *Worcester Fndn. for Exp. Biol., Shrewsbury, MA.*

11:15 Behavioral effects of hippocampal X-irradiation. **R. KAPLAN, R. B. WALLACE** and **J. WERBOFF.** *Univ. of Hartford, West Hartford, CT.*

VOLUNTEER PAPERS

82. Auditory System

8:30 AM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **G. MOUSHEGIAN**

8:30 Kinetics of noise-induced reduction and recovery of mammalian cochlear microphonic response. **D. G. DRESCHER.** *Central Inst. for the Deaf, St. Louis, MO.*

8:45 Short-latency auditory responses in man: stimulus following to monaural and binaural sounds. **G. M. GERKEN, G. MOUSHEGIAN, R. D. STILLMAN** and **A. L. RUPERT.** *Callier Ctr. for Communication Disorders, Dallas, and Univ. of Texas at Dallas, Richardson, TX.*

9:00 Auditory sensory epithelial development in the bullfrog. **C. W. LI** and **E. R. LEWIS.** *Univ. of California, Berkeley, CA.*

9:15 Processing of simple and complex stimuli by the globular and multipolar cell areas of the kangaroo rat cochlear nuclei. **D. M. CASPARY, A. L. RUPERT** and **G. MOUSHEGIAN.** *Southern Illinois Univ. Sch. of Med., Springfield, IL, Callier Ctr. for Communication Disorders and Univ. of Texas, Dallas, TX.*

9:30 Properties of responses to tones and noise of single cells in the dorsal cochlear nucleus of unanesthetized cats. **E. YOUNG** and **W. E. BROWNELL.** *Univ. of Chicago, Chicago, IL.*

9:45 Tonotopic organization of neurons in nucleus magnocellularis and nucleus laminaris of the chicken. **E. W. RUBEL** and **T. PARKS.** *Yale Univ., New Haven, CT.*

10:00 Electrophysiological observations in the cochlear nuclear complex. **D. T. KENNEDY.** *Wayne State Univ., Detroit, MI.*

10:15 Parallel alterations in electrocorticogram patterns and spontaneous multi-unit activity of the auditory system in paralyzed cats. **G. HUMPHREY** and **S. ORMAN.** *Univ. of Illinois Med. Ctr., Chicago, IL.*

10:30 The organization of projections from nucleus magnocellularis to nucleus laminaris in the chicken. **T. PARKS** and **E. W. RUBEL.** *Yale Univ., New Haven, CT.*

10:45 Coding of species specific vocalization in the auditory midbrain nucleus of the guinea fowl. **H. SCHEICH, R. KOCH** and **G. LANGNER.** *Max Planck Inst. f. Biophys. Chem., Gottingen, F. R. Germany.*

11:00 The differential telencephalic projections of the subdivisions of the medial geniculate of the rat. **D. K. RYUGO** and **H. P. KILLACKEY.** *Univ. of California, Irvine, CA.*

11:15 Trophic effects of deafferentation on synaptic ending of Golgi type II cells in the medial geniculate body of cats. **D. K. MOREST.** *Harvard Sch. of Med., Boston, MA.*

VOLUNTEER PAPERS

83. Habituation and Conditioning

8:30 AM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **J. M. FUSTER**

8:30 First-order interneurons: sensitization and habituation. **M. D. EGGER** and **C. H. CONE.** *Yale Univ., New Haven, CT.*

8:45 The structural correlates of visual inattention following ectosylvian lesions in the cat. **S. HORENSTEIN, R. G. SCHWARZ, T. YAMAMOTO** and **P. A. YOUNG.** *St. Louis Univ., St. Louis, MO.*

9:00 Neuronal responses to environmental stimuli of behavioral significance in the thalamus and frontal cortex of the squirrel monkey (*Saimiri sciureus*). **R. B. GOLDBERG** and **J. M. FUSTER.** *UCLA, Los Angeles, CA.*

9:15 Single unit response decrements in the inferior colliculus of decerebrate cats during repeated acoustic stimulation. **D. E. REGAN** and **J. BUCHWALD.** *UCLA, Los Angeles, CA.*

9:30 Changes in cortical excitability associated with the development of cortically reinforced conditioned response. **J. E. BOSTON** and **G. KANDEL.** *RPI, Troy, NY.*

9:45 Alterations of reticular responses during repetitive vestibular, cutaneous and cortical stimulation: CNS analogs of habituation and sensitization? **B. W. PETERSON, J. I. FRANCK** and **N. G. DAUNTON.** *Rockefeller Univ., New York, NY.*

10:00 Effect of unconditioned stimulus intensity on spinal conditioning. **A. R. LIGHT** and **R. G. DURKOVIC.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

10:15 Role of the contralateral spinal roots in spinal habituation. **D. R. KEPPNER** and **P. ROCCAFORTE.** *Illinois Inst. of Technol., Chicago, IL.*

10:30 Differences in extracellular current required to activate cortical neurons of different auditory receptive properties as functions of stimulus, stimulus-association, and conditioning. **C. D. WOODY, J. D. KNISPEL, T. J. CROW** and **P. A. BLACK-CLEWORTH.** *Ment. Retardation Res. Ctr., UCLA, Los Angeles, CA.*

10:45 Neural coding of reinforcing and aversive conditioning in the rat. **M. I. PHILLIPS.** *Univ. of Iowa, Iowa City, IA.*

11:00 Classically conditioned eye blink and changes in activity in the precruciate cortex and thalamus in the cat. **S. D. CHANDLER** and **S. L. LILES.** *LSU Med. Ctr., New Orleans, LA.*

11:15 Unit activity and evoked potentials during readout from memory. **E. SCHWARTZ, A. RAMOS** and **E. R. JOHN.** *New York Med. Col., New York, NY.*

THURSDAY MORNING

VOLUNTEER PAPERS

84. Brain Lesions and Behavior

8:30 AM—*Stockholm Room, Chase-Park Plaza Hotel*

Chairman: **P. S. GOLDMAN**

8:30 Pattern distribution as a cue in visual discrimination in striate lesioned hooded rats. **D. D. STRACHAN** and **T. D. PARKER.** *Loyola Univ., Chicago, IL.*

8:45 Anatomical and behavioral studies of striate and extrastriate visual cortex in the bushbaby, *G. senegalensis.* **F. ATENCIO** and **J. P. WARD.** *Duke Univ., Durham, NC.*

9:00 Intermodal transfer in the prosimian bushbaby (*Galago senegalensis*) with lesions of posterior neocortex. **J. P. WARD** and **J. FRANK.** *Memphis State Univ., Memphis, TN.*

9:15 Size constancy discrimination in brain-lesioned monkeys: evidence for critical efferent pathways of inferotemporal cortex. **L. G. UNGERLEIDER.** *Stanford Univ., Stanford, CA.*

9:30 Cryogenic depression of prefrontal cortex: spatial vs. nonspatial memory defect. **R. H. BAUER** and **J. M. FUSTER.** *UCLA, Los Angeles, CA.*

9:45 Prefrontal electrocortical correlates of cue position during performance of delayed response tasks by monkeys. **S. C. ROSEN, A. GADOTTI** and **J. S. STAMM.** *SUNY, Stony Brook, NY.*

10:00 Alternation behavior in cats with small ablations of medial visual cortex. **J. WINER** and **J. F. LUBAR.** *Duke Univ., Durham, NC, and Univ. of Tennessee, Knoxville, TN.*

10:15 Feasibility of spinal cord or brain surgery in fetal rhesus monkeys. **E. TAUB, G. BARRO, E. A. MILLER, P. N. PERRELLA, A. JAKNIUNAS, P. S. GOLDMAN, J. M. PETRAS, C. C. DARROW II** and **D. F. MARTIN.** *Inst. for Behavioral Res., Silver Spring, MD, NIMH, Bethesda, MD, Walter Reed Army Inst. of Res., Washington, DC, and Litton Bionetics, Inc., Kensington, MD.*

10:30 Failure to find recovery of function after two-stage frontal lesions in aged rats. **D. G. STEIN** and **A. FIRL.** *Clark Univ., Worcester, MA.*

10:45 Involvement of nigro-neostriatal dopaminergic neurons in the acquisition of a conditioned avoidance response. **A. P. ZIS, H. C. FIBIGER** and **A. G. PHILLIPS.** *Univ. of British Columbia, Vancouver, Canada.*

11:00 Contribution of the caudo-putamen to spontaneous alternation in rats. **M. POTEGAL** and **L. R. SQUIRE.** *New York State Psychiat. Inst., New York, NY, and VA Hosp., San Diego, CA.*

11:15 Deficit in passive avoidance behavior following bilateral medial forebrain bundle lesions in rats. **J. P. HEYBACH** and **G. D. COOVER.** *Northern Illinois Univ., DeKalb, IL.*

11:30 Nerve growth factor facilitates recovery of both learned and unlearned behaviors after parasagittal lateral hypothalamic knife cuts. **G. L. WEST.** *Univ. of Oklahoma Hlth. Sci. Ctr., Oklahoma City, OK.*

11:45 The effect of light and dark on the recovery period following lateral hypothalamic lesions. **L. HARRELL** and **S. BALAGURA.** *Univ. of Massachusetts, Amherst, MA.*

12:00 Thalamic stimulation and lesion effects upon limbic induced aggression. **O. J. ANDY, L. GIURINTANO, S. GIURINTANO** and **T. McDONALD.** *Univ. of Mississippi Med. Ctr., Jackson, MS.*

VOLUNTEER PAPERS

85. Somatosensory: Mechanoreception and Nociception

8:30 AM—*Park Room, Chase-Park Plaza Hotel*

Chairman: **R. DUBNER**

8:30 The response and innervation pattern of hair mechanoreceptors. **R. P. TUCKETT, K. W. HORCH** and **P. R. BURGESS.** *Univ. of Utah Sch. of Med., Salt Lake City, UT.*

8:45 Threshold vs. dynamic response properties of type I and type II cutaneous mechanoreceptors. **K. W. HORCH** and **P. R. BURGESS.** *Univ. of Utah Sch. of Med., Salt Lake City, UT.*

9:00 The antagonism of amino acid responses by cholinolytic agents in the isolated frog spinal cord. **R. A. NICOLL.** *SUNY, Buffalo, NY.*

9:15 Population studies of cat joint receptors: tonic responses. **W. J. HEETDERKS** and **W. J. WILLIAMS.** *Univ. of Michigan, Ann Arbor, MI.*

9:30 Dynamic characteristics of rapidly adapting knee joint receptors in cats. **M. C. FARIAS** and **S. L. BeMENT.** *Univ. of Michigan, Ann Arbor, MI.*

9:45 Torque and angular dependence of discharge in joint afferent neurons in the cat. **P. GRIGG.** *Univ. of Massachusetts Med. Sch., Worcester, MA.*

10:00 Functional properties of primary afferents thought to subserve pain in the primate glabrous skin. **A. P. GEORGOPOULOS.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

10:15 Heat sensitivity in cold fibers innervating monkey glabrous skin. **R. R. LONG.** *Johns Hopkins Univ. Sch. of Med., Baltimore, MD.*

10:30 The response of unmyelinated (C) nociceptive afferents to thermal and mechanical stimuli applied to the monkey's face. **R. E. BEITEL** and **R. DUBNER.** *NIH, Bethesda, MD.*

10:45 Escape thresholds to noxious heat applied to the monkey's face. **R. DUBNER, R. E. BEITEL** and **F. J. BROWN.** *NIH, Bethesda, MD.*

11:00 Spinal afferent projections to the brainstem of the opossum. **J. L. CULBERSON** and **A. J. McDONALD.** *West Virginia Med. Ctr., Morgantown, WV.*

VOLUNTEER PAPERS

86. Neurochemistry II

1:00 PM—*Khorassan C, Chase-Park Plaza Hotel*

Chairman: **N. MARKS**

1:00 Studies of the synthesis of proteins in goldfish brain following the acquisition of new behavior patterns. **V. E. SHASHOUA.** *McLean Hosp., Harvard Med. Sch., Belmont, MA.*

1:15 Training increases leucyl-tRNA acceptor activity in goldfish brain. **B. B. KAPLAN** and **J. L. SIRLIN.** *Cornell Univ. Med. Col., New York, NY.*

1:30 Phosphorylation of brain nuclear protein in goldfish after behavioral training. **L. MORIOKA, V. G. ALLFREY** and **J. L. SIRLIN.** *Cornell Univ. Med. Col. and Rockefeller Univ., New York, NY.*

1:45 Protein synthesis with isolated nerve and glia cell-fractions: two modes of synthesis. **T. YANAGIHARA.** *Mayo Clin. and Mayo Fndn., Rochester, MN.*

2:00 Isolation and lipid composition of bovine perikarya. **G. H. De VRIES** and **M. E. HOWELL.** *Health Sci. Div., Virginia Commonwealth Univ., Richmond, VA.*

2:15 Characterization of cyclic nucleotide phosphodiesterases in neuronal and glial enriched fractions of rat brain. **W. J. PLEDGER, G. C. PALMER** and **S. J. STRADA.** *Univ. of Texas Med. Sch., Houston, TX, and Univ. of New Mexico, Albuquerque, NM.*

2:30 Bulk isolation of large neuronal perikarya from anterior spinal cord. **D. L. McILWAIN** and **P. CAPPS-COVEY.** *Univ. of North Carolina Sch. of Med., Chapel Hill, NC.*

2:45 Adenosine and prostaglandin E_1 stimulation of adenyl-cyclase in homogenates of mouse neuroblastoma cells. **A. J. BLUME** and **C. FOSTER.** *Roche Inst. of Molec. Biol., Nutley, NJ.*

3:00 *Crotalus adamanteus* snake venom nerve growth factor purification. **J. R. PEREZ-POLO.** *Univ. of Texas, Austin, TX.*

3:15 Cleavage of membrane-bound proteins of myelin. **N. MARKS, A. GRYNBAUM** and **A. LAJTHA.** *New York State Res. Inst. for Neurochem., Ward's Island, NY.*

VOLUNTEER PAPERS

87. Basal Ganglia II

1:00 PM—*Chase Club, Chase-Park Plaza*

Chairman: **C. D. HULL**

1:00 Spontaneous unit activity in caudate nucleus. **N. DAFNY.** *Univ. of Texas Med. Sch., Houston, TX.*

1:15 Firing patterns of neurons in putamen and globus pallidus during static and dynamic tilt of awake monkeys. **M. E. ANDERSON** and **D. ATTWOOD.** *Univ. of Washington, Seattle, WA.*

1:30 Caudate and pallidal unit activity during delayed instrumental response performance in monkey. **S. SOLTYSIK, C. D. HULL** and **N. A. BUCHWALD.** *Ment. Retardation Res. Ctr., NPI, UCLA, Los Angeles, CA.*

1:45 Reward-associated excitation and pain-associated inhibition lasting seconds in single medial globus pallidus neurons. **J. J. KEENE.** *Univ. of Puerto Rico Sch. of Med., San Juan, PR.*

2:00 Pallidal and entopeduncular single unit activity in cats during drinking. **T. I. LIDSKY, N. A. BUCHWALD** and **C. D. HULL.** *Ment. Retardation Res. Ctr., NPI, UCLA, Los Angeles, CA.*

2:15 Antidromic and orthodromic activation of the caudate neurons. **S. T. KITAI, W. PRECHT, T. OHNO** and **A. WAGNER.** *Wayne State Univ. Sch. of Med., Detroit, MI, and Max-Plank Inst. for Brain Res., Frankfurt/M, Germany.*

2:30 Caudate responses to nigral stimulation after MFB lesions. **E. GARCIA-RILL, M. S. LEVINE, C. D. HULL, N. A. BUCHWALD** and **A. HELLER.** *Ment. Retardation Res. Ctr., NPI, UCLA, Los Angeles, CA, and Univ. of Chicago, Chicago, IL.*

2:45 Perseverative instrumental behavior in caudatectomized cats. **J. R. VILLABLANCA, C. E. OLMSTEAD** and **R. J. MARCUS.** *Ment. Retardation Ctr., NPI, UCLA, Los Angeles, CA.*

VOLUNTEER PAPERS

88. Somatosensory: Effects of Lesions

1:00 PM—*Khorassan A, Chase-Park Plaza Hotel*

Chairman: R. B. GLASSMAN

1:00 A role for the dorsal columns of monkey in tactile discrimination. A. S. SCHWARTZ and A. AZULAY. *Barrow Neurolog. Inst., Phoenix, AZ.*

1:15 Deficits in tactile direction sensitivity after dorsal column lesions in monkeys. C. J. VIERCK, JR. *Univ. of Florida Col. of Med., Gainesville, FL.*

1:30 Postcentral somatic mechanoreception. I. Dorsal column and anterolateral lesions. J. LEVITT and M. LEVITT. *Bowman Gray Sch. of Med., Winston-Salem, NC.*

1:45 Postcentral somatic mechanoreception. II. Dorsal quadrant, hemisection, and anterolateral lesions. M. LEVITT and J. LEVITT. *Bowman Gray Sch. of Med., Winston-Salem, NC.*

2:00 Serial cortical lesions and retention of a difficult tactile discrimination. S. FINGER, J. PURETZ and D. SIMONS. *Washington Univ., St. Louis, MO.*

2:15 Effect of ventrobasal and posterior thalamic lesions on cats' somesthesis. R. B. GLASSMAN, M. W. FORGUS and J. E. GOODMAN. *Lake Forest Col., Lake Forest, IL.*

2:30 Quantitative evaluation of cutaneous sensory function. K. L. BARNES and J. P. CONOMY. *Case Western Res. Univ. Sch. of Med., Cleveland, OH.*

2:45 Modification of thalamic evoked activity by dorsal column stimulation in the human. P. L. GILDENBERG and K. S. K. MURTHY. *Univ. of Arizona Col. of Med., Tucson, AZ.*

3:00 Variation of sensitivity to thermal stimulation over body surface. J. C. STEVENS and L. E. MARKS. *John B. Pierce Fndn. and Yale Univ., New Haven, CT.*

3:15 The primary somatosensory evoked response as indicator of changes in stimulus submodality and sensory quality. H. STOWELL. *Central State Hosp., Milledgeville, GA.*

VOLUNTEER PAPERS

89. Cerebellum III

1:00 PM—*Starlight Room, Chase-Park Plaza Hotel*

Chairman: **R. LLINAS**

1:00 Pathways mediating two types of visual response in the cerebellum of the frog. **F. SHAFA** and **W. B. MARKS.** *Johns Hopkins Univ., Baltimore, MD, and NIH, Bethesda, MD.*

1:15 Receptive fields of cerebellar cells receiving exteroceptive input in gymnotid fish. **J. BASTIAN.** *UCSD Sch. of Med., La Jolla, CA.*

1:30 Electrolocation of objects in weakly electric fish. **W. F. HEILIGENBERG.** *SIO–USCD, La Jolla, CA.*

1:45 Development of cerebellar afferent synaptic input and inhibitory interneuronal function. **D. J. WOODWARD** and **D. G. PURO.** *Univ. of Rochester, Rochester, NY.*

2:00 Reversal properties of climbing fiber potential in Purkinje cells of cat cerebellum. **R. LLINAS** and **C. NICHOLSON.** *Univ. of Iowa, Iowa City, IA.*

2:15 Extracellular field potentials and changes in potassium ion concentration in catfish cerebellum. **C. NICHOLSON, R. VOLKIND** and **W. YOUNG.** *Univ. of Iowa, Iowa City, IA.*

2:30 Evidence for an axonal influence, distinct from axonal size, on the thickness of the myelin sheath. **V. L. FRIEDRICH, JR.** and **E. MUGNAINI.** *Univ. of Connecticut, Storrs, CT.*

2:45 Ultrastructural evidence of impaired cerebellar synaptogenesis due to experimentally induced hypothyroidism. **R. L. SMITH, W. J. BROWN, M. A. AKERS** and **M. A. VERITY.** *UCLA Sch. of Med., Los Angeles, CA.*

VOLUNTEER PAPERS

90. Catecholamines and Behavior

1:00 PM—*Tiara Room, Chase-Park Plaza Hotel*

Chairman: **G. R. BREESE**

1:00 Role of lever responding and water reinforcement in altering catecholamine metabolism. **M. W. OGLESBY** and **L. S. SEIDEN.** *Univ. of Chicago, Chicago, IL.*

1:15 Neurochemical effects of chronic pretreatment with α-methyltyrosine or U-14,624 in rats. **J. H. KHALSA** and **W. M. DAVIS.** *Sch. of Pharm. of Mississippi, University, MS.*

1:30 Recovery of function following damage to central catecholamine-containing neurons. **E. M. STRICKER, M. J. ZIGMOND** and **M. I. FRIEDMAN.** *Univ. of Pittsburgh, Pittsburgh, PA.*

1:45 Pharmacologic changes in performance of normal and brain damaged rats. **B. SCHNEIDERMAN** and **R. L. ISAACSON.** *Univ. of Florida, Gainesville, FL.*

2:00 Behavioral evidence of a CNS neurotransmitter balance using primate social colonies. **R. F. SCHLEMMER, JR., D. L. GARVER, J. M. DAVIS** and **J. P. BEDERKA, JR.** *Illinois State Psychiat. Inst. and Univ. of Illinois Med. Ctr., Chicago, IL.*

2:15 Application of multivariate analyses to experiments measuring multiple behavioral and neurochemical indices. **J. L. HOWARD, B. R. COOPER, L. D. GRANT** and **G. R. BREESE.** *Wellcome Res. Labs., Res. Triangle Park, and Univ. of North Carolina, Chapel Hill, NC.*

VOLUNTEER PAPERS

91. Somatosensory—Medulla

1:00 PM—*Empire Room, Chase-Park Plaza Hotel*

Chairman: **S. G. NORD**

1:00 Medullary projections of group I and II afferents from neck muscle in the cat. **V. C. ABRAHAMS** and **P. K. ROSE.** *Queen's Univ., Kingston, Ontario, Canada.*

1:15 Analysis of cells in the cuneate nucleus of the cat. **P. BLUM.** *Univ. of Vermont, Burlington, VT, and Duke Univ., Durham, NC.*

1:30 Sensory neurons in the pontine nuclei. **A. GIBSON, J. BAKER, J. STEIN** and **M. GLICKSTEIN.** *Brown Univ., Providence, RI, and Univ. Lab. of Physiology, Oxford Univ., Oxford, England.*

1:45 Ascending projections of brainstem genital sensory neurons in the female cat. **J. D. ROSE.** *Dartmouth Col., Hanover, NH.*

2:00 Representation of the cornea in the brainstem of the rat. **S. NAGANO, J. A. MYERS** and **R. D. HALL.** *MIT, Cambridge, MA.*

2:15 Response characteristics of neuron subsets in the rostral trigeminal nucleus excited by the lingual nerve. **M. A. BIEDENBACH.** *Univ. of Washington, Seattle, WA.*

2:30 Projection of tooth pulp afferents to the spinal trigeminal complex. **S. G. NORD** and **R. F. YOUNG.** *SUNY Upstate Med. Ctr., Syracuse, NY.*

2:45 Location and response properties of neurons in the caudal trigeminal nucleus excited by the ethmoidal nerve. **R. W. BEUERMAN** and **M. A. BIEDENBACH.** *Univ. of Washington Sch. of Med., Seattle, WA.*

VOLUNTEER PAPERS

92. Cellular Neurophysiology

1:00 PM—*Tiara Lounge South, Chase-Park Plaza Hotel*

Chairman: **P. D. COLEMAN**

1:00 Effect of light deprivation on the electrooretinogram and the visual evoked response in the rat. **R. F. SPENCER, J. G. PARNAVELAS** and **P. D. COLEMAN.** *Univ. of Rochester Sch. of Med. and Dent., Rochester, NY.*

1:15 Electrophysiologic and vascular measurements of the cat's retina exposed to X-irradiation. **C. T. GAFFEY.** *Donner Lab., Univ. of California, Berkeley, CA.*

1:30 Signal processing by type III (on/off) ganglion cells in the frog's visual system. **F. S. KNOX III.** *LSU Sch. of Med., Shreveport, LA.*

1:45 Abrupt transition in the duration of posttetanic potentiation as a function of temperature in *Aplysia californica.* **W. T. SCHLAPFER, G. A. SMITH, P. B. J. WOODSON, J. P. TREMBLAY** and **S. H. BARONDES.** *UCSD and VA Hosp., San Diego, CA.*

2:00 Nonlinear growth of facilitation at crayfish and squid neuromuscular junctions. **G. D. BITTNER, V. L. SEWELL** and **M. P. CHARLTON.** *Univ. of Texas, Austin, TX.*

2:15 Possible instrumental avoidance in *Paramecium.* **D. J. BENSON, W. B. RUCKER** and **C. McDIARMID.** *Mankato State Col., Mankato, MN.*

2:30 An ultrastructural study of the rat medial habenular nucleus. **J. L. RIBAS** and **C. P. WINGFIELD.** *Walter Reed Army Inst. of Res. and Armed Forces Inst. of Pathol., Washington, DC.*

2:45 A technique for producing mathematically predictable etched microelectrodes. **J. G. McELLIGOTT, J. R. ALDEGHI, M. H. LOUGHNANE** and **R. J. TALLARIDA.** *Temple Sch. of Med., Philadelphia, PA.*

ABSTRACTS

1 EFFECT OF LITHIUM CARBONATE PRETREATMENT ON ETHANOL INDUCED DEPRESSION AND HYPOTHERMIA IN MICE; COMPARATIVE STUDY WITH DH-524 AND OTHER DRUGS. Abdulmuniem H. Abdallah, Douglas M. Roby, Chem. Biol. Res., Dow Chemical Co., Midland, Michigan.

The effect of lithium carbonate, DH-524 (2-(3,4-dichlorophenoxy)methyl-2-imidazoline), bemegride, doxapram and d-amphetamine pretreatment on ethanol induced depression and hypothermia was studied in male mice.

The compound DH-524 (10, 15 mg/kg iv) significantly antagonises ethanol induced narcosis and hypothermia. d-Amphetamine (2 mg/kg iv) and Lithium carbonate (20 and 40 mg/kg iv) antagonise only the hypothermic effect of ethanol. Moreover, unlike d-amphetamine, DH-524 does not significantly increase spontaneous motor activity of mice. Bemegride (10 mg/kg iv) and doxapram (25 mg/kg iv) do not significantly antagonise the effect of ethanol. In fact, doxapram potentiates, rather than antagonises the effects of ethanol. In conclusion, DH-254 differs from all other agents tested in that it antagonises the pharmacological effects of ethanol in doses which produce no other pharmacological effects.

2 ORGANIZATION OF THE SUPERIOR VESTIBULAR NUCLEUS OF THE SQUIRREL MONKEY. William K. Abend* (SPON: R. Schor). Dept. Physiol., Univ. of Chicago, Chicago, Ill. 60637

Single units were recorded in barbiturate-anesthetized, cerebellectomized animals. Convergence of canal inputs and the response to controlled angular accelerations were studied. One series of socalled intact animals had 6 active semicircular canals. Another series had the 3 canals on one side rendered nonresponsive by plugging; the superior nucleus on the plugged and unplugged sides was explored. Convergence was studied by successive stimulation of each pair of parallel canals. Spread of the stimulation to canals not under test was controlled by a procedure involving reversal of response direction by small shifts in canal position. Convergence of inputs from nonparallel canals was detected in about 10% of the units in intact animals. In some units convergence was confirmed by demonstrating addition of response magnitudes when the associated canals were simultaneously stimulated. Units influenced by the ipsilateral superior canal were usually located in the lateral half of the nucleus, posterior canal units in the medial half. Relatively few horizontal canal units were found. Data from the plugged and unplugged sides indicate that all 6 canals provide inputs to the nucleus; almost all units receive a Type I canal input. Electrical polarization of the round windows shows that almost all units have a bilateral labyrinthine input. These results demonstrate that most units receive a synergic input from parallel canals, involving a crossed inhibitory pathway. This synergy is reflected in two ways. First, the mean sensitivity to angular acceleration of units on the unplugged side is roughly one half that of units in intact animals. Second, units on the unplugged side have nearly linear input-output relations until inhibitory cut-off occurs. Plugged-side units have inhibitory cut-off and excitatory saturation. (Supported by NIH and NASA grants)

3 SPEECH LATERALITY: ITS ORIGIN. William L. Abler* (spon.: Karl H. Pribram) Dept. of Psychology, Stanford University, Stanford, CA 94305

The course of development of the tongue in embryo shows that the tongue is a bilaterally fused organ. Selectively impeding the movements of first one side of the tongue during speech, and then the other, showed that the two sides of the tongue exhibit asymmetry with respect to skill in speaking. During speech, one side of the tongue must lead while the other side follows on borrowed skill. Speech laterality must have developed in the brain as a result of a need to obtain unique control of a bilaterally fused organ: Any time that the two halves of the brain are not giving precisely the same instructions at precisely the same time, the two sides of the tongue would enter into direct muscular competition. Speech laterality developed in the brain when one side won the competition for control of the bilaterally fused tongue. Cross lateral skill borrowing is the device by which one side of the brain controls the movements of the entire tongue by controlling the movements of only one side.

4 EVIDENCE CONCERNING A VESTIBULAR CONTRIBUTION TO SPONTANEOUS ALTERNATION IN RATS: A PROGRESS REPORT. L. Abraham*, M. Potegal and S. Manning*. (SPON: S. Gilman). Columbia Teachers College, 10027; N.Y. State Psychiatric Institute, 10032; and Hunter College, CUNY, 10021, New York, N.Y.

According to Douglas (JCPP 62:171, 1966) rats' above chance tendency to enter alternate arms of a T-maze on successive trials (spontaneous alternation) is guided largely by feedback from the vestibular system supplemented by olfactory input from the odor trail of the Ss' previous response. Manipulation of testing conditions, based on this analysis, make it possible to compare spontaneous alternation guided by olfactory cues (OSA) to spontaneous alternation guided by vestibular cues (VSA). In a direct test of the vestibular contribution to these behaviors, we found that Ss with bilateral vestibular neurotomies failed completely to alternate in the VSA condition, but were relatively unimpaired when compared to control Ss with VII nerve lesions in the OSA condition. In performing the neurotomies, a new surgical approach to the vestibular branch of the VIII nerve through the external auditory meatus and oval window was used; though histology is not yet available high speed cinematography revealing failure of S's righting reflexes when dropped has demonstrated there is extensive damage of the vestibular nerves.

While this work appears to confirm a vestibular contribution to VSA, there are conflicting reports on the effects of intertrial rotation. Douglas reported a disruption of VSA with intertrial rotation; other studies, including preliminary work in our own laboratory, have failed to find such disruption. We are now attempting to resolve these discrepancies.

5 MEDULLARY PROJECTIONS OF GROUP I AND II AFFERENTS FROM NECK MUSCLE IN THE CAT. V.C. Abrahams and P.K. Rose*. Department of Physiology, Queen's University, Kingston, Ontario, Canada K7L 3N6.

The medullary course of Group I and II afferents from the neck muscle, biventer cervicis, were examined using conventional microelectrode techniques. The most abundant medullary projection is to the spinal nucleus of the trigeminal nerve. Primary fibres ascend dorso-laterally, turn ventrally and then terminate among cells with connections from cutaneous receptors of the face. The second order cells from neck muscle do not appear to have facial fields. Primary afferents also are present in narrow bands between the external cuneate nucleus and the spinal nucleus of the trigeminal nerve and in the ventral part of the cuneate nucleus. In one experiment, substantial termination of Group I and II primary afferents was found in the ventral cuneate nucleus adjacent to units activated by light touch of the skin of the neck. Primary afferents from neck muscle terminate within 2-3 mm of the obex and do not appear to travel higher in the brain stem. Thus, neck muscle afferents like forelimb muscle afferents have a cuneate projection, but unlike other lower body proprioceptive projections also have a substantial primary input to the spinal trigeminal nucleus.

Supported by M.R.C. of Canada.

6 VESTIBULAR CONNECTIONS TO THE RETICULAR FORMATION. Charles Abzug and Barry W. Peterson. Rockefeller University, New York, N.Y. 10021.

Electrical stimulation was applied to various portions of the vestibular system, and averaged intracellular responses were recorded intracellularly from neurons located in the contralateral medial ponto-medullary reticular formation (RF) of cats anesthetized with pentobarbital. When the stimulus was applied to the vestibular nerve, only 48% of the neurons exhibited a short-latency PSP with a magnitude of 100μV or more. However, when stimuli were applied directly to various portions of the vestibular nuclear complex, 81% of the contralateral RF neurons exhibited a response. Minimum latency both for EPSPs and for IPSPs was 0.8 msec, and most latencies were below 3.0 msec. In several instances PSPs of one polarity were evoked from more than one site. In such cases, when EPSPs were produced the superior nucleus was usually the most effective site. For IPSPs there was no particular region that predominated. In many cases high-frequency testing suggested that the PSPs were monosynaptic, even though the range of latencies was long compared to the straight-line conduction distance, which was never longer than 7 mm. Also, PSPs were evoked from the vestibular nuclei in many RF neurons that did not respond to stimulation of the vestibular nerve even with triple shocks. Therefore we also studied the antidromic response times of vestibular neurons from the contralateral RF, and found a range from 0.6 to over 3.0 msec. Most of the antidromically responding neurons were not activated even polysynaptically by stimulation of the vestibular nerve. We conclude that the secondary vestibular neurons that project to the contralateral RF either have tortuous pathways or else project via fibers of slow conduction velocity. Furthermore, the function of these neurons is not simply to relay information from primary vestibular receptors. Supported by grants NSF GB 36927 and NS 02619. C.A. was an NIH Postdoctoral Fellow.

7 EFFECTS OF THE HYPERBARIC ENVIRONMENT ON SELF-STIMULATION BEHAVIOR IN THE RAT. Michael J. Ackerman and Morris Waxler.* Behav. Sci. Dept., Nav. Med. Res. Inst., Bethesda, Md. 20014

Electrical stimulation of the brain (ESB) has been shown to be an extremely powerful reinforcement that can be used to maintain a stable rate of bar-press behavior (self-stimulation). Rats chronically implanted with electrodes in the lateral hypothalamus were taught to bar press for ESB (1/4 sec of 60 Hz AC). After stable bar-press rates had been established, Ss were exposed to the hyperbaric environment with different mixtures of oxygen, nitrogen, and helium. Changes in the rate of bar-press behavior were noted. These changes may be attributed to the narcotic effect of breathing nitrogen under pressure.

8 EFFECTS OF MARIJUANA ON CAT SLEEP-WAKEFULNESS STAGES FOLLOWING PRE-TREATMENT WITH P-CHLORO-PHENYLALANINE AND 5-HYDROXYTRYPTAPHAN. P. M. Adams and E. S. Barratt, (Sponsored by J. T. O'Neal), Dept. of Psychiatry, University of Texas Medical Branch, Galveston, Texas 77550.

Daily eight-hour recordings of EEG, EOG, and EMG from chronically implanted cats were used to monitor arousal, slow wave sleep, rapid eye movement (REM) and drowsy or light sleep. Following 5 days of baseline, the cats were given 50mg/kg of either P-chloro-phenylalanine (PCPA) or 75mg/kg of 5-Hydroxytryptaphan (5-HTP) for 5 successive days. Daily recordings of the sleep-wakefulness stages were made throughout. Following pre-treatment with 5-HTP or PCPA, 15 days of daily marijuana (2.7mg/kg Delta 9-tetrahydrocannabinol) treatment were administered with a 5-day recovery period immediately following. Slow wave sleep was significantly effected with both pre-treatments. Increased slow wave activity following 5-HTP was potentiated by the subsequent treatment with marijuana. The depressed level of slow wave sleep found with PCPA was followed by enhanced recovery and subsequent depression as marijuana treatment continued. These results suggest the importance of further study into the possible role of serotonin (5-HT) in the action of marijuana on the neurophysiology of sleep-wakefulness.

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9 EFFECT OF ATROPINE ON THE ACETYLCHOLINE RECEPTOR-IONIC CONDUCTANCE MODULATOR COMPLEX OF THE FROG SARTORIUS MUSCLE. M. Adler* and E.X. Albuquerque. (SPON: E. Koenig). Dept. Cell Biol. & Pharmacol., Univ. Maryland, Sch. Med., Baltimore, Md. 21201

The effect of the anti-muscarinic agent, atropine, was investigated on frog sartorius muscle using conventional voltage clamp techniques. Endplate currents (EPCs) were recorded from glycerol-treated muscles at 20°C under control condition and after the addition of atropine to the muscle bath. The time course of the EPC, which reflects the underlying conductance change of the sub-synaptic membrane following action of ACh, underwent marked alterations in the presence of atropine; a concentration (6.0×10^{-5} M) of the drug which reduced the EPC to $\sim$ 50%, shortened the rise time and half-decay time (HDT) by 25 and 53%, respectively, at a holding potential of -90 mV. The falling phase of the EPC did not depart from a single exponential function, but its voltage sensitivity disappeared during treatment with atropine. The reduction of the HDT was found to be dose dependent: a small reduction in the HDT (18%) was evident at a concentration of 1.5×10^{-5} M, and 70% shortening of the HDT occurred at 1.5×10^{-4} M. Further increases in drug concentration abolished the EPC with no additional changes in time course, suggesting that atropine may affect the amplitude and time course by separate mechanisms. The EPC equilibrium potential was shifted from a mean value of -0.46 mV in control to a mean of +4.6 mV in the presence of atropine (1.5×10^{-4} to 6.0×10^{-5} M), indicating a possible preferential blockade of potassium conductance. The alterations of the EPC were reversed following 60 to 90 min wash with normal Ringer's solution. The shortening of the EPC time course suggests that atropine may block the ionic conductance modulator (ICM) in the open conformation. ICM is our designation for the macromolecular entity associated with the cholinergic receptor and involved in the regulation of ionic conductance at the endplate. (Supported by USPHS Grants NS-08233 and GM-00107.)

10 SENSORY FIELD OF THE PUDENDAL NERVE IN FEMALE RATS: CHANGES OVER THE ESTROUS CYCLE. Norman T. Adler, Barry R. Komisaruk, and Paula Davis.* University of Pennsylvania, Rutgers University - Newark, Rutgers University -- New Brunswick.

Multi-unit activity in the pudendal nerve of estrous-cycling female rats was recorded. By applying tactile stimuli to the genital region of the body surface, the size and sensitivity of this peripheral nerve's sensory field were measured. The purpose of this experiment was to determine whether this nerve's sensory field would change over the estrous cycle. Previously, we found that exogenous estrogen increased the size of the sensory field in ovariectomized rats (Science, 1972, 178:1295). We employed three measures of sensory field size: 1) length of field from the tip of the clitoris to the maximum dorsal border, 2) maximum lateral extent from midline and 3) total area. A measure of sensitivity was derived by determining threshold to calibrated fibers (von Frey hairs) at six standard points in the field and then taking the average. All females showed normal estrous cycles. On the basis of vaginal smear records and manual tests for lordosis, each female was classified as "estrous" or "diestrous." Estrous females had significantly larger and more sensitive sensory fields than diestrous females. The percentage increase for the four different measures varied between 17% and 28%. For estrous and diestrous conditions respectively, mean clitoral field lengths were 9.7 and 7.6 mm; lateral field lengths were 27.3 and 23.2 mm; total areas were 319 and 249 mm^2. The mean thresholds for the two groups (in $\log_e$ force in mg) were 2.90 and 3.53. The dynamics of this peripheral nerve are therefore sensitive to changes correlated with the estrous cycle.

11

Abstract withdrawn

12 ELECTROPHYSIOLOGICAL CORRELATES OF STIMULATION-PRODUCED ANALGESIA, MORPHINE ANALGESIA, AND THEIR BLOCKADE BY NALOXONE. Huda Akil *, and Donald E. Richardson * (SPON: Frank Krasne). Dept. Neurosurgery, Sch. Med., Tulane University, New Orleans, La. 70112

Electrical stimulation of subcortical sites can produce total blockade of pain in rat, cat and man. This stimulation-produced analgesia (SPA) appears to exhibit some characteristics of morphine analgesia. This study compares electrophysiological effects of SPA and morphine, and examines the effect of naloxone on both. Cats were chronically implanted in Centray Gray (CG) and Medial Thalamus (MT), and tested for analgesia. Subsequently, average evoked responses to noxious input were recorded from MT, and the effect of CG analgesic stimulation and morphine were compared. Both techniques led to a selective blockade of the same late components. Naloxone alone (0.7 mg/kg) altered the evoked response to noxious input in MT. After recovery of the baseline, naloxone blocked the effect of SPA and morphine on the thalamic evoked response. This work suggests effects of naloxone beyond those specifically associated with narcotic antagonism. Its blockade of SPA has been previously demonstrated in behavioral studies in the rat (Akil et al, in prep.). The parallels in the electrophysiological effects of morphine and SPA, and the blockade of both by naloxone, further support the notion that these two powerful analgetic techniques might act by modulating a common pain inhibitory mechanism in the brain.

13 APHAGIA AND ADIPSIA IN RATS PRODUCED BY KNIFE CUTS VENTRAL TO THE GLOBUS PALLIDUS. George F. Alheid* and Sebastian P. Grossman. (Spon: Hazel Murphy) Dept of Psychol., Univ. of Chicago, Chicago, Ill. 60637

Knife cuts were made in a plane parallel, and adjacent to the ventral surface of the globus pallidus of male, albino, rats. Following surgery the animals were aphagic, (median 4.5 days) and adipsic (median 7.5 days). In contrast to the well known syndrome following lateral hypothalamic (LH) lesions these animals did not display permanent adipsia in recovery, (i.e. when completely food deprived) and were able to respond to a glucoprivic challenge from i.p. injection of 2-deoxy-glucose (600 mg/kg) by increased food intake. It is concluded that the sectioned nerve pathways may contribute to the lateral hypothalamic syndrome and that the permanent deficits with regard to food and water regulation found after LH lesions are not a necessary consequence of surgically induced aphagia and adipsia.

14 CEREBRAL INPUTS TO DENTATE NEURONS IN PRIMATES. Gary I. Allen, Peter F.C. Gilbert* and Tom C. T. Yin. Dept. of Physiology, State Univ. of New York at Buffalo, N. Y. 14226

The lateral nucleus of the cerebellum (dentate nucleus) is part of a cerebro-cerebello-cerebral circuit that has been implicated in the control of skilled movements. The present study was designed to determine the response characteristics of single dentate neurons to cortical stimulation in cebus monkeys under nitrous oxide anesthesia. The projection pattern of inputs to these neurons from motor, somatosensory and association areas of the cerebral cortex was studied, thus extending previous observations on the cat. The responses of dentate neurons consist of combinations of the following components: early inhibition, excitation, later inhibition, and rebound excitation. The excitation is weaker and the rebound stronger than in the cat. Several regions of the sensorimotor and association areas project somatotopically to dentate. The association areas project to all portions of dentate while the motor cortex tends to project to the more dorsal portion of dentate. Although not all possible regions of the cortex were stimulated, the association areas projecting most strongly to dentate in these experiments were: area 6 on the mesial surface (supplementary motor area) and on the lateral surface (premotor), and prefrontal cortex. Inputs from peripheral nerves were generally ineffective in activating the dentate neurons. Since the dentate nucleus projects to the motor cortex, the neuronal circuitry is available for a pathway from association and motor areas through the cerebellar hemisphere to motor cortex. These observations are consistent with the hypothesis that the cerebellar hemisphere and dentate participate in the planning and pre-programming of movements.

15 THE ROLE OF THE LIMBIC SYSTEM IN THE HYPERSECRETION OF ACTH FOLLOWING ADRENALECTOMY IN THE RAT. J. P. Allen* and C. F. Allen* (SPON: N. Hagino). School of Aerospace Medicine, Brooks AFB, Texas 78235 and S. W. Foundation for Research and Education, San Antonio, Texas 78230.

Recent studies have shown that extra hypothalamic central nervous system (CNS) elements which enter the medial basal hypothalamus laterally are essential for the compensatory hypersecretion of ACTH following adrenalectomy (adx) in the rat. These findings prompted us to study the role of various limbic system structures in this physiologic mechanism. In three separate experiments, plasma ACTH concentrations were measured in adrenalectomized adult male rats in which the septal region, amygdaloid complexes, or their hypothalamic efferents had been destroyed or interrupted. These data were compared to ACTH levels found in intact or adrenalectomized controls. Three weeks after discrete CNS radiofrequency or knife-cut lesions were made and adx performed, the animals were decapitated, and trunk blood collected. Plasma ACTH concentrations were measured by radioimmunoassay. Destruction of the septal region, fornices and striae terminali did not block the post-adx hypersecretion of ACTH. In contrast, bilateral knife-cut lesions between the lateral hypothalamic area and amygdaloid nuclei which severed the direct medial projecting amygdalo-hypothalamic fibers but not the striae terminali blocked the increased ACTH secretion normally present following adx. Animals with bilateral amygdalar destruction and adx did not survive three weeks. These data suggest that the amygdaloid complexes in the rat may function as a glucocorticoid sensor involved in the compensatory hypersecretion of ACTH following adrenalectomy. Furthermore, the direct amygdalo-hypothalamic pathway and not the striae terminali appear essential for this physiologic effect.

16 BRAIN STEM AFFERENTS TO THE VESTIBULO-CEREBELLUM AS MAPPED WITH HORSERADISH PEROXIDASE TRACERS. K. E. Alley*, R. Baker and J. I. Simpson*. Div. Neurobiol., Dept. Physiol. & Biophys., Univ. Iowa, Iowa City 52241.

The visual and vestibular systems provide two important sources of inputs to the vestibulo-cerebellum. We have studied the projections from precerebellar nuclei in the brain stem to the flocculus and nodulus in adult rabbits and cats, utilizing combined morphological and physiological techniques. Micropipettes, filled with HRP (40% in 0.9% saline), were used for recording and injecting small doses of peroxidase (0.5-2.0 µl) into areas of the vestibulo-cerebellum where visually evoked climbing fiber activity was found. These same areas also receive mossy fiber inputs from vestibular stimulation. Injections into the flocculus produced a positive peroxidase reaction in a circumscribed region of the rostral third of the medial accessory olive and the dorsal cap of Kooy. Additional peroxidase activity was identified in the neurons of the pontine and vestibular nuclei as well as in Scarpa's ganglion. Nodular injections yielded a reaction product in the ß nucleus and a contiguous portion of the medial accessory olive. In addition, scattered groups of midline medullary and vestibular (primary and secondary) neurons were labelled. These experiments indicate that there are two distinct olivary projections to the flocculus and nodulus. Visually evoked responses were recorded in the posterior third of the inferior olive, and subsequent electrolytic lesions indicated that the field potentials were localized to the dorsal cap and ß nucleus. It is therefore suggested that the visually related climbing fiber activity recorded in the flocculus and nodulus is channeled through this region of the olive; however, the physiological function of the other olivary and pontine inputs to the vestibulo-cerebellum identified with HRP remains to be analyzed. (Supported by USPHS research grants EY-01074 from NEI and NS-09916 from NINDS.)

17 A STUDY OF THE EQUILIBRIUM INHIBITION OF THE BINDING OF α-BUNGAROTOXIN TO THE ACETYLCHOLINE RECEPTOR BY SERUM IgG FROM MYASTHENIA GRAVIS PATIENTS. Richard R. Almon, Clifford G. Andrew*, and Stanley H. Appel*. Div. Neurology and Dept. of Biochemistry, Duke University Medical Center, Durham, North Carolina, 27710

Impaired neuromuscular transmission has been implicated in the muscle disorder Myasthenia Gravis (MG). Although the exact site of the pathophysiologic defect has not been defined, recent evidence suggest involvement of the acetylcholine receptor. A syndrome similar to MG has been observed in rabbits immunized with electric organ acetylcholine receptor. In addition diminished binding of the cholinergic ligand α-bungarotoxin to MG muscle biopsies has been reported. In the present experiment we have examined the equilibrium properties of the interaction between skeletal muscle ACH receptor, α-Bgtx and serum IgG from certain patients with MG. The results show that the IgG(MG) is a cooperative, non-competitive inhibitor of the binding of α-Bgtx to the acetylcholine receptor derived from denervated mammalian skeletal muscle. At saturation levels of IgG(MG), the number of acetylcholine receptor sites is effectively reduced by 40%. Although the IgG (MG) inhibits the binding of α-Bgtx to the ACH receptor, α-Bgtx does not prevent the IgG(MG) from binding to the 9.5 S receptor particle. Serum IgG, derived from sources other than MG patients, neither binds to the acetylcholine receptor nor inhibits the binding of α-Bgtx to the ACH receptor. These data show that serum IgG against the ACH receptor is present in certain patients with MG and may mediate the impaired neuromuscular transmission observed in this muscle disorder.

18 THE EFFECTS OF COCAINE AND D-AMPHETAMINE ON SIMIAN ELECTROENCEPHALOGRAPHIC RESPONSES TO PHOTIC DRIVING. H.L. Altshuler, N.R. Burch*, P.E. Phillips* and R.G. Dossett*. Texas Research Institute of Mental Sciences and Baylor College of Medicine, Houston, Texas 77025.

Cocaine (C) and d-amphetamine (A) were previously demonstrated to produce pronounced changes in the period analytic descriptors of the spontaneous occipital electroencephalogram (EEG) of the monkey, which were unrelated to photic responses. The current study reports EEG responses to photic stimulation at frequencies of 3-30 Hz following C and A. Experiments were done in which intravenous doses of saline, C (0.5 mg/kg - 5.0 mg/kg) and A (0.25 mg/kg - 2.5 mg/kg) were administered to rhesus monkeys during 90 minute experiments composed of both spontaneous and photically driven EEG recordings. Both drugs caused profound changes in the EEG responses to photic stimulation. Photic driving responses were uniformly inhibited at the stimulation frequency following 2.5 mg/kg of C and 0.5 mg/kg of A, but the responses were shifted to other frequencies often in proximity to the driving frequency. The shift in response frequency was not observed as shifts to harmonic frequencies, nor were there clear dose-related aspects to the response shifts. The extreme potency of these compounds in altering EEG responses to photic stimulation demonstrates further the profound effects of C and A on the primate visual system.

19 THE ROLE OF THALAMIC N. VA-VL IN AVERSIVE CONDITIONING OF CONTACT PLACING. Vahe E. Amassian, Christian T. Wertenbaker* and Harvey Reisine*, Dept. of Physiology, SUNY, Downstate Medical Center, New York 11203.

Contact placing (CP) in cats is usually inhibited within a few trials if a compartment filled with water is substituted for the solid surface on which the forepaw had previously landed; it is restored (disinhibited) after the affected paw has been put on a solid for, e.g., 20 sec (Wertenbaker et al. (1973), Brain, Behav. Evol. 8:304-320). We have tried to define the neural circuits subserving plasticity of CP, preparatory to making an electrophysiological analysis. Unilateral lesions of various sizes and locations in VA-VL of 7 cats yielded, after recovery of CP in the contralateral forepaw, marked deficits in water inhibition if the lesions were large and included antero-ventral portions of VA. One of the most effective lesions in the series caused the least reduction (to 43% of the control side) in the MI surface positive response to stimulation of contralateral N. interpositus; the inference that VA-VL subserves water inhibition by processing an alternative outflow to that from the cerebellum agrees with the finding, in 4 cats, that massive lesions of N. interpositus either alone or with N. dentatus, or of N. fastigius did not impair water inhibition.

During the testing period, a VA-VL lesion did not grossly impair the aversive response to passively lowering the affected paw into water; the lesion might impair a memory function and/or the motor pathway for water inhibition. While the former cannot be excluded, it is significant that CP recovering from a VA-VL lesion is markedly 'jerky', suggesting a release from an inhibitory process; in the intact cat, such process might prevent CP during water conditioning. (Aided by USPHS grants, NS 11219 & 05773).

20 CHOLINERGIC ENHANCEMENT AND SUPPRESSION OF DESYNCHRONIZED SLEEP. T. Amatruda*, T. McKenna*, D. Black*, R.W. McCarley, and J.A. Hobson. Dept. Psychiat., Harvard Med. Sch., Boston, Mass., 02115.

Lesion, stimulation, and cell recording experiments implicate the pontine tegmentum in desynchronized sleep (D) generation. We have proposed that neurones of the gigantocellular tegmental field (FTG) may use acetylcholine as their transmitter, be cholinoceptive, and drive D; in our model, FTG cells are reciprocally interconnected and reciprocally interactive with cells of the locus coeruleus (LC) which may use norepinephrine as their transmitter, be cholinoceptive, and inhibit the FTG suppressing D. We wished to investigate the phenomenon of carbachol-induced D in the light of our hypothesis by injecting this long-acting cholinergic substance into the regions of the FTG and LC.

Six adult male cats were prepared for chronic electrographic recording and pairs of parallel guide tubes were aimed at the LC (L 1.9 - 2.3, A 2.5, H.C. -2.5) and FTG (L 1.9 - 2.3, P 1.1, H.C. -5.5) in the ipsilateral tegmentum. 3 ug or 9 ug carbachol in 3 ul artificial CSF, or CSF alone, were injected through cannulae whose tips were directed at the sites of interest via the guide tubes after the cats had been acclimated to a head restraint box. Recordings of EEG, EMG, and EOG were scored for waking, synchronized sleep, and D for four hours post injection. Injection sites were localized histologically to nuclear groups using Berman's atlas and terminology.

Carbachol induced a range of effects including very prolonged D episodes when injected into the pontine tegmental reticular formation. The enhancement of D (when compared to a baseline of 6.2%) was maximal in the FTG (30.3%), less marked at FTG boundaries (13.3%), and minimal in other tegmental loci (9.6%). At LC sites, D suppression was observed (1.5%). The results are consistent with the interactional model.

21 THE NEUROPHYSIOLOGICAL BASIS OF "DISTINCTIVE FEATURES". James A. Anderson. Div. of Applied Math., Div. of Bio-Med. Sci., Brown University, Providence, R. I. 02912.

A model for memory, suggested by neurophysiological and neuroanatomical considerations, has been presented previously. We assume (1) nervous system activity is most usefully represented as the set of simultaneous individual neuron activities in a group of neurons, (2) different memory traces interact strongly at the synapse, that is, different traces make use of the same synapses, and (3) individual synapses associate two patterns of neural activity by incrementing synaptic connectivity proportional to the product of pre- and post-synaptic activity, forming a matrix of synaptic connectivities. If we assume there is a positive feedback connectivity matrix of this type connecting a set of neurons to itself (lateral excitation, mediated perhaps by excitatory recurrent collaterals on cortical pyramidal cells) it can be shown that the eigenvectors of the connectivity matrix with large eigenvalues behave in many respects like psychological "distinctive features" and that new inputs will tend to be analyzed in terms of these eigenvectors. The time course of cortical events upon presentation of a stimulus is consistent with these notions.

22 FIRING PATTERNS OF NEURONS IN PUTAMEN AND GLOBUS PALLIDUS DURING STATIC AND DYNAMIC TILT OF AWAKE MONKEYS. M.E.Anderson and Deborah Attwood, Depts of Rehab. Medicine and Physiology and Biophysics and Regional Primate Research Center, University of Washington, Seattle, Wash. 98195.

Participation of the basal ganglia in the control of postural adjustments to changes in the center of gravity are suggested by the absence of appropriate postural adjustments in humans or animals with lesions of these nuclei. The activity of neurons in the putamen and globus pallidus was studied in Macaca mulatta trained to maintain a restricted head position in space during tilt of the primate chair in which they were seated. Chair position was controlled by a servo-driven DC torque motor and was monitored along with logic signals indicating head position within the target zone, EMG activity of neck and/or limb muscles, and activity of neurons in putamen, external, or internal globus pallidus. Tonic firing rates during static chair positions were similar to those reported by De Long (1971); cells in the putamen fire at irregular slow rates, and cells in globus pallidus fire at high tonic frequencies, interrupted by brief pauses. Interspike interval distributions were compared for horizontal, 10 anterior, and 10 posterior tilt static chair positions, and few neurons in putamen or either segment of the globus pallidus showed changes in firing patterns. Most neurons in globus pallidus and a few in putamen showed changes in firing correlated with some phase of continuous or irregularly triggered single cycle sinusoidal or ramp chair tilt. During dynamic tilt some neurons showed firing rate changes strongly correlated with chair position, while others showed changes more closely correlated with velocity or acceleration. Our data indicate that firing patterns of neurons in putamen or globus pallidus do change in association with tilt-elicited postural adjustments in this operant paradigm and suggest further studies to determine the sensory and motor parameters critical to these changes.

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23 ALTERED NEURONAL EXCITABILITY ACCOMPANYING EXPERIMENTAL PREVENTION OF SUPERSENSITIVITY IN UNDERCUT CORTEX. T.E. Anderson*, L.T. Rutledge and R.S. Dyer. Dept. Physiol., Univ. Mich., Ann Arbor, Mich., 48104

Long-term (chronic) electrical stimulation of undercut cortex prevents development of supersensitivity in the partially isolated slab. The current study examined the effect of surface electrical stimulation upon spontaneous spike discharge of cortical cells in experimental and normal cats. Marginal and suprasylvian gyri were undercut on one side in each experimental cat. Some of these cats were implanted with stimulating electrodes in the undercut area and chronic electrical stimulation was given in daily sessions to prevent supersensitivity. Unit studies were made in terminal experiments. In normal cortex, surface stimulation produced inhibition in 80% of the cells, was without effect in 11%, and excited 9%. In undercut-supersensitive cortex 63% of the cells responded with inhibition and the remainder, 37%, showed excitation followed by inhibition. In chronically stimulated undercut cortex, which was not supersensitive, 60% of the cells were unaffected by electrical stimuli. Of the remainder, 35% were inhibited and 5% were excited. Chronic stimulation thus produced apparent changes in the excitability of cortical neurons. However, rates of cell discharge may indicate that different populations were sampled. The mean rate of the 60% unaffected by surface stimulation (undercut-nonsupersensitive) was 4.5/sec. Cells in normal cats showing an inhibitory or excitatory effect, (89%), had a rate of 7.0/sec. In undercut-supersensitive cortex the rate was 6.6/sec. Chronic stimulation may promote, by an unknown mechanism, shifts in the types of cells spontaneously active. Alternatively, the results may be explained by the phenomenon of accommodation produced in some neurons during chronic stimulation. Supported by NIH Grant 04119.

24 BEHAVIORAL AND ELECTROPHYSIOLOGICAL MEASURES OF AROUSAL IN GARTER SNAKES. Michael L. Andry* and Marvin W. Luttges. Dept. Psychol., Dept. Aerospace Engr. Sci., Univ. of Colorado, Boulder, Colo. 80302

Behaviors of garter snakes (Thamnophis radix) were studied under varying stimulus conditions and then categorized as representative of six possible states of arousal. Two electrophysiological measures of arousal were studied. (1) Clip electrodes attached to the lateral anterior surface of the body recorded the electrocardiograph. (2) Electrodes implanted on the surface and in the depths of the brain recorded the electroencephalograph (EEG). Heart rate was found to be a good indicator of behavioral excitation in general, but did not distinguish between very transient changes in excitation level. Both power spectral and visual analyses of EEG samples yielded several parameters which identified excitation levels much more precisely than did heart rate. Total power, power of specific frequency ranges, and power ratios between different frequency ranges within an EEG sample all served to identify excitation level. The power of 1-3 Hz. EEG activity indicated amount of behavioral excitation; additional examination of the power of 6-11 Hz. EEG activity designated the excitation level. For the first time a systematic quantitative study of relationships between EEG activity and behavioral excitation levels has been reported in a non-mammalian vertebrate. The evidence suggests a commonality in basic features underlying behavior-CNS activity relationships in snakes and mammals.

25 THALAMIC STIMULATION AND LESION EFFECTS UPON LIMBIC INDUCED AGGRESSION. O. J. Andy, L. Giurintano, S. Giurintano*, T. McDonald*. Dept. of Neurosurgery, University of Mississippi Medical Center, Jackson, Miss. 39216.

Aggression is elicited by electrical stimulation of the septo-hypothalamic perifornical region in freely moving cats. Stimulation is started with 3-4 volts and progressively increased with each trial to 12-14 volts and the series repeated in the order of decreasing voltages. The thresholds for eliciting components of the aggressive response are determined. Three similar stimulation series are repeated in conjunction with a simultaneously applied electrical stimulation of the center median nucleus. Thalamic voltages are varied for each of the 3 series. A repeat control series of limbic hypothalamic induced aggression is obtained following which an electrolytic lesion is placed in the center median nucleus. The thresholds for septohypothalamic induced aggression are again evaluated. Stimulation of the center median nucleus decreases the threshold for eliciting septo-hypothalamic induced aggression. Combined electrical stimulation elicits somato-motor components of behavior which could not be elicited with either one stimulated alone. In addition, thalamic stimulation intensified the septo-hypothalamic rage. Thalamic lesions raised the threshold for eliciting rage and reduced its intensity. It is hypothesized that the center median nucleus and surrounding thalamic structures may serve to modulate the character and magnitude of aggressive behavior by modifying the thresholds of excitability of the septo-hypothalamic aggression system.

26 A NEURAL MODEL FOR SCHIZOPHRENIA. Photios A. Anninos, Basim Assaf* and Silvio Zenone*. Dept. of Physics, Sir George Williams University, Montreal, P.Q., H3G 1M8.

A neural net model is presented here based on neurophysiological factors responsible for schizophrenia. These factors may include (a) an imbalance in excitatory and inhibitory processes and (b) inappropriate arousal to stress which is also related to the same effect. This research involves investigation of the effects of variations in "microscopic" structure on the behavior of artificial nerve nets (Anninos, 1972). The simulation procedures described there were utilized, but these procedures are strictly operational and the question therefore arises: how may we define and measure net behavior and how may we distinguish between "normal" and "abnormal" behavior patterns? In this model we consider as the "normal" structure the one which the cyclic activity (Anninos, 1972) is proportional to the stimulus. It is also reasonable to expect that at least with few specific patterns of "microscopic" organization a deviation may be detected from this proportionality and these patterns may be identified on a strictly operational basis - with "abnormal", in our case "schizophrenic", structure of the net. Study of such neural net structures may give us insight into the laws of organization and behavior of such abnormality.

Photios A. Anninos. Kybernetik. 11, 5-14 (1972).

27 PROPERTIES OF SYNAPTIC MEMBRANOUS AND MITOCHONDRIAL MONOAMINE OXIDASE OF THALAMIC AREA OF BOVINE BRAIN. R.C. Arora*, C. Vugrincic*, F. Ungar* and S.G.A. Alivisatos. Dept. Biochem., Chicago Med. Sch., Chicago, Ill.,60612

Monoamine oxidase (MAO), an enzyme responsible for the oxidative deamination of biogenic amines is considered to play a role in the activity of the central nervous system. It is considered to be localized in outer mitochondrial membranes. However, studies in liver and heart indicate the presence of membranous MAO activity other than those of mitochondria (Experientia 27: 30, 1971). DeRobertis reported the presence of synaptic membranous MAO in addition to its mitochondrial MAO in rat brain cortex. These reports led us to examine the presence of MAO in synaptosomes and synaptic membranes of thalamic area of bovine brain and compare the properties with its mitochondrial MAO. Synaptosomes were obtained on discontinuous sucrose gradient. Hypoosmotic shock of synaptosomes yielded the mixture of membranes and mitochondria, which were separated and isolated again by sucrose discontinuous gradient and ficol gradients. Various marker enzymes such as acetylcholinesterase, Na^+/K^+-dependent ATPase and NAD-glycohydrolase (NAD'ase) for synaptic membranes and rotenone insensitive NADH cytochrome c reductase and succinic dehydrogenase for mitochondrial membranes were used in our study. We found the presence of MAO in the membrane particles particularly those obtained at the interface of 0.9 M and 1 M which were free from contamination of mitochondrial membranes as shown by the absence of marker enzymes. Membranes (1.0 M) and mitochondria both have MAO enzyme A and enzyme B. Chloroform and methanol (2:1) treatment of synaptic membrane increases sp. activity while in the case of mitochondria, there is no change or slight decrease in the sp. activity. Studies were also done using inhibitors; pargyline and clorogyline. The studies reveal the presence of MAO in synaptic membranes in addition to that in the mitochondria and their difference in properties. (Supported by NIMH, NSF of National Institutes of Health and the Deree Foundation, U.S.A.)

28 WHAT ARE THE NEURONS IN VL TELLING THE MOTOR CORTEX? H. Asanuma, and R.W. Hunsperger, The Rockefeller University, New York, N.Y., 10021

Asanuma, Fernandez, Scheibel and Scheibel have recently reported the existance of special wide projection fibers arising from VL and terminating in the motor cortex (Exp. Brain Res. 1974). These fibers arise from neurons which do not receive specific inputs from the periphery, but rather receive diffuse information such as twisting of joints or pressure applied to deep structures over wide fields. The present experiments were designed to investigate the functional significance of these inputs to the motor cortex. Acute and chronic experiments were performed with cats on the skull of which was mounted a closed chamber. Microstimulation in the ventral thalamus produced descrete contraction of a limb muscle. These contractions were not abolished by chronic ablation of the motor cortex but disappeared by section of the rubro-spinal tract. After chronic section of the brachium conjunctivum, microstimulation of VL either did not produce muscle contraction or produced contractions which had different characteristics from those seen in intact cats. In such cases the characteristics of the responses suggested that the projection from VL to the motor cortex is not specific but diffuse, indicating that the inputs from a given small area in VL are not transfered to a specific cortical efferent zone but to a group of zones. From these results it was concluded that afferent inputs from VL to the motor cortex are not only carrying diffuse information from the periphery, but also relaying specific information to a group of efferent zones about what outputs are being sent from the subcerebellar nuclei to the spinal cord.
(Supported by NIH grant #NS 10705)

29 INHIBITION OF SYNAPTOSOMAL BIOGENIC AMINE UPTAKE BY SYMPATHOMIMETIC AMINES. Ruth Ashkenazi and Bernard Haber, Marine Biomedical Institute, Univ. Texas Med. Branch, Galveston, Texas 77550

Paramethoxyphenylethylamine (PMPEA) as well as the parent amine, phenylethylamine (PEA) enhance spinal cord monosynaptic reflexes, presumably by interaction with monoaminergic systems (Walker, et al., 1970). In the present studies we have examined the possibility that PMPEA, like PEA, releases biogenic amines in vivo, and that both compounds may interact with reuptake mechanisms. Rat brain synaptosomes were isolated on Ficoll gradients, and incubated at 37° with H^3 serotonin (5HT), H^3 Norepinephrin (NE), H^3 Dopamine (DA) at or below Km concentrations. PEA was found to inhibit the uptake of both catecholamines at micromolar concentrations, whereas the uptake of 5HT was affected to a lesser extent. Conversely, PMPEA was far more effective in blocking 5HT uptake and 10 times less effective than PEA on the synaptosomal accumulations of both DA and NE. I.P.administration of both indirectly acting sympathomimetic amines caused significant depletion of mouse heart and brain NE, whereas only PMPEA at higher dosages depleted brain 5HT. In in vitro studies, both PEA and PMPEA were effective substrates for monoamine exidase, but did not inhibit activity of tyrosine hydroxylase. Behavioral observations suggest that PEA produces an amphetamine like response, and PMPEA a pronounced catatonic state accompanied by tail erection and hyperexcitability to tactile stimuli. From the present data, we conclude that PEA and PMPEA produce alterations in monosynaptic reflexes by release of endogenous NE and 5HT, and by blockade of reuptake mechanisms. Possibly PMPEA has more pronounced and selective effects on serotonergic systems. (Supported by NIH Grant NS 11255, DHEW Grant AA00271, Welch Grant H-504, and supporting grants from the Moody and Lanier Foundations.)

30 A NEW PROGRAM FOR INVESTIGATING ADULT HUMAN SKELETAL MUSCLE GROWN ANEURALLY IN TISSUE CULTURE. Valerie Askanas and W. King Engel. I.R.M., N.Y.U. Med. Ctr., N.Y. 10016 and NIH, Bethesda, Md. 20014.

Although muscle tissue culture (TC) provides unique opportunities for investigating the pathogenesis of human neuromuscular disorders, overgrowing fibroblasts and death of muscle after 3 weeks in vitro has limited previous investigations. With our new "explant-reexplanting" technique, abundant growth of mature muscle in long-term TC was achieved. This enabled us to apply the "sandwich" technique and obtain several histochemical (HC) reactions on serial cross-sections of the cultured fibers. Thus, an advanced degree of muscle fiber maturation but lack of fiber-type differentiation into reciprocally staining fiber types was demonstrated with ATPase (regular myofibrillar and following H^+ and OH^- preincubation), succinic dehydrogenase, NADH-tetrazolium reductase and phosphorylase reactions. For electron-microscopic (EM) study the embedded muscle cultures, with or without prior EM-HC staining, were, en disc, peeled off of the Petri dishes and counterstained with methylene-blue (young myotubes stained light, mature fibers dark). The fibers of special interest by light microscopy (LM) were marked, punched out by our special hollow drill, thin-sectioned, and examined by EM. EM-HC appearance of developing cultured muscle fibers correlated with the fresh-frozen LM-HC cross-sections and longitudinal whole preparations of similar fibers. This program has enabled us to perform detailed HC and EM examination of cultured normal and pathologic human muscle in the successive stages of development and permitted us to devote EM time selectively to those fibers specifically chosen by light-microscopy, a procedure of critical importance when the goal is study in cultured diseased human muscle of structural changes which often occur only in some fibers and only in certain regions thereof.

31 ANATOMICAL AND BEHAVIORAL STUDIES OF STRIATE AND EXTRASTRIATE VISUAL CORTEX IN THE BUSHBABY, G. SENEGALENSIS. Frank Atencio and Jeanette P. Ward. Duke Univ., Durham, NC 27706.

While two visual pathways have been demonstrated in a variety of mammals, present evidence suggests that there may be considerable interspecies differences in the function of each pathway. Thus, a tree shrew without striate cortex is not conspicuously deprived of vision but in simians the striate system is deeply involved in vision. This study was planned to determine if the prosimian visual system was more like that of simians or like that of tree shrews and other mammals. Striate, lateral occipital, posterior inferotemporal or parietal cortex was removed in 10 bushbabies. Each lesion group had a different pattern of thalamic retrograde degeneration. Behavioral testing over a 2½ year period showed the following: Striate lesions gave the most profound visual deficits, but the animals could still discriminate large moving or stationary objects and large stripe patterns. Lateral occipital lesions removed "foveal" vision, but spared 3/4 of area 17 & 18; learning of a simple pattern discrimination was retarded and this deficit was exaggerated when "distracting" cues were added to the pattern. Removal of the temporal area gave deficits like those produced by lateral occipital lesions. Parietal lesions gave no visual deficits. Thus, behavioral effects of striate lesions in the bushbaby resemble those described for the monkey more than the tree shrew, while the other lesions produce disorders resembling those found in most mammals, including macaque and tree shrew. (Supported by USPHS Grant MH 04849 to I.T. Diamond).

32 BIOCHEMICAL AND AUTORADIOGRAPHIC STUDY OF MEDIAN AND DORSAL RAPHE PROJECTIONS AND TRANSPORT RATE USING RADIOACTIVE PROLINE. Efrain C. Azmitia, Jr. and Menahem Segal. Lab of Neuropharmacology, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032.

The rate of transport of labeled proteins was measured in rats injected into the midline raphe with C-L-Proline and killed 0.5, 4,12,24, or 120 h later. The midbrain, hypothalamus-preoptic-septum (HPS), and hippocampus (HC) were dissected out and the amount of labeled proline (pmoles) in TCA particulate or soluble fraction determinded. The expression of the data as pmole/mg-protein and as percent of midbrain radioactivity reveals two types of transport. One wave of radioactive proteins (>30 mm/day) arrives at the HPS within 4 h and at the HC within 12 h and has a fast turnover rate(approx 12 h). A second wave is significant only in the HPS after 120 h. The same injection site was utilized in other rats to trace by radioautography the projections of the median and dorsal raphe using H-L-Proline with survival times of 4-48 h. Raphe efferent axons pass mainly into the median forbrain bundle with major branches to the fasciculus retroflexus, precommissural fornix, diagonal band into the medial aspect of the cingulum bundle, and the stria terminalis. The main terminal areas were the HC, medial and lateral habenular nuclei, medial septal nucleus, mammillary bodies, nucleus of the posterior commissure, olfactory tubercule, pyriform cortex, and the suprachiasmatic nucleus.

33 A COMPARISON OF MICROFLUOROMETRIC AND BIOCHEMICAL ESTIMATES OF CATECHOLAMINE CONTENT IN RAT MEDIAN EMINENCE. N. G. Bacopoulos*, R. K. Bhatnagar, W. J. Schnute* and L. S. Van Orden III. The Toxicology Center, Department of Pharmacology, University of Iowa, Iowa City, Iowa 52242.

A previous report from this laboratory (Pharmacologist, 15:210, 1973) indicated that a poor correlation between microfluorometric estimates of catecholamine content in median eminence and biochemical measurements of whole hypothalamic catecholamines. A better correlation between these two measurements was obtained in other hypothalamic areas and in the caudate nucleus. The present study was undertaken to examine further the discrepancy between the microfluorometric and biochemical studies of the median eminence. Specifically, we attempted to determine whether the slow decline of catecholamines observed histochemically following α methyl-p-tyrosine (αMPT) could be verified biochemically, or was an artifact of the histochemical method. Doses of αMPT chosen to induce the desired levels of catecholamine depletion of whole hypothalamus were given ip. to adult male rats. An isotopic-enzymatic method sufficiently sensitive to measure norepinephrine (NE) and dopamine (DA) in a single median eminence-ventral arcuate nucleus specimen (0.7-0.8 mg of tissue) was employed for comparison with microfluorometric measurements. After αMPT, NE and DA of median eminence declined at rates significantly lower than total hypothalamic catecholamines. In addition NE declined more slowly than DA. Therefore a correlation between the results obtained by the two different methods was obtained when the same tissue was examined. These findings suggest that microfluorometric estimates may, under proper conditions, comprise a reasonable quantitative method for the determination of catecholamines in very small parts of brain.

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34 REGIONAL DIFFERENCES IN THE BEHAVIORAL AND ANATOMICAL EFFECTS OF DEEP CEREBELLAR LESIONS IN THE RAT. Ronald H. Baisden*, Michael L. Woodruff, Barbara Schneiderman* and Alan O. Alderman* (SPON: C. Van Hartesveldt). Dept. of Anatomy, Upstate Medical Center, SUNY at Syracuse, Syracuse, N.Y. 13210; Dept. of Psychology, University of Florida, Gainesville, Fla. 32608.

Several reports have indicated that anatomical connections exist between the cerebellum, particularly the fastigial nucleus, and portions of the limbic system such as the septal area (Harper & Heath, Exptl. Neurol. 39: 285-292, 1973). Electrical stimulation of the cerebellum is known to alter electrical activity of cortex and hippocampus (Iwata & Snider Electroenceph. clin. Neurophysiol. 11: 439-446, 1959). It might be expected that portions of the cerebellum would participate in the modulation of behaviors generally thought to be governed primarily by limbic and midbrain structures. A recent study demonstrating modulation of hypothalamically induced attack behavior in the cat by fastigial stimulation supports this proposal (Reis, et al. Science 182: 845-847, 1973). In the present study normal rats and rats with small bilateral lesions in either the region of the fastigial or dentate nuclei were trained in two-way active avoidance. Rats with deep lateral cerebellar lesions acquired the avoidance task significantly faster than unoperated controls, while rats with deep medial cerebellar lesions were significantly impaired in the acquisition of this task. A sufficient postoperative recovery period was given (6 weeks) to allow for recovery from gross motor deficits resulting from the operation. Additional rats received unilateral lesions in the same cerebellar sites. The brains of these rats were processed using the Fink-Heimer method. Degeneration was observed in the midbrain. The data are interpreted as indicating that both the fastigial and dentate nuclei participate in modulation of two-way active avoidance and should be included with the limbic structures thought to influence this behavior.

35 ACTIVITY OF PRESTRIATE NEURONS IN BEHAVING MONKEY. Joan S. Baizer and David Lee Robinson. Lab. of Neurobiology, NIMH, Bethesda, Md. 20014

Previous studies of superior colliculus have shown that many cells in the superficial layers show an enhanced response to a visual stimulus when it is to be the target for a saccade. This enhancement is selective and occurs only prior to saccades into the area of the receptive field. A few cells in striate cortex also have an enhanced response; however, the effect is not selective for saccades into the receptive field. Prestriate cortex receives a direct input from striate cortex, and may also receive an input from superior colliculus via a thalamic relay. We wished to determine if response properties of prestriate cells more closely reflected those of striate cortex or colliculus. We recorded from cells in the lunate sulcus, mapping their receptive fields while the monkey fixated. We encountered oriented and non-oriented receptive fields. Cells with oriented fields responded best to appropriately placed slits of light and were classified as simple, complex, or hypercomplex. Cells with non-oriented fields responded as well to small spots of light as to slits of any orientation, and to stimulus movement in any direction. Although almost all cells responded to stationary stimuli, some gave much better responses to moving stimuli. We found that some cells in prestriate cortex showed the enhancement effect. As with cells in striate cortex, and in contrast to cells in the colliculus, the enhancement was not selective, occurring prior to saccades into the receptive field and to points far distant from the field. We conclude that some cells in the lunate sulcus have receptive field properties similar to cells of striate cortex, and some similar to colliculus cells, but both types show only non-selective enhancement.

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36 NEUROTRANSMITTER IDENTIFICATION IN SMALL, FLUORESCENT CELLS OF RAT PARACERVICAL GANGLIA BY MICROSPECTROFLUOROMETRY AND IMMUNOHISTOCHEMISTRY. H. A. Baker*, J. A. Redick*, W. J. Schnute* and L. S. Van Orden III. Dept. of Pharmacology, University of Iowa, Iowa City, Ia. 52242

Small, intensely-fluorescent (SIF) cells in rat superior cervical ganglia have been found to contain dopamine (Björklund et al. Acta physiol. scand. 78: 334, 1970). Similar cells occur in prevertebral and terminal ganglia, and identification of the specific catecholamine found in each case is important. Typical terminal ganglia of rats, the paracervical or Frankenhauser's, were examined by three independent methods. Ganglia were frozen and cryostat sections prepared at from -25° to -50°C. Formaldehyde vapor treatment of freeze-dried sections produced the expected catecholamine fluorescence in SIF cells, but did not distinquish between the specific amines. The trihydroxyindole method (Angelakos and King, Nature 213: 391, 1967) yields different emission maxima for norepinephrine (475 nm) and epinephrine (515 nm) and no fluorescence for dopamine. The SIF cell fluorescence observed was characteristic of norepinephrine. Antibodies to dopamine-beta-hydroxylase were employed in a fluorescence immunohistochemical method (Hartman, J. Histochem. Cytochem. 21: 312, 1973) Presence of this enzyme in SIF cells of paracervical ganglia confirmed the microspectrofluorometric studies excluding dopamine as the major catecholamine in these cells. Studies with antibodies against phenylethanolamine-N-methyltransferase are in progress to further test the suggestion that norepinephrine is the principal catecholamine in SIF cells of rat paracervical ganglia.

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37 A MODEL FOR MYOTATIC REFLEX CONTROL OF UPRIGHT STANCE IN MAN. E. Baran* and R. Herman. Temple University Health Scs. Cntr., Phila., 19141

A linear mathematical model depicting the contribution of the myotatic stretch reflex to upright equilibrium control in man is constructed. The model consists of two second order linear differential equations, two first order linear differential equations and a direct variation equation (proportionality factor). The equations have been generated from transfer functions obtained from human and animal neurophysiological data, a mechanical muscle model, and the inverted pendulum equation. The open loop model predicts the muscle forces generated from step and ramp (magnitude $<$ 1 mm) input stretches of the human triceps surae muscle in upright quiet stance. It is assumed that the axis about which anterior-posterior body sway occurs is the ankle axis and the response to input stretches occurs about the ankle. A digital computer program is used to test the model. The OS-8 Fortran system on the PDP-12 digital computer is used to generate the program. The reflex control loop appears to stabilize very small amplitude sway motions by generating 1.5 to 3 ft-lb/degree gains observed from neurophysiological data and the proposed open loop model. The forces generated from the reflex gain contribute to approximately one third of the total forces required to maintain upright stability for small input stretches of the human triceps surae muscle.

Location of Work: Krusen Research Center, Temple University Health Sciences Center, Phila., Pa.
Acknowledgement: Dr. Richard Herman- primary investigator in neural systems control of equilibrium in man.

38 LIGHT MICROSCOPIC LOCALIZATION OF GLUTAMATE DECARBOXYLASE IN BOUTONS OF RAT SPINAL CORD BEFORE AND AFTER DORSAL RHIZOTOMY. Robert Barber*, Barbara J. McLaughlin, Kihachi Saito*, and Eugene Roberts. Div. Neurosci., City of Hope Medical Center, Duarte, Ca. 91010.

Anti-serum to purified glutamate decarboxylase (GAD), the enzyme which forms γ-aminobutyric acid (GABA), has been used to localize GAD immunocytochemically in rat cerebellum, (PNAS:71, 1974) and was found to be specific for boutons of GABA neurons (Brain Res., in press). These methods were used to localize GAD on 75 μ sections of rat lumbo-sacral spinal cord. Light microscopic analysis revealed the relative distribution of GAD containing boutons in the gray matter of the spinal cord. An intense reaction for GAD was evenly distributed throughout laminae I-III, with punctate reaction product appearing heaviest over lamina I and adjacent to Lissauer's tract. Considerably less GAD positive reaction product was observed in deeper dorsal horn laminae (IV-VI). A heavy punctate reaction was found around the central canal and in the area above the central canal occupied by the dorsal commissure. In the ventral horn motor nuclei, an intense reaction was observed on somata of large motoneurons. The spinal cords of animals, on which unilateral dorsal rhizotomies were performed prior to immunocytochemistry, were found to have lost some reactivity in the dorsal horn on the operated side by the third postoperative day. By the fourth day there was almost complete loss of activity in laminae II and III with only a few islands of GAD activity remaining. GAD activity in lamina I was not affected by the rhizotomies. The loss of GAD positive boutons in laminae II and III coincided with the maximal degeneration in primary afferent terminals in the rat dorsal horn (Exp. Brain Res.:6, 1968). This finding may be attributable to a transynaptic effect between degenerating dorsal root fibers and GABA-nergic interneurons in the dorsal horn. Supported by NIH Grants NS-01615, MH-22438 and NS-09578.

39 **TURNOVER IN VIVO OF GLUCOSE CARBON IN GLYCOSPHINGOLIPIDS OF ADULT RAT BRAIN.** Amiram Barkai, Alemka Kisic* and Maurice M. Rapport. New York State Psychiatric Inst. and Columbia Univ., College of Physicians and Surgeons, New York, N. Y. 10032.

A semicompartmental model was used to study the quantitative contribution of glucose to the biosynthesis of brain glycosphingolipids in the adult rat in vivo. Rates of flow of glucose carbon (R) into several brain glycolipids were calculated from two measurements: the curve representing the decrease of plasma [^{14}C] glucose specific activity with time and the specific activity of the glycolipid 180 minutes after intravenous injection of a tracer dose of D-[U-^{14}C]-glucose. The R values (ng glucose-derived C per min per mg glycolipid C) were used to calculate half lives of glucose carbon in the total carbon pool of cerebrosides and gangliosides. Brain cerebrosides were separated by TLC. The half life calculated for galactocerebrosides with normal FA chain (faster band) was 68 days whereas for galactocerebrosides with hydroxy FA chain (slower band) the half life was 117 days, and even longer half life was observed with sulphatides (315 days). The shortest half life was obtained for a ceramide disaccharide fraction (18 days) which has not been completely characterized, but contains glucose and galactose and comprises about 1% of total neutral glycosphingolipids in the rat brain. The half life of glucose carbon in this ceramide disaccharide was shorter than the half life calculated for brain gangliosides (31 days), thus indicating that this compound may serve as a branch point for ganglioside biosynthesis rather than occur as a breakdown product of more complex molecules.

40 PEPTIDE REGULATION OF BURSTING PACEMAKER ACTIVITY IN A MOLLUSCAN NEURON. J. L. Barker, H. Gainer and M. Ifshin*. NIH, NICHD, Bethesda, Md. 20014.

The effects of vertebrate peptides on the electrical activity of identified molluscan neurons were investigated using intracellular recording techniques. Antiduretic hormone (ADH) and structurally related peptides selectively altered the electrical activity of two homologous neurosecretory cells. No effect of these substances on 10 other identified neurons was observed. All other hormones and releasing factors tested were without effect on these cells. Active peptides produced bursting pacemaker potential (BPP) activity in non-bursting cells from dormant or semi-dormant snails and potentiated this activity in cells from active snails. The threshold concentration for this effect was 10^{-9}M. The ADH effect long-outlasted the period of bath (or iontophoretic) application. In 13 of 15 cells the sensitivity to the peptides was confined to the axon and axon hillock. Somal sensitivity was present on the other two. Associated with the induction of BPP activity was a change in the I-V relations from linear to non-linear over the -40 to -70 mV range. Iontophoresis of ADH onto a cell whose membrane had been hyperpolarized beyond this range did not produce an observable voltage response or conductance change. Upon removal of the hyperpolarizing current, well-developed BPP activity was present. In contrast, the transient voltage responses and conductance changes to iontophoresis of a variety of conventional putative transmitters (i.e., ACh, dopamine, glutamate) were present over a much wider membrane potential range. The results suggest a membrane regulatory role for these peptides and thus may be indicative of a new form of information transfer in the nervous system. In preliminary experiments we have isolated a water-soluble, low molecular weight peptide fraction from the snail nervous system which has effects identical to ADH on the neurosecretory cell.

41 EEG POTENTIALS TIME-LOCKED TO SACCADIC EYE MOVEMENTS OF READING AND OPTOKINETIC NYSTAGMUS: FORM, TOPOGRAPHY, AND DIFFERENTIAL ATTENTION ASPECTS. John S. Barlow. Massachusetts General Hospital, Boston, Mass. 02114.

An earlier finding (*Dis. Nerv. Syst.* 32:668, 1971) of a late positive wave peaking at approximately 300 msec (P300) in the lambda complex associated with quick or saccadic eye movements of reading, but not for those of optokinetic nystagmus (OKN), has been further explored with EEG and eye-movement (infrared monitoring) recordings in healthy subjects under conditions that included the following: (1) conventional OKN, using horizontally moving vertical stripes; (2) reading of text (a) upside down and (b) right side up; (3) same as 2b, but with (a) reading attentively and (b) reading with distraction; (4) same as 2, but with moving text (i.e., combined reading and OKN), and finally (5) same as 4, but using computer-generated moving (a) text or (b) strings of repeated letters, on an oscilloscope screen. Data were processed with a small digital correlator (Bioengineering Resource Facility, University of Iowa) and a minicomputer (PDP-12). Preliminary results include: (1) confirmation of the earlier finding of a P300 for reading, but not for conventional OKN; (2) primarily occipital localization for the lambda complex for reading, in contrast to a less sharply defined parietal localization for OKN; (3) inconstantly, an occipital negative shift, with or without superimposed waves of 7.5 Hz, immediately preceding saccades (cf. *Electroenceph. clin. Neurophysiol.* 34:758, 1973); (4) P300 evident for reading with distraction as well as for reading for content; (5) no P300 for reading upside down text. The suggestion from certain findings that more specific differential effects for these several experimental conditions may obtain in the left posterior temporal region (Wernicke's area for language) is being pursued. [Supported by NIH Grant No. NS-03752]

42 QUANTITATIVE EVALUATION OF CUTANEOUS SENSORY FUNCTION. Karen L. Barnes and John P. Conomy. Dept. Biomed. Engr. and Div. Neurology, Case Western Reserve Schl. Med., Cleveland, Ohio, 44106.

A technique originally devised for the evaluation of simian peripheral nerve and cutaneous sensory function by operant conditioning has been modified to yield a quantitative assessment of human cutaneous sensation. By combining simultaneous behavioral and electrophysiological observations of stump-tail maccaques, we have developed a behavioral index of pain threshold in the awake primate. A timed stepping mechanism increments stimulus intensity to the skin or sciatic nerve, while the monkey must press a lever to decrement intensity. A permanent record of tolerated stimulus level and bar-press behavior is compared with simultaneous records of peripheral nerve fiber activity from a chronic sciatic nerve electrode. The same "staircase" variant of Fechner's method of limits yields a reliable and reproducible evaluation of cutaneous sensation in human subjects with neurologic disease, providing quantitative information not available in current bedside testing methods or other electrophysiological tests. Each subject serves as his own control both across skin regions and over successive tests, documenting the clinical course of diseases which alter cutaneous sensation. By changing stimuli various cutaneous senses can be tested. The method quantifies absolute cutaneous thresholds, duration of perception, and provides an index of perceptual intensity. Graphic examples of these parameters are demonstrated in patients with both peripheral and central nervous system disorders. In addition to clinical studies, the method can be used to investigate basic mechanisms of normal cutaneous sensation or to evaluate agents or treatments which modify the response of a subject to cutaneous stimuli.

43 EEG SENSORY EVOKED RESPONSES (ERs) IN EARLY INFANCY MALNUTRITION. Ann B. Barnet, Marta Vicentini* and Margarita Campos S.*. Children's Hospital National Medical Center, Washington, D.C. 20009

To test whether ERs reflect abnormalities in brain function associated with early infancy malnutrition, a group of infants, aged 3 to 9 months at time of hospital admission, suffering from third degree malnutrition (marasmus), were followed by serial ER recordings during rehabilitation on a special metabolic ward. Normal infants from the hospital's day care center served as controls. Auditory evoked responses (AERs) were recorded from C3, C4, and CZ (10-20 placements) referred to joined mastoids. 100 stimuli were presented at a rate of one every 2.5 seconds. Analysis time was 1.25 sec. AER latency was prolonged in all of the malnourished infants in the recordings taken near the time of admission. Mean P2 latency was approximately 250 msec. for the malnourished group vs. 190 for the controls. N2 differences were of the same magnitude. Over a three month period, a higher than normal rate of latency decrease was observed in some of the patients. Throughout the period of hospitalization, AERs recorded from left and right hemispheres were consistently less symmetrical in the malnourished group than in the controls. Asymmetry ($> 5\ \mu V$) of P2N2 amplitude was found in more than 50% of the patients but in less than 5% of the controls. The malnourished infants also tended to have flatter, less complex responses than the normal controls. This study was carried out through the courtesy and cooperation of Dr. Joaquín Cravioto, Chief, Dept. of Investigacion and Dr. Mario Shkurovich, Dept. Neurol., Institucion Mexicana de Asistencia a la Niñez. It was supported by the W.T.Grant Foundation and PHS HD02296 and K2MH45472.

44 SODIUM ASPARTATE-ISOLATED SECOND ORDER PROCESSES AT THE PHOTORECEPTOR LEVEL IN PRIMATES. William S. Baron and Robert M. Boynton, Center for Visual Science, University of Rochester, Rochester, New York 14627

Sodium aspartate has been used to isolate the primate late receptor potential (LRP) *in vivo* by injecting it into the vitreous. The initial effect of sodium aspartate is to cause an extraordinary constriction of the retinal vasculature, and then in higher concentrations to block synaptic transmission. When high intensity stimuli are used, the first part of the response obtained with this preparation is similar in shape to the response obtained when the LRP is isolated by blocking the retinal circulation. When low intensity stimuli are used, the responses are of opposite polarity to the LRP. While the stimulus is on, a plateau is maintained, but when the light is turned off the change in potential seems to be composed of three components, (1) the LRP, (2) a d.c. potential of opposite polarity to the LRP, and (3) a long latency potential similar to the e-wave which has not previously been found in the primate ERG. The effect of the sodium aspartate may be either (1) to reduce the rate of excitation or inhibition between processes, which normally have very similar latencies, and thereby produce a temporal separation of them, or (2) to unveil the existence of feedback mechanisms which normally function in parallel with controller cells, those cells having been blocked by the sodium aspartate.

45 EFFECT OF BILATERAL LESIONS TO THE CINGULUM BUNDLE ON THE BEHAVIOR AND NEUROPHYSIOLOGY OF THE SQUIRREL MONKEY. E. S. Barratt, P. M. Adams and J. T. O'Neal. Dept. of Psychiatry, Behavioral Science Laboratory, and Dept. of Surgery, Division of Neurosurgery, University of Texas Medical Branch, Galveston, Texas 77550.

Bilateral electrolytic lesions to the cingulum bundle of the squirrel monkey were made prior to or following the acquisition of a conditioned emotional response (CER). Neurophysiological measures of spontaneous and evoked activity in a number of brain sites were made from chronic indwelling electrodes prior to and following lesions. Animals receiving lesions prior to acquisition training on the CER failed to acquire the response while those trained prior to the making of the lesions retained the CER without impairment. The spontaneous activity of the animal following lesions was largely unchanged with the exception of an increased amplitude of the EEG from anterior thalamic nucleus after 20 days of post-lesion recovery. Post-lesion evoked potentials indicated a reduced amplitude of evoked recordings in prefrontal and premotor limbic cortex with anterior thalamus stimulation. These findings suggest the effect of cingulum bundle lesions may be to reduce the amount of sensory input to cortical loci associated with the formation of appropriate behavioral responses.

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46 A MODEL FOR ODORANT MOVEMENT BASED ON THE CHROMATOGRAPHIC THEORY OF OLFACTORY DISCRIMINATION. David P. Bashor and W. Marcus Cooke*. Depts. Biol. and Chem., UNC, Charlotte, 28223

Odorant molecules are influenced by chromatographic processes as they traverse the nasal capsule (Mozell, Science 181:1247, 1973). To aid the study of the transport processes and odorant-receptor interactions occurring in the nasal cavity, we have developed the following model for movement of a bound odorant wave along a one-dimensional nasal epithelium. Let $a(x,t)$ be the fraction of applied odorant bound at a distance x along the olfactory epithelium, at time t; x_1 = length of mucosa; x = a position on mucosa ($0<x\leq x_1$); $\bar{x}(t)$ = position on mucosa of maximum binding ($0<\bar{x}\leq x_1$); s = standard deviation of bound odorant wave. For Gaussian input,

$$a(x,t) = \frac{1}{(2\cdot\pi)^{\frac{1}{2}}\cdot s}\, e^{-\frac{(x-\bar{x})^2}{2\cdot s^2}} \qquad (1).$$

To accurately evaluate $a(x,t)$, a general density function must be defined where the rate of movement of $\bar{x}$ along the mucosa, $d\bar{x}/dt$, as well as the way in which s changes with $\bar{x}$ or t, $ds/d\bar{x}$, is known. It is known from chromatographic theory that s linearly changes as the solute moves down the column, in this case the mucosa. Specifying s_o, the standard deviation of the input wave, an expression for s is $s = s_o + m\cdot\bar{u}$. Also $d\bar{x}/dt = \bar{u}$; $\bar{x} = \bar{u}\cdot t$, where $\bar{u}$ is the average linear mobile phase velocity in the nasal capsule. Thus s becomes $s = s_o + m\cdot\bar{u}\cdot t$. Substituting these results in (1) gives the analytical form of the model;

$$a(x,t) = \frac{1}{(2\cdot\pi)^{\frac{1}{2}}\cdot(s_o + m\cdot\bar{u}\cdot t)}\, e^{-\frac{(x-\bar{u}\cdot t)^2}{2\cdot(s_o + m\cdot\bar{u}\cdot t)^2}}$$

Supported in part by a Cottrell Grant from the Research Corporation, and the UNCC Foundation.

47 RECEPTIVE FIELDS OF CEREBELLAR CELLS RECEIVING EXTEROCEPTIVE INPUT IN GYMNOTID FISH. Joseph Bastian. Dept. of Neurosci., Sch. Med., UCSD, La Jolla, Ca., 92037

Purkinje cells in the caudal lobe of the cerebellum of the weakly electric fish Apteronotus albifrons receive input from the electrosensory system. These cells change their firing frequency in response to distortions in the fish's electric field caused by objects moving in the environment. The quality of the object (insulator or conductor), the size, direction of movement and to a lesser extent rate of movement are all parameters which affect the form of the cell's response. A simpler stimulus, a small bipolar pair of stimulating electrodes, can also evoke responses in these cells when moved close to the fish's skin. This stimulus was moved over the fish in a systematic fashion so that the receptive fields of single purkinje cells could be determined. Relatively simple excitatory or inhibitory fields as well as more complex fields made up of contiguous excitatory and inhibitory areas were found. Nearly all of the cells responded differently to opposite directions of movement as well as to different rates of movement. Stationary stimuli presented at an area of skin known to be part of a receptive field resulted in responses of the same type as caused by the moving stimulus however the amplitude of the response was reduced. In addition to providing a better understanding of the role of the cerebellum in the analysis of electrosensory information these results give a clear demonstration of receptive fields of purkinje cells receiving an exteroceptive input.

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48 CRYOGENIC DEPRESSION OF PREFRONTAL CORTEX: SPATIAL VS. NONSPATIAL MEMORY DEFECT. Richard H. Bauer and Joaquin M. Fuster. Department of Psychiatry and Brain Research Institute, School of Medicine, University of California, Los Angeles, Calif. 90024.

Rhesus monkeys were trained to perform two tasks requiring mnemonic retention of visual cues. The cues were presented in a panel with three translucid stimulus-response keys forming an isosceles triangle. Trials in both tasks conformed to the sequence of cue, delay and choice. In one task (delayed response; DR), the cue was positional: white-light illumination of one of the two lower keys, immediately turned off by the monkey's pressing of the lighted key. After the ensuing delay, both keys were turned on simultaneously and the monkey was rewarded for again pressing the key previously lit. In the other task (delayed matching-to-sample; DMS), the cue was a color: red or green light on the top key. After the delay, the two colors appeared on the lower keys and the animal was rewarded for pressing the key with the color of the cue. Delays of 0 to 32 sec. were imposed. Position and color were changed randomly. Blocks of DR trials were alternated with blocks of DMS trials. After training, cooling probes were implanted on the cortical surface. Cooling of lateral prefrontal cortex (20°C) induced a performance deficit on trials with delay of 4 sec. or longer. For any given length of delay, the DR deficit was similar in magnitude to the DMS deficit. No deficit was produced by parietal cooling on either task. Choice reaction-time was correlated with length of delay. The results constitute further support for a functional role of the lateral prefrontal cortex in short-term memory. In addition, they indicate that this role is equally important for retention of spatial information as for retention of nonspatial information.

49 UPTAKE OF CHOLINE BY THE NEURONS OF THE CHICK CILIARY GANGLION. Robert L. Beach*, Janusz B. Suszkiw* and Guillermo Pilar. Biological Sciences Group, Univ. of Ct., Storrs, Ct., 06268

Uptake of Choline (Ch) by ciliary ganglia isolated from 9 day old chicks was measured at 37°C in Tyrode's solution. Rates of uptake were linear for up to 60 minutes and were temperature dependent. One predominant saturable component with a K_T of $1x10^{-4}M$ and a V_{max} of 7.9 picomoles/ganglion/min. was observed. This uptake was not modified by reduction of sodium concentration in the incubation solution from 150mM to 20.5mM. Dinitrophenol at concentrations of $10^{-3}M$ or $10^{-4}M$ had no effect. Oubain ($10^{-3}M$ and $10^{-4}M$) inhibited uptake slightly if present during a 30 min. preincubation. Hemicholinium inhibited Choline uptake with a K_I of $9x10^{-5}M$ and acted competitively at $2x10^{-6}M$ Ch. 2 and 3 day denervated ganglia showed no reduction in uptake at $2x10^{-6}$ M or $2x10^{-5}M$ Ch. Since the relative volume of ganglion cells to presynaptic terminals is greater than 20:1 and the volume of glial cells is less than half that of the ganglion cells, the measured rate of uptake represents mainly the cholinergic cell bodies. Choline uptake was measured in irises which are innervated by the terminals of the ciliary neurons. This uptake was neither sodium dependent nor was it decreased by section of the ciliary nerves. Thus uptake by the nerve terminals was probably masked by that of the iris muscle. These experiments suggest that the cholinergic ganglion cell bodies have a choline uptake system similar to that found in non-nervous tissues.

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50 THE EFFECTS OF NICOTINAMIDE AND L-METHIONINE ON MOUSE SLEEP-WAKE CYCLES. John M. Beaton, Ronald J. Bradley, G. Vernon Pegram*, and John R. Smythies* Neurosciences Program and Department of Psychiatry, University of Alabama in Birmingham, Alabama 35294.

We have previously reported that L-methionine induces disruption of both behavior and sleep-wake cycles in mice and rats. These effects are not prevented by the simultaneous administration of nicotinamide. However, when nicotinamide alone is administered to mice there is a significant increase in the amount of rapid eye movement sleep (REM). Methionine has the opposite effect, inducing a significant decrease in REM time. All mice were injected daily with 250 mg/kg of either nicotinamide or methionine for 21 days prior to sleep analysis. The two mouse strains tested, Swiss and C57 brown, showed comparable alterations in sleep pattern. The REM increase caused by nicotinamide is reminescent of the effects of reserpine and indicates that nicotinamide administration may exert some effects on normal brain function. This suggests that further pharmacological study of nicotinamide in this light might be of interest.
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51 SPECIFIC IDENTIFICATION OF SEROTONINERGIC AXON TERMINALS IN RAT CEREBRAL CORTEX. Alain Beaudet* and Laurent Descarries. Centre de recherche en sciences neurologiques, Université de Montréal, Montréal, Québec, Canada.

Presynaptic axon terminals which take up and retain serotonin-^{3}H (5-HT-^{3}H) may be visualized by means of high resolution radioautography in the fronto-parietal cortex of adult rats pretreated with monoamine oxidase inhibitor (Anat. Rec. 178:342, 1974). Following prolonged superfusions with 10^{-4} or 10^{-5} M 5-HT-^{3}H (specific activity:11-11.7 Ci/mM), the labeling is intense, selective and seemingly confined to nerve endings containing endogenous serotonin. Indeed, the number of reactive terminals appears undiminished in the cortex of rats entirely deprived of noradrenergic innervation by earlier administration of 6-hydroxydopamine. Furthermore, labeled nerve endings are no longer present after stereotaxic destruction of the raphé nuclei. The use of relatively high concentrations of 5-HT-^{3}H allows detection of a vast majority of serotoninergic terminals, which predominate in the superficial layers of cortex. The greater proportion of reactive nerve endings exhibit large dense-core vesicles, and typical junctional zones of synaptic contact are occasionally visible between the labeled bulbs and dendritic processes. Further radioautographic characterization of the intralaminar distribution and ultrastructural features of cortical 5-HT terminals should help to elucidate the role of these afferents previously unamenable to detailed morphological analysis.
(Supported by grant MA-3544 of the Medical Council of Canada).

52 LIGHT ADAPTATION IN THE VENTRAL PHOTORECEPTOR OF LIMULUS. Michael M. Behbehani and Richard Srebro, Neurosensory Laboratory, S.U.N.Y., at Buffalo, N. Y. 14214

We have studied the process of light adaptation in the ventral photoreceptor cell of the Limulus under voltage-clamp by performing the following experiment: The cell was penetrated with twin electrodes and allowed to dark adapt. After about one hour the cell was voltage-clamped at resting potential. Under computer control, the cell was stimulated by a single flash or twin flashes of light, each 10 msec long. For each trial the computer selected, at random, a single flash or twin flashes. In those trials that twin flashes were selected the delay between two flashes was selected at random from a table of delays. The response of the cell was sampled for 2 1/2 seconds following the first flash and was recorded. The result of this experiment showed that the adaptation process consists of two phases. An early phase that occurs whenever there is a temporal overlap of discrete waves and has an expotential recovery time-course with time constant of about 75 msec. This phase of light adaptation occurs at light intensities barely above discrete wave intensities as well as at much higher intensities with the same recovery time-course at all intensities and it is initiated by photocurrent. The kinetics of this phase of adaptation is correlated to photocurrent. A second phase of light adaptation occurs at higher intensity and develops after approximately 1/2 second and decays over a period of several seconds.

53 GEOMETRY OF RECEPTIVE FIELDS OF CAT RETINAL GANGLION CELLS. K.Behrend*and H.Scharstein*(SPON: C.E. Spooner) MPI F.Biophys.Chemie,Goettingen and MPI f.Verhaltensphysiol.,Seewiesen W-Germany.

Receptive fields of cat retinal ganglion cells were plotted by means of a moving light spot scanning an area of 25x25 degrees of visual field permiiting us to map the excitatory receptive field(ERF)and that part of the inhibitory receptive field(IRF)revealed by reduction in the ongoing firing.Recordings were made from single fibers of the optic nerve at the optic chiasma.A decrease in the background illumination thereby increasing contrast did not alter the ERF or IRF of on-center neurons whereas it enlarged the inhibitory area of off-center neurons.In cells in or close to the area centralis this enlargement was symmetrical to the field center but in more peripheral cells where the increment to the field can be up to 3o degrees it may be asymmetrical and complex.A method is described to reconstruct the geometry of receptive fields from plots in the horizontal and vertical direction by means of a sensitivity contour profile.This was found to be elliptical or circular in the cells so far investigated with this method (3 on-center,2 off-center neurons).The elliptical cells can be said to have an orientation preference.

54 THE RESPONSE OF UNMYELINATED (C) NOCICEPTIVE AFFERENTS TO THERMAL AND MECHANICAL STIMULI APPLIED TO THE MONKEY'S FACE. R. E. Beitel and R. Dubner, NIDR, NIH, Bethesda, Md. 20014.

Single unit activity was recorded extracellularly in the trigeminal ganglion in anesthesized rhesus monkeys. Conduction velocities, determined from electrical stimulation of receptive fields (RFs), were in the range for unmyelinated C fibers (Mean = .82 m/sec; S.D. = ±.17). Cutaneous RFs were usually single spots (Mdn = 2mm^2) and were identical for thermal and mechanical stimuli. Discharges to thermal stimuli were investigated with feedback-controlled contact thermodes which permitted step temperature changes ≥10 /sec. Thermal thresholds ranged from 41° - 50°C (Mdn = 47°C), and maximim discharge frequencies were obtained in the noxious heat range (45° - 55°C). Application of stimuli 5°- 8°C above threshold for 30 sec typically sensitized the units, indicated by lowered threshold, increased frequency of discharge, afterdischarges or the appearance of 'spontaneous' spikes. For a graded series of 5 sec duration stimuli from adapting temperatures of 30°- 40°C, the number of spikes increased as a monotonic function of stimulus intensity over the range from threshold to 50° - 55°C. However, noxious stimuli >55°C suppressed the frequency of discharge to subsequent graded series of thermal stimuli. Units failed to respond throughout the duration of 30 sec stimuli if the final temperature exceeded 50°C. All units studied had mechanical force thresholds which were innocuous to human subjects (von Frey technique; Mdn = 1.2 gm; Range = 0.07 to 2.04 gm.). Unit discharge frequencies to noxious mechanical stimulation were less than discharge frequencies to noxious heat. These data indicate that C nociceptive afferents from the monkey's face respond maximally to noxious heat. The units are sensitized by stimulation near threshold but are suppressed by stimuli >55°C.

55 PATTERNED MOTOR OUTPUT IN THE 7 DAY CHICK EMBRYO. Anne Bekoff* (SPON: V. Hamburger). Biol. Dept., Washington Univ., St. Louis, Mo. 63130.

An analysis has been made of the motor output to the hindlimb of 7 day chick embryos through the use of EMG recordings from the ankle antagonist muscles, lateral gastrocnemius (G) and tibialis anterior (T). The earliest independent movement of the ankle joint has been observed at $6\frac{1}{2}$ to 7 days. That these early movements are neurogenic rather than myogenic can be shown by the fact that ankle movement and organized EMG activity cease after section of the sciatic nerve. EMG recordings from the 7 day embryos indicate that the early motor output is well organized. (1) The movement-associated EMG activity occurs in bursts of action potentials, suggesting that contraction of a single muscle, e.g. G, is the result of coordinated activation of a pool of G motoneurons. (2) The antagonists, G and T, are activated alternately, indicating that the circuitry necessary for this coordinated pattern of motor output has already been laid down. (Supported by NSF grant GB 35534 to P.S.G.Stein and NIH grant NS 05721 to V.Hamburger.)

56 FLUID DYNAMICS IN MODELS OF THE SEMICIRCULAR CANALS. Luis D. Benítez and Alfredo M. Martínez*. Dept. Sci. Res., Natl. Med. Ctr. I.M.S.S., México, D. F.

Several types of tubular systems representing models of one or several semicircular canals were subjected to varying types of accelerations. The flow patterns in the fluid filling the models were observed and recorded both photographically and with a flowmeter. Parameters explored were: spatial plane of the model relative to the plane of acceleration, diameter of the canal and of the "ampula", viscosity of the fluid, presence or absence of a "utricule" and of a double canal system representing the perilymphatic and endolymphatic spaces. Results show each of these parameters to affect significantly the flow patterns. Flow interactions between canals were observed at some spatial positions.

57 EFFECTS OF MORPHINE ON PAIN EVOKED POTENTIALS IN THE UNANESTHETIZED RHESUS MONKEY. C. Thomas Bennett, Agu Pert and Tony L. Yaksh, Experimental Medicine Branch, Biomedical Laboratory, Edgewood Arsenal, MD 21010 USA

Pain evoked potentials (PEP) were recorded from over 100 sites in the unanesthetized rhesus monkey. Rhesus monkeys were implanted with arrays of 22 ga stainless steel guide cannulae aimed at various CNS regions. Following recovery, concentric bipolar electrodes construcded from 27 ga stainless steel tubing and 0.11 mm stainless steel wire, exposed 0.5 mm at the tip, were introduced into the entorhinal region and various midbrain areas which we have previously found to be analgesically responsive to morphine. PEP's were elicited by electrical foot shock (1 ma) and averaged with a PDP-12 computer. It was found that the amplitude of PEP's was diminished by brain tissue (40 μg) or I.V. (5 mg/kg) injections of morphine sulfate at over 30 sites in seven monkeys. A transient significant reversal of the morphine induced depression was obtained by I.V. injections of naloxone (2 mg/kg). The effect of systemic administrations of morphine on the PEP was not caused by a nonspecific depressant effect on the CNS since unaffected PEP's were often found as close as 3 mm from a site at which a PEP was depressed. The role of morphine in subcortical mechanisms of nociception will be discussed.

58 POSSIBLE INSTRUMENTAL AVOIDANCE IN PARAMECIUM. David J. Benson*, William B. Rucker, and Colin McDiarmid*

The ciliated protozoan, Paramecium Caudatum, will escape from a capillary tube into which it has been pulled by capillary action. Indeed, Huber, Rucker, and McDiarmid (J. of Comp. Physiol. Psychol., 1973, 86, pp. 258-266) have demonstrated that paramecia can learn to escape at increasing rates over trials, with retention of two and one-half hours. Since the action of being sucked into the tube and being in the tube proved to be aversive enough to demonstrate an escape learning response, it was decided to use this aversive stimuli to develop an avoidance response. Single Paramecia were not sucked up into the tube for each trial until they had crossed six lines on a 1/10 inch grid. Each paramecia was trained for sixty trials. The mean latencies per trial over blocks of ten trials increase from 8.3 seconds to 16.0 seconds. ($F=5.14$, $df=5/72$, $p<.001$). When a three line criterion was tested with other subjects, the increase was not significant ($F=2.0$, $df=5/72$, $p<.1$). Since line crossing activity was found to increase over escape training without the contingency (Huber et al, op. cit.), these results suggest that instrumental avoidance learning is possible in protozoa.

59 EVIDENCE FOR DUAL NEUROTROPHIC EFFECTS ON THE METABOLISM OF SPECIFIC MUSCLE PROTEINS. Bonnie Beresford*, Michel P. Rathbone* and David M. Logan*. Dept. Neurosciences, McMaster Univ., Hamilton, Canada and Biol. Dept., York Univ., Downsview, Ontario, Canada. (SPON: J. Diamond).

We have investigated the neural control of amino acid incorporation into the proteins of triceps muscles of newts (Triturus viridescens). Muscles from one side were denervated and a sham operation done on the other side, which provided the control triceps. The animals were injected intraperitoneally with ^{14}C-leucine at various times after denervation. One hour after injection the muscles were removed and the muscle proteins analysed by electrophoresis on SDS acrylamide gels. Between 2 and 10 hours after denervation the incorporation of ^{14}C-leucine into total protein of the denervated muscles exceeded that in the control muscles by up to 50%. By 48 hours leucine incorporation into the denervated muscles was reduced to 70% of that in the control ones, and subsequently remained at this lower level. Compared to controls, muscles denervated 2 to 10 hours previously not only showed a higher incorporation of ^{14}C-leucine, but the proportion of this in myosin was significantly increased. In contrast during the period when the incorporation of ^{14}C-leucine into denervated muscles is reduced its distribution among the various proteins is the same as in the control muscles. Our results are consistent with the existence of two neurotrophic effects. First, denervation removes an inhibitory effect on leucine incorporation into muscle protein, particularly myosin. Secondly, a more generalised trophic effect is removed that results in the observed uniform decrease of incorporation of ^{14}C-leucine into all proteins after 48 hours.

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60 EFFECTS OF PREOPTIC, HYPOTHALAMIC, AND VENTROMEDIAL TELENCEPHALIC LESIONS ON BEHAVIORAL THERMOREGULATION IN THE LIZARD, DIPSOSAURUS DORSALIS. Mitchell L. Berk* and James E. Heath*. (SPON: R.W. Wylie). Dept. Zool., Dept. Physiol. and Biophysics, Univ. Ill., Urbana, Ill. 61801.

Electrolytic lesions were placed stereotaxically in the preoptic area, hypothalamus, and the ventromedial telencephalon to determine their functions in behavioral thermoregulation in the desert iguana. Lesioned, sham-operated, and control animals were placed in a thermal shuttle box. Body temperatures (Tb) were recorded continuously for 1-3 days. The Tb's at which Dipsosaurus would shuttle from the cold to the hot side of the box (LBTS, low body temp. at shuttling) and the Tb's at which they would shuttle from the hot to the cold side (HBTS, high body temp. at shuttling) were analyzed. The frequency of shuttling and the Tb's at which thermal comfort postures (raising toes, tail, and trunk of body off the substrate of the hot side of the box) occurred were also determined. Lesions in the nucleus of the diagonal band of Broca (NDB)-medial preoptic area, medial septal area, n. anterior hypothalamus-n. suprachiasmaticus, n. interstitialis, and lesions of the ventromedial telencephalon-medial forebrain bundle (MFB) resulted in lower mean LBTS's than control or sham-operated animals. Lesions in the NDB-medial preoptic area resulted in either an increase or no effect on the mean HBTS and its standard deviation. Large ventromedial telencephalic-MFB-medial preoptic area lesions resulted in decreased HBTS's and also the occurrence of normal thermal comfort postures at very low Tb's. The frequency of shuttling was reduced to very low levels in all the above cases. Lesions in the ventromedial and dorsal hypothalamic nuclei, and the anterior hypothalamic area had little effect on thermoregulation. Although medial preoptic area lesions dramatically alter thermoregulation, the totality of results suggests complex interactions with other hypothalamic and limbic system nuclei.

61 THE USE OF TRITIATED LEUCINE AND PROLINE TO MAP EFFERENT PROJECTIONS OF CELLS IN THE CAT DORSAL COLUMN NUCLEI. Karen J. Berkley. Dept. Psychol., Fla. St. Univ., Tallahassee, 32306

Künzle and Cuénod (Brain Res., 1973) have shown that tritiated proline and leucine are not always incorporated by the same population of neurons within a given nucleus. On occasion, 'larger' and 'medium-sized' cells are more likely to incorporate leucine, whereas 'smaller' cells are more likely to incorporate proline. Similar results were often observed in the dorsal column nucleus (DCN) of the cat in this experiment. Cells greater than about 18 μ in DCN were more likely to incorporate leucine than proline.

When the dorsal column nucleus of the cat is injected with tritiated leucine or proline, labeled protein is transported to terminals in the ventrobasal nucleus of the thalamus and the dorsal portion of the inferior olive. The amount of label appearing in the olive does not appear to depend upon the particular isotope used. On the other hand, the amount of label appearing the the ventrobasal nucleus does appear to depend upon the isotope used. The density and extent of labeling in the ventrobasal nucleus if often greater if tritiated leucine is used than if tritiated proline is used. These results suggest that the population of cells in DCN whose axons terminate in the ventrobasal nucleus may be different from the populstion of cells whose axons terminate in the dorsal portion of the inferior olive.

(Supported by PHS grant NS 02992.)

62 **EATING, GROOMING, THREAT, AND ESCAPE INDUCED BY MEDULLARY STIMULATION IN THE CAT.** Gary G. Berntson and Howard C. Hughes*. Dept. Psych., Ohio State Univ., Columbus, Ohio 43210

Behavioral effects of electrical stimulation of the medullary reticular formation were examined in free-moving cats. We found that stimulation of the dorsomedial tegmentum could elicit coordinated grooming behavior, while stimulation of the ventrolateral tegmentum could elicit either grooming or eating. Stimulation-induced eating and grooming behaviors were directed and goal dependent, and were not merely directly elicited motor automatisms. Findings suggested that these behaviors resulted from the facilitation of specific sensorimotor mechanisms, rather than the induction of generalized drive states. Other elicited responses included fragmentary components of threat behavior and escape. Many electrodes producing escape or threat were located in or near classical sensory paths, while others were located in the reticular formation. The findings contribute to the growing view that the lower brainstem may play an important role in the elaboration and control of complex species- characteristic behaviors.

63 HIPPOCAMPAL RESPONSES TO FIMBRIAL AND COMMISSURAL STIMULATION. Phillip J. Best and Charles E. Olmstead. Dept. Psychology, Univ. Virginia, Charlottesville, VA 22901, and Dept. Psychiatry, Mental Retardation Ctr., NPI, UCLA, Los Angeles, CA 90024.

During spontaneously occurring sleeping and waking, the spontaneous single unit activity of the dorsal hippocampus can be demonstrated to undergo regional specific changes as well as state specific changes (Olmstead, Best, & Mays, 1973). It has been hypothesized that these changes are due to extrahippocampal influences. To test this hypothesis, single unit activity was recorded from 201 electrodes (62 u) chronically implanted in 48 albino rats and evaluated under sleep and waking conditions and during stimulation of fimbral pathways and heterolateral hippocampal connections. Sixteen of 39 units studied under all conditions showed decrements in firing following fimbrial stimulation. An identical phenomenon occurs during paradoxical sleep at a moment when hippocampal afferents show their highest level of activity. Only one of the 39 cells showed an increment in firing. Only one of the cells tested showed any response - an increment in firing - to commissural stimulation. These results indicate that the slowing of the majority of hippocampal output cells during paradoxical sleep is triggered by extrahippocampal influences rather than by interhippocampal factors. These data do not rule out, however, the fact that the actual mechanism of the cells' deceleration is due to intrinsic hippocampal circuitry. (Supported by USPHS Grant MH-16478, awarded to Phillip J. Best.)

64 **LOCATION AND RESPONSE PROPERTIES OF NEURONS IN THE CAUDAL TRIGEMINAL NUCLEUS EXCITED BY THE ETHMOIDAL NERVE.** **R.W. Beuerman and M.A. Biedenbach. Dept. Physiol. Biophys., Sch. Med., Univ. Washington, Seattle, 98195**

The aim of this study was to establish the location of neurons in the trigeminal nucleus excited by the ethmoidal nerve and to determine differences in their response properties. The ethmoidal nerve supplies the mucosa of the nasal cavity and is composed of a majority of unmyelinated axons and is chemosensitive. Cats were anesthetized with chloralose, paralyzed with gallamine and the brain stem exposed for unit recording. The ethmoidal nerve was stimulated electrically every 3 sec for unit detection. An electrode placed in the ethmoidal projection area of the thalamus was used to test whether the cells could be driven antidromically. This report consists of the first part of the study, describing a unit population obtained between 2 mm and 6.5 mm caudal to the obex. Driven units were recorded throughout this region, but the greatest yield was obtained between 2 mm and 3 mm caudal to the obex. Driven units were also found less frequently in the reticular formation medial to the trigeminal nucleus as confirmed by dye marking. This unit population displayed a large latency range to electrical stimulation (3 msec to 58 msec, mean latency 17.3 msec). Many of these units appear to receive highly convergent input; recruitment of more axons in the ethmoidal nerve shortened the latency and increased the number of spikes per discharge. Many units receive additional input from other peripheral nerves as indicated by tactile receptive fields in the face or chest region. Very few of these cells have direct thalamic projection, but almost half could be synaptically driven by the thalamic electrode. This latter set of cells could be inhibited over several hundred msec by prior conditioning with the ethmoidal nerve. (Supported by NIH DE00248.)

65 RESEARCH AND CLINICAL APPLICATIONS OF THE SOMNOGRAM. R.G.Bickford, K. Hanson*, T. Jones* and K. Burchiel*. Dept. Neurosciences, Sch. Med., UCSD, La Jolla, 92037

The basic somnogram is a condensed display of 1) EEG spectrum, 2) integrated EEG, 3) EOG and 4) EMG. Hidden line suppression is used for parameter #1 with fine ball point plotting at 80 lines/inch and 8 seconds EEG/spectral line. Parameter #2,#3,and #4 and plotted horizontally with the spectrum with line length representing intensity. Using this pictorial display 8 hours sleep can be effectively condensed to 3 standard pages. The plots are made on-line with a PDP-12, 8K computer and plotter.

The basic somnogram has the following advantages over classical sleep staging techniques; 1) it is automatic and not prone to rater error, 2) in addition to providing data necessary for judging the phases of sleep it monitors all functions continuously avoiding the arbitrary cirteria of sleep staging.

The expanded somnogram used in clinical applications allows for simultaneous plotting of the additional parameters, evoked potentials, respiration, heart rate, alongside the above four parameters. In addition, numerical values of selected parameters areprinted alongside the pictorial display at convenient intervals. This display is finding wide application in the study of sleep disorder (apnea), newborn baby syndromes and clinical coma.

Supported by USPHS NS 08962 and ROCHE

66 RESPONSE CHARACTERISTICS OF NEURON SUBSETS IN THE ROSTRAL TRIGEMINAL NUCLEUS EXCITED BY THE LINGUAL NERVE. M.A. Biedenbach. Dept. of Physiology, University of Washington, Seattle, Washington 98195

The aim of the study was to identify the total neuron population in a part of the trigeminal nucleus which could be excited by the lingual nerve. Hence, electrical stimulation of the whole nerve, rather than mechanical tongue stimulation, was employed while searching for unit potentials. In anesthetized cats the brain stem was exposed dorsally, for recording in the trigeminal nucleus at levels from 1-9 mm rostral to the obex. All driven units, when tested additionally for mechanosensitivity, divided into 3 main subsets: One half of the units had tactile fields on the face or head but not on the tongue, evidently receiving more effective excitation from other branches of the trigeminal nerve. One fifth of the units were not mechanosensitive and termed mute. Only one third responded to tactile tongue stimulation. This set had a range of mechanical thresholds but only the most sensitive, (s-units), could be entrained to mechanical sine wave stimulation up to 100 Hz, thus resembling peripheral tongue mechanoreceptors. All 3 unit subsets occurred throughout the nuclear region studied but the s-units most frequently between 3-5 mm rostral to the obex. Response to electrical stimulation indicates that s-units make monosynaptic connections with peripheral axons: Latencies 1-3 msec and following electrical stimulation rates of 200/sec, although an increasing number of spikes per discharge on suprathreshold stimulation suggests some convergence of afferent fibers. The responses of the other subsets, including the remainder of tactile tongue units, indicate multisynaptic connections: Latencies 3-38 msec, following much lower electrical stimulation rates and greater response variability on repeated stimulation. Conditioning-testing stimulation of the lingual nerve revealed that in nearly all units excitation was followed by reduced excitability lasting a few hundred msec. (Supported by NIH DE02152 and DE))248)

67 QUANTITATION OF GANGLION CELL RESPONSES TO MULTIPLE STIMULUS CONDITIONS IN PIGEON RETINA. Richard Binggeli. Dept. of Anatomy, Univ. of Southern California, School of Medicine, Los Angeles, California 90033.

Responses were recorded from more than 200 ganglion cell axons in the optic tract while stimulating repetitively with a programmed sequence of colored flashes, spots, and varying sized targets moving at different velocities and in different directions. Magnetic tape recorded responses to repeated stimulus presentations were averaged, analyzed numerically and displayed photographically, as post-stimulus time histograms, or interspike interval histograms. Distributions of responses were plotted of all units with a single stimulus condition, or a single unit to a variety of stimulus conditions. The distributions of ganglion cell responses to white or colored flashes are roughly exponential with rather low means (1-2 impulses) with the majority of cells firing with less than one impulse to every flash. The flashing of dark center spots does not significantly alter this distribution whereas small light center spots more than double the mean firing. This is consistent with finding 70% of the units with excitatory centers and inhibitory surrounds and with most of the excitatory receptive fields being less than 1° in diameter. Most units respond with higher frequencies and longer bursts to moving targets, many having a directional preference as previously reported. Several units were subjected to 50 to 100 different stimulus conditions and a method of displaying their response profile to these stimuli was developed. The results argue against the classification of ganglion cells on the basis of receptive field characteristics, tonic or phasic discharge patterns or even on the basis of optimal stimulus parameters.

68 CATECHOLAMINE LEVELS IN TRAUMATIZED SPINAL CORD. W. G. Bingham, R. Ruffolo*, S. J. Friedman*. Depts. Pharm. and Surg., Ohio State Univ. Med. Sch., Columbus, Ohio 43210

The possibility that endogenous biogenic amines might augment the destructive effects of trauma to the CNS has been considered by several investigators in the past decade. Recently, accumulation of norepinephrine (NE) in areas of trauma was cited as a contributor to paraplegia in spinal cord injury. More recent studies have questioned this hypothesis. The present study carried out on the rhesus monkey represents the first study of this theory in primates. Three segments of thoracic spinal cord were exposed through separate incisions. An upper (T-2) and lower (T-10) segment served as controls, while the T-6 segment was subjected to trauma. Similar tissue segments from untraumatized animals served as normal controls. Blunt trauma was inflicted by dropping a 20 gm. weight 15 cm. onto the intact dura of the T-6 segment. Tissue was excised at 1/2, 1 and 4 hrs. post-trauma, frozen and assayed for NE and dopamine (DA). NE activity decreased following injury as a first order process with a half-life of 6.36 hrs. At no time were levels of NE activity above normal or control levels. Levels of DA activity were more variable. The only significant change was a rise which occurred in the T-10 control segment, 4 hrs. after injury. DA levels were never significantly elevated in injured tissue. The data indicate: 1) NE activity is not elevated in injured spinal cord tissue; 2) it is unlikely that NE plays a significant role in enhancing tissue injury; 3) DA activity is not significantly altered in regions of cord injury.

69 ALTERATION OF VISUAL RECEPTIVE FIELD CHARACTERISTICS OF NEURONS IN DORSAL LATERAL GENICULATE NUCLEUS AND LATERAL POSTERIOR NUCLEUS FOLLOWING COMPLETE OR PARTIAL NEONATAL STRIATECTOMY. Dorwin Birt* and David Stewart, Dept. of Psych., Ind. U., Bloomington, Ind. 47401.

Visual receptive field characteristics (RFC) of neurons in dorsal lateral geniculate nucleus (LGNd) and pulvinar (Pul) were studied in adult Dutch belted rabbits which has been completely or partially striatectomized at five days postnatal and compared with the RFC of neurons in these and other thalamic nuclei of normal adults. In normals, neurons with RFC which fit the classifications of concentric, movement sensitive, and direction selective were frequently found in those thalamic nuclei which receive direct retinal innervation (e.g., LGNd) but were not found in those which receive only indirect retinal innervation (e.g., Pul). In contrast, 38% of neurons studied in Pul of infant striatectomized rabbits fit the categories of concentric or movement sensitive. It was thought that this alteration of RFC might be due to the development of an anomalous direct retinal projection to LP, but anatomical studies did not provide evidence for this. In animals with partial neonatal striatectomy a shifting and possible compression of retinotopic mapping occurred in remnants of LGNd. These findings are consistent with the growing body of evidence for the plasticity of immature mammalian nervous system and may relate to the frequent reports that animals show less impairment following lesions performed in infancy as compared to similar lesions performed on adults.

70 AN ULTRAVIOLET PHOTORECEPTOR IN A DIPTERAN COMPOUND EYE AND A REINVESTIGATION OF THE TWO-PEAKED SPECTRAL SENSITIVITY OF DIPTERAN PHOTORECEPTORS. Lewis G. Bishop and Hendrik E.A. Eckert. Dept. of Biol. Sci., USC, Los Angeles, 90007

Intracellular recordings of the receptor potential to flashes of monochromatic light demonstrate the presence of ultraviolet photoreceptors in the retina of the honeybee-mimic dronefly Eristalis tenax. Photoreceptors for visible light were also observed. Hence, the dronefly has the neural capability for color vision. This is consistant with the results of earlier behavioral studies. This chromatic system is different from that reported for other flies where electrophysiological, behavioral and photometric investigations have revealed one photoreceptor with a peak in the visible spectral region and another with two prominent peaks, one in the UV and the other in the visible spectral region. We have reinvestigated this phenomenon in the chalky mutant of the blowfly Calliphora erythrocephala, and present new data relevant to the number of photopigments in the dipteran retina. Supported by NSF GB-30733 and AFOSR-71-2112.

71 NON-LINEAR GROWTH OF FACILITATION AT CRAYFISH AND SQUID NEUROMUSCULAR JUNCTIONS. George D. Bittner, V. Lawrence Sewell, and Milton P. Charlton. Dept. of Zoology, University of Texas, Austin, 78712.

When two shocks are applied to the single excitor motor neuron which innervates the crayfish opener muscle bathed in normal saline or to fibers which synapse on the post-synaptic giant fiber of the squid stellate ganglion bathed in low Ca^{++} saline, the facilitation seen at the second pulse decays with a double exponential time course similar to that reported for frog neuromuscular junctions bathed in low Ca^{++} (Mallert and Martin. J. Physiol., 193:679-694, 1967). However, in crayfish, the rate of growth of facilitation during a burst of equal internal stimuli cannot be approximated by the linear summation model developed by Mallert and Martin for the frog neuromuscular junction--a model which we have found also applies to squid synapses. Since the time course of the decay of facilitation remained unchanged in crayfish opener synapses after a burst, the striking the increase in facilitation during a burst must arise from a progressive, non-linear, increase in facilitation to each stimulus. It may well be the case that the pattern of transmitter release seen at crayfish neuromuscular junction will more closely approximate the release kinetics found at vertebrate CNS synapses since (unlike squid or frog synapses) both crayfish motorneuronal and vertebrate CNS synapses usually release relatively few quanta when bathed in normal concentrations of extracellular calcium.

72 SPECIES DIFFERENCES IN THE ADENYL CYCLASE RESPONSIVENESS TO NEUROTRANSMITTERS IN THE SUPERIOR CERVICAL GANGLION. Asa C. Black, Jr.,*, Ramesh C. Bhalla*, and Terence H. Williams. Dept. Anat., Coll. Med., Univ. of Iowa, Iowa City, 52242.

It has been shown that preganglionic stimulation of the *rabbit* superior cervical ganglion (S.C.G.) results in an increase in cyclic AMP levels, which has been attributed to release of dopamine from an interneuron, which causes hyperpolarization of the post-ganglionic neuron. Electron-microscopic examination of *feline* S.C.G. in these laboratories revealed that the interneurons are a rarity in this species. Whole desheathed feline ganglia or slices of bovine ganglia were preincubated for 20 minutes, and then incubated for 10 minutes in the presence of the appropriate agonist in Eagles medium. After incubation, the tissues were processed to measure cyclic AMP by protein binding assay. The following results were obtained:--

Dopamine Concentration Moles/liter	Cyclic AMP (picomoles per mg. protein)* Bovine Ganglion	Percent Control	Feline Ganglion	Percent Control
$1x10^{-4}$			43.1±7.8 (6)	160%
$5x10^{-5}$	151±20.8 (6)	524%	41.0±4.5 (4)	152%
$1x10^{-5}$	118±11.6 (5)	410%	41.1±5.9 (5)	153%
$5x10^{-6}$	102±10.4 (5)	353%	46.7±11.5 (4)	174%
Control	28.8±2.18 (6)	100%	26.9±5.7 (4)	100%

* standard error of the mean; number of points in parenthesis.

Dopamine and NE caused a dose-related increase in cyclic AMP levels in bovine but not in feline S.C.G. We attribute this lack of response in feline ganglion to the absence of an adrenergic receptor in the post-ganglionic neuron, and to the paucity of interneurons in this species.

73 ONTOGENY OF THE RESERPINE-ELICITED INDUCTION OF TYROSINE HYDROXYLASE IN RAT SUPERIOR CERVICAL GANGLION, ADRENAL AND LOCUS COERULEUS. By Ira B. Black and Donald J. Reis, Dept. Neurol, Cornell U. Med. Coll., New York 10021

The administration of reserpine to adult rats results in increased activity and amount of the enzyme tyrosine hydroxylase (TH) in adrenal medulla, superior cervical ganglion (SCG) and in the nucleus locus coeruleus (LC) in brainstem. To determine whether the induction of TH by reserpine in these tissues occurs at birth or develops post-natally, we treated rats of different ages with reserpine, 5 mg/kg s.c. 24 and 48 hours before death. TH was assayed in all 3 tissues. TH was inducible in adrenal medulla from day 2, in LC from day 6, but not in SCG until day 24 of life. In all 3 tissues the adult level of responsiveness was gradually acquired over days. The inability to induce TH in neonatal SCG could not be attributed to changes in the dose/response characteristics since a wide range of doses failed to increase enzyme activity; nor was it due to absence of functional innervation of SCG, since preganglionic denervation at birth prevented normal maturation of TH.

We conclude that the reserpine-elicited induction of TH develops at different times specific for each organ, and appears to depend on maturation of mechanisms intrinsic to the specific adrenergic cells in each area examined. (Supported by NIH Grants NS10259, NS11302, NS06911, MH24285.

74 PATTERN DISCRIMINATION THRESHOLDS AFTER VISUAL CORTICAL LESIONS IN MONKEYS Lillian Blake*†, Charlene Jarvis and Mortimer Mishkin. Lab. Psychol., NIMH, Bethesda, MD, 20014

Ablation of inferior temporal (IT) cortex, particularly of the posterior region, produces severe impairment in pattern discrimination learning. The present study examined whether this impairment is associated with raised pattern discrimination thresholds. The rationale was as follows: Since IT neurons receive their visual input indirectly from striate cortex (Bender et al, Physiologist, 1972), and are activated by very specific and sometimes complex stimulus features (Gross et al, J. Neurophysiol., 1972), IT cortex could be the end stage of a serial processing system for pattern vision; its removal might thus result in raised thresholds due to the loss of the system's most finely-tuned pattern detectors. To test this, groups of three monkeys each were given either anterior IT, posterior IT, or foveal striate lesions, or kept as controls. They were trained after surgery on a threshold task in which a 90° white angle on a grey ground was the standard, and 15 angles ranging from 10° through 88.5° were the comparisons. As expected, monkeys with posterior IT lesions were the most severely impaired in learning the initial discrimination (90° vs. 10°). However, only the monkeys with foveal striate lesions showed significant impairment on the subsequent threshold determinations. The findings indicate that the pattern discrimination learning deficits produced by IT lesions are not the result of raised pattern discrimination thresholds, and, by implication, that IT neurons are probably not the most finely-tuned detectors of simple patterns. These and additional data to be presented point instead to a loss in selective attention to stimulus features as the explanation for the discrimination learning deficit following posterior IT lesions.

†Lillian Blake died May 6, 1973

75 CYCLOHEXIMIDE-INDUCED AMNESIA: POSSIBLE INVOLVEMENT OF BRAIN CATECHOLAMINES. Alan S. Bloom*, Elton E. Quinton and Laurence A. Carr. Neuropsychopharmacology Program, University of Louisville, Louisville, Kentucky, 40206.

Male C57 Bl/6J mice injected with cycloheximide, 150 mg/kg, 30 minutes before a single training trial on a passive avoidance task showed impaired memory when tested 72 hours later. When administered immediately after training, d-amphetamine SO_4,5 mg/kg, greatly attenuated the memory impairment caused by cycloheximide. To determine whether cycloheximide or d-amphetamine SO_4 altered memory formation by acting on brain catecholamine neurons, the effects of these drugs on the conversion of H^3-tyrosine to H^3-dopamine and H^3-norepinephrine were studied. Within 30 minutes after injection of cycloheximide, the brain concentrations of newly synthesized norepinephrine and dopamine were significantly decreased to 25% of control, reaching minimal levels of 11% of control 210 minutes after the injection. Protein synthesis, as measured by incorporation of H^3-tyrosine, was decreased approximately 90 to 95% between 30 and 210 minutes after administration of cycloheximide. When d-amphetamine SO_4 was given 30 minutes after the cycloheximide injection, there was a significant increase in the brain concentration of newly synthesized catecholamines 30 minutes later compared with mice which received cycloheximide only. d-Amphetamine SO_4 had no effect, however, on the inhibition of protein synthesis caused by cycloheximide. The results suggest that amnesia induced by cycloheximide may be due in part to a reduction in synthesis of brain catecholamines and that the memory deficit can be overcome with drugs which can activate noradrenergic or dopaminergic neurons.

76 ANALYSIS OF CELLS IN THE CUNEATE NUCLEUS OF THE CAT. Paul Blum. Dept. Physiol., Univ. of Vermont, Burlington, Vt. 05401 and Dept. of Physiol. Pharmacol., Duke Univ., Durham, N.C. 27710

Contrasting models of the organization of the dorsal column nuclei are composed of differing functional elements. Traditional views show a major division between relay cells and inhibitory interneurons. A newer concept replaces interneurons with inhibition producing long axons from various brain structures. In this study, a population of cells from the cuneate nucleus of the chloralose anesthetized cat were studied. It was found that neurons could be grouped with maximum order by making the primary division on the basis of response to repetitive ipsilateral forepaw stimulation. Cells responding at greater than 20 Hz stimulation (strong cells) had small receptive fields, short constant latencies from peripheral stimulation and little convergence from central structures. Cells not following to 20 Hz (weak cells) had a much greater range of peripheral latencies, receptive fields that could include the entire body surface and convergence from central structures. Relay cells and interneurons were present in both groups. Drugs were applied by microiontophoresis to a group of these cells. Glutamate was a powerful excitant to both weak and strong cells. Fibers, identified by lack of response to glutamate, were not found. These data indicate that strong and weak cells are functionally distinct subdivisions among the cell populations of the cuneate nucleus.
(supported by grants NS 09472, NS 05330 and NS 10507)

77 ADENOSINE AND PROSTAGLANDIN E_1 STIMULATION OF ADENYL-CYCLASE IN HOMOGENATES OF MOUSE NEUROBLASTOMA CELLS. Arthur J. Blume and Carolyn Foster* Dept. Phys. Chem., Roche Inst. Mol. Biol., Nutley, N.J. 07110.

One can see an elevation in cellular cAMP levels in intact neuroblastoma cells after addition of adenosine and/or prostaglandin (PG) E_1. As supportive evidence that both in vivo stimulatory effects are due to increased synthesis of cAMP and not decreased cAMP degradation, we now report that adenosine and PGE_1 increase adenyl cyclase activity in homogenates of neuroblastoma clone NS20 cells. Washed cells were suspended in 2mM Tris/maleate pH 7.4;0.3mM $EDTA_{Na}$pH 7.4 and 0.24M sucrose and homogenized at 4°. Adenyl cyclase activity was measured according to the method of Kebabian et al.(PNAS 69: 2145, 1972) at 35° using 3mM ATP as substrate and 0.25mM RO20-1724 as the phosphodiesterase inhibitor. The basal adenyl cyclase activity in crude homogenates was 4-5pmol/min/mg protein and adenosine (50μM), NaF(10mM) and PGE_1(0.56μM) were found to stimulate the enzyme 3-4X, 6-7X and 9-12X respectively. Less than 14% of the cyclase activity was pelleted after centrifugation at 800xg. However, basal and all three stimulated cyclase activities were pelleted after 30 min. centrifugation at 250,000xg. Since cyclase activity could not be detected in this high speed supernatant the above indicates that the vast majority of neuroblastoma adenyl cyclase is particulate in nature and probably membrane bound. We have used the 800xg supernatant to characterize in detail the adenosine and PGE_1 stimulations and Ca^{++} inhibition of neuroblastoma adenyl cyclase.

78 ACTIVATION OF "KINDLED" SEIZURES DURING ALCOHOL WITHDRAWAL IN THE RAT. Carl A. Boast*, Bruce E. Hunter*, Don W. Walker, Joseph N. Riley* and Steven F. Zornetzer. Dept. Neuroscience Col. Med., Univ. Fl. and VA Hospital, Gainesville, Fl. 32602

Repeated electrical stimulation of areas in the limbic system results in the progressive development of epileptiform afterdischarge and motor seizures (Kindling). The experiment examined the effects of prior establishment of a kindled epileptic focus on behavioral and EEG seizure activity during alcohol withdrawal. Rats were administered brief daily electrical stimulation in the amygdala or hippocampus until such stimulation elicited sustained motor seizures on five consecutive days. They were then maintained on alcohol-containing liquid diets for 14-26 days. The results obtained during acute alcohol abstinence from rats with and without pre-existing latent epileptiform foci differed in two ways: 1) The "kindled" rats showed a greater incidence of spontaneous convulsions. These convulsions more closely resembled those observed following electrical stimulation (masticatory seizures; rearing, forelimb clonus) than those found normally during alcohol withdrawal (whole-body tonic-clonic). 2) EEG seizure activity during convulsions was altered such that cortical areas were involved to a much greater extent in the "kindled" rats. The results suggest that the presence of an excitable latent epileptiform focus in brain tissue during alcohol withdrawal may bias the usual pattern of hyperactivity thereby altering the behavioral and EEG manifestations of the acute abstinence syndrome. Supported by PHS Grant #AA00200 and the Veterans Administration Project: #MRIS 9183.

79 NEUROPSYCHOPHARMACOLOGY OF METHAQUALONE. William O. Boggan, Dept. Psychiatry and Biochem., Med. Uni. of S. C., Charleston, S. C. 29401

The anticonvulsant effects of methaqualone were studied in mice given transcorneal supramaximal electroconvulsive shock (ECS), 20 mA for 0.2 sec., and attempts were made to correlate effects observed with changes in neurotransmitter concentration in brain. Methaqualone protects animals against ECS in a dose related manner. At lower concentrations (25 mg/kg) the drug decreased only the number of animals dying (60% in controls, 0% in drug treated), whereas higher concentrations (75 mg/kg) diminished the clonic (100% in controls, 30% in drugged) and tonic (100% in control, 10% in drugged) aspects of the convulsive syndrome. The peak effect of methaqualone is approximately one hour with a duration of action longer than four hours. No changes in brain concentration of norepinephrine, dopamine, serotonin, or 5-hydroxyindole acetic acid (5-HIAA) were found in drug treated, nonconvulsed animals at the time of peak anticonvulsant effects. However, 5-HIAA concentration in brain was significantly greater in drug treated-convulsed animals than in vehicle treated convulsed animals at this time. These findings suggest that methaqualone may enhance the amount of serotonin released during ECS, possibly making more 5-HT available to receptors and to reuptake. This hypothesis is supported by other data (McBride et. al., pp. 157, Abstracts Amer. Soc. for Neurochem., 1974) demonstrating that 5-hydroxytryptophan, also anticonvulsant with respect to ECS, enhances the release of 5-HT and the concentration of 5-HIAA. Other possible explanations for our effects on 5-HIAA, such as the diminished transport of 5-HIAA out of brain, as appears to be the case after an acute injection of ethanol, or enhanced synthesis of 5-HT cannot be ruled out though preliminary data do not support the latter hypothesis.

80 REGIONAL STUDIES OF THE CONSEQUENCES OF ACUTE AND CHRONIC INTRACEREBRAL MORPHINE INJECTION. Kenneth A. Bonnet and John Rogers*. Dept. Psychobiol. and Physiol., Stanford Res. Institute, Menlo Park, California 94025

Fisher rats were implanted with bilateral fine guage cannulae for injection of morphine into discrete brain structures. Footshock sensitivity was determined for four motoric responses and vocalization by a modified jump-flinch procedure. Bilateral injections of saline one week postoperatively revealed significant group differences in shock sensitivity. Bilateral 1 or 10μg morhpine injections produced different response category profiles for each implant group. Caudate animals became hypersensitive in most response categories. Center median animals were dramatically analgesic in the vocalisation response. Only substantia nigra animals resembled the response profiles of animals given systemic morphine. Repeated 10μg injections resulted in tolerance on all response categories for substantia nigra, and loss of hyperalgesia in the caudate animals. Posterior hypothalamus showed increasing analgesia with successive injections and no indications of tolerance development. Subsequent systemic morphine injection (5mg/Kg) was reduced in analgesic effects only in animals given repeated morphine injections into the posterior hypothalamus. (Supported in part by DA-00356-01).

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Abstract withdrawn

82 Changes in Cortical Excitability Associated with the Development of a Cortically Reinforced Conditioned Response. James E. Boston and Gillray Kandel*. Dept. of Psychology, R.P.I., Troy, New York.
Changes in cortical excitability associated with the development of a cortically reinforced response have been reported by numerous investigators (e.g. Nikolayeva, Sechenov J. of Physiol. 41: 19-24, 1955). These changes in cortical excitability were studied in four cats. Three cannulae and a multi-electrode array were implanted in the motor-sensory region of the cortex of each cat. The responses to be conditioned were chosen from the responses elicited by direct stimulation of the cortex via these electrodes. Three of the four cats developed conditioned responses (CRs) of forelimb movement and the fourth cat developed CRs of head movement. Correlations were found between performance of the CR and the excitability of the cortical locus stimulated to evoke the unconditioned response (cortical locus-US), i.e. as performance developed the cortical locus-US increased in excitability. By measuring threshold changes at the cortical locus-US with and without the conditioned stimulus (CS), it was found that the excitability change at that locus was not induced specifically by the CS. In addition, it was found that these threshold changes observed at the cortical locus-US were not restricted to that locus, but occurred generally throughout the implanted area. Electrocorticograms taken from the cortical locus-US area also failed to show any changes associated with CR performance. Based upon the above results, it was concluded that the CR is not mediated by a shift in excitability at the cortical locus-US induced by the CS.

83 OPTIMUM STIMULI FOR CAT TONGUE CHEMORECEPTORS. J. C. Boudreau, T. E. Nelson* and J. Oravec*. Sensory Sciences Center, Graduate School of Biomedical Sciences, University of Texas at Houston, Texas, 77025.

Single unit spike potentials from geniculate ganglion cells innervating fungiform papilla chemoreceptors were studied in anesthetized cats. A wide variety of chemical compounds were applied to the tongue in distilled water or saline in 50mM concentration or less. Group I chemoresponsive neurons were optimally discharged by compounds containing a group capable of donating a proton. Discharge was proportional to the pH of the solution relative to the pK of the ionizable group. Certain heterocyclics (e.g. thiazolidine and pyridine) were much more stimulatory than any other substances tested. Group II chemoresponsive neurons were found to be affected by a wide variety of compounds, although certain amino acids were found to be among the most effective excitatory or inhibitory compounds. Certain heterocyclic ring compounds were found to be as effective as the parent compounds in eliciting discharge. Thus pyrrolidine and imidazole were as stimulating as L-proline and L-histidine respectively. Heterocyclic compounds with a nitrogen heteroatom were the most stimulating compounds tested. Heterocyclics with an oxygen heteroatom tended to be ineffective. Compounds with sulphur heteroatoms often elicited complex excitatory/inhibitory responses. The greatest degree of group II inhibition was seen with certain heterocyclics (e.g. pyrrole). In general aromaticity of heterocyclic compounds was associated with ineffectiveness or inhibition. (Supported in part by N.I.H. and N.S.F. Research Grants).

84 Demonstration of calcium-induced 'tight junctions' between cholinergic synaptic vesicles and the nerve terminal membrane: Implications for the vesicle hypothesis. Alan F. Boyne*(SPON: J. Jew).
Dept. of Anatomy, University of Iowa, Iowa City, Iowa 52242.

The vesicle hypothesis states that the neurotransmitter released on stimulation is directly derived from synaptic vesicles and that this is the basis for the quantization of acetylcholine (ACh) release seen at many cholinergic terminals. A difficulty with the hypothesis is that potential morphological correlates of the discharge event have been notably lacking.

Neurotransmitter release is Ca^{++} dependent. Boyne, Bohan and Williams have recently studied the results of Ca^{++}, Mg^{++}, and Na^{+} containing fixatives on the cholinergic nerve terminals of Narcine brasiliensis electric organ. The composition of the fixative has been described (Nature 224, 32, 1973). With 90 mM Ca^{++} or Mg^{++}, a population of vesicles fused to the terminal membrane and bulging into the terminal cleft can be seen. Such ultrastructures were not seen in the absence of divalent cations.

Since Zimmerman and Whittaker (J. Neurochem. 22, 435 (1974)) have shown that vesicular ACh is released more rapidly than vesicular ATP in electric organs stimulated to fatigue, it seems reasonable to hypothesize that ACh may be preferentially released through the pentalaminar fusions of the above vesicle population. Preferential release of ACh over ATP can be shown in isolated vesicles as a function of temperature and of phospholipase A treatments. The resulting population of ACh-depleted but intact vesicles would be well placed to take up ACh and to account for the reports that it is the newly synthesized transmitter which is preferentially released on stimulation. Eventual perforation of the fused membranes would lead to the exocytotic incorporation of vesicle membrane into the terminal membrane and would begin the recycling of vesicle membrane proposed by others.

85 CURRENT SOURCE IN A WEAKLY ELECTRIC MORMYRID FISH. Joel C. Bradbury* and Curtis C. Bell. Laboratory of Neurophysiology, Good Samaritan Hospital and Medical Center, Portland, Oregon 97210

We have quantitatively described the current source in Gnathonemus petersii. The electric organ discharge (EOD) of this fish is brief (total duration <5 msec) and biphasic with the rostral end of the electric organ first positive and then negative with respect to the caudal end. We measured the output voltage (V) with skin electrodes at either end of the electric organ and measured current flowing through the organ (I) with a toroidal coil sealed around the tail. We then varied the resistive load seen by the electric organ in two ways: a) by changing the ionic concentration of the medium, and b) by shunting the skin electrodes through different resistors while the fish was in a medium of high resistivity. The plot of V against I for the peak of the first phase of the EOD gave a straight line with a negative slope. Since the output voltage (V) of a simple battery is related to current flowing through it (I) by the relation of $V=V_B-R_S \cdot I$ where V_B is the open circuit voltage and R_S is the source resistance of the battery, a simple battery model is adequate for the first phase. In such a model V_B is equal to the voltage intercept and R_S is equal to the slope of the V vs I plot (Ranges: V_B, 6-10V; R_S, 7-10Kohms). The peak of the second phase of the discharge could not be modeled in this way. As resistive load increased and current of the second phase fell, the voltage at first increased but then fell sharply. However, when diodes and shunting resistors were used to vary the loads seen by the first and second phases independently, the straight line relationship noted for the first phase was also seen with the second phase. In fact, it appears that V_B of the second phase is a function of the amount of first phase current. R_S is unaffected. These findings are consistent with what is known about the cellular basis of the EOD (Bennett and Grundfest, 1961).

86 RESERPINE SENSITIVE UPTAKE, SYNTHESIS AND STORAGE OF CATECHOLAMINES IN ADRENERGIC NEUROBLASTOMA CELLS. Xandra O. Breakefield* and Marshall W. Nirenberg. N.H.L.I., Bethesda, Md. 20014

Neuroblastoma cells from clone N1E-115 resemble normal adrenergic neurons in that they have high tyrosine hydroxylase activity, dense core vesicles 1000 Å in diameter, long neurites and excitable membranes. In these studies we show that dopamine (DA) uptake, the conversion of DA to norepinephrine (NE), and DA and NE storage are sensitive to reserpine and associated with a particulate subcellular fraction. Differentiated cultures were exposed to 5×10^{-7} M [^{3}H]DA in the presence of 2×10^{-5} M nialamide and 10^{-4} M ascorbic acid. Cells took up about 0.3 pmole [^{3}H] DA/min/mg protein for 2 hours. Chromatography of material extracted from cells that had been incubated for 30 min with [^{3}H]DA revealed that 52 and 42% of the [^{3}H] compounds obtained had the chromatographic mobilities of DA and NE, respectively. In the presence of 5×10^{-5} M reserpine, uptake of [^{3}H]DA was reduced to 35% of control values. With reserpine treated cells, 52% of the cellular [^{3}H] material was DA and only 3% NE. Catecholamine storage and release were studied using cells that had been incubated with [^{3}H]DA for 30 min, washed and then incubated in the absence of DA. Thirty % of the cellular [^{3}H] material was released within 10 min after washing and 35% within 30 min. Cells were then extracted and the [^{3}H] compounds characterized; 70% of the labeled material was shown to be NE. This [^{3}H] material was shown by centrifugation to be associated with subcellular particles. These results show that clonal neuroblastoma cells are able to synthesize and store NE and that storage reactions are similiar to those of normal adrenergic neurons.

87 FIGURE DISTORTIONS ELICITED BY VISUAL TRACKING. Bruce Bridgeman, Melanie J. Mayer*, and Loyd Glen*, University of California, Santa Cruz, California 95064.

If a spot on a screen is moved at a constant speed in a tall, narrow square-wave pattern, and it moves through one period in about 60 msec, an observer perceives an "X" dancing across the screen and capped at top and bottom with horizontal lines. The illusion depends upon slow tracking of the stimulus, for it does not occur if fixation is maintained on a stationary point. The perceived slant of the vertical component of the movement is a result of the fact that the time constant of the eye tracking system is much slower than the period of the wave; experimental measurements show that the eye tracks the average position of the spot and does not attempt to follow its vertical oscillation. The degree of apparent slant can be explained quantitatively by a vector summation of the vertically-moving spot and the horizontally-moving eye, so that a slanted image is described on the retina. Because tracking is smooth and accurate, the slanted lines appear straight and intersect at their centers. An integrated Gestalt-figure is seen moving horizontally across the screen. The illusion is a dramatic demonstration of the failure of the tracking system to compensate perceptually for target motion orthogonal to the direction of tracking.

88 LAMINAR CELL COUNTS OF NEURON DENSITY AND GLIA/NEURON RATIO IN CORTICAL AREA 3 OF RATS GIVEN CORTICOSTERONE NEONATALLY. Kenneth R. Brizzee and Evelyn Howard. Division of Biomedical Sciences, Dept. Neurobiology, Delta Regional Primate Research Center, Covington, La. 70433, Dept. Anat. Tulane Univ. School of Medicine, New Orleans, La. 70112 and Division of Behavioral Biology, Dept. Psychiat., The Johns Hopkins Med. School, Baltimore, Md. 21205.

Laminar cell counts of neurons/mm^3 and glia/mm^3 have been made in columns of area 3 of the cerebral cortex of rats given a single large dose of corticosterone at 2 to 3 days of age, and studied at 2 to 11 months. There was an increase in the number of neurons/mm^3 of 11.5%, presumably a result of the reduced weight of the cerebrum (13%). Less direct evidence has indicated that the reduction in cerebral weight occurs with little generalized loss of neurons, and that the DNA deficit after corticosterone treatment is mainly due to a deficit in glia (Howard and Benjamins, 1974). The counts showed a decrease in the glia/neurons ratio of 19% in cortical area 3. (Supported by NIH Grant RR00164-12)

89 THE AFFERENT AND EFFERENT CONNECTIONS OF THE ANTERIOR OLFACTORY NUCLEUS (AON) IN THE RABBIT AS STUDIED WITH THE AUTORADIOGRAPHIC AND HORSERADISH PEROXIDASE(HRP) AXON TRACING METHODS. R. Broadwell* (SPON: R.H. Bleier). Dept. of Neurophysiol., Univ. Wis., Madison, Wis. 53706.

The afferent projections to the AON were studied using the HRP method. HRP is taken up by axon terminals and transported in a retrograde direction by axoplasmic flow to the soma. Following the injection of $\frac{1}{2}\mu$l of HRP into the AON in 6 female rabbits, HRP labeled perikarya were found ipsilaterally in the mitral and tufted cells of the main olfactory bulb, the horizontal limb of the nucleus of the diagonal band(HLDB), layer II of the prepyriform cortex rostral to the HLDB, and in the contralateral AON pars externa. The efferent projections of the AON were followed using the autoradiographic axon tracing method. $\frac{1}{4}$-1μl of H^3-leucine(25μC/μl) was injected into the left AON in 17 female rabbits. Survival times were 1-30d. Termination of AON efferents was observed bilaterally in the glomerular and granular layers of the main olfactory bulb and layer IB of the prepyriform cortex, contralaterally in layer IB of the AON pars externa, lateralis and dorsalis, and ipsilaterally in the tenia tecta, medial septal area, prepyriform claustrum, olfactory tubercle and HLDB. An additional fiber bundle could be traced through the HLDB and anterior amygdala to a position dorsolateral to the optic tract and lateral hypothalamus. In this region the fibers split into two groups. The fibers of one group ascend medial to the internal capsule to terminate in a posterior segment of the bed nucleus of the stria terminalis, while fibers in the second group loop medially over the optic tract to enter and pass caudally in the lateral hypothalamus to terminate lateral to the mamillary complex, possibly within the nuclei gemini of Lundberg (J. Comp. Neurol., 119: 311, 1962). This study suggests that the AON and prepyriform cortex are closely related with respect to their reciprocal connections and common sites of efferent fiber termination i.e. AON, prepyriform cortex,tenia tecta, HLDB, and lateral hypothalamus.

90 NEGATIVE CONTRAST EFFECTS WERE ABSENT WHEN REINFORCING LATERAL HYPOTHALAMIC BRAIN STIMULATION WAS SWITCHED TO THE CONTRALATERAL ELECTRODE. Bruce L. Bromley and Daniel K. Tranberg*. Dept. Psychol. MSC, Moorhead, Minn. 56560

Response rates for electrical stimulation of the brain vary directly with intensity. At intermediate intensities both positive and negative contrast effects have been reported (PRev 76: 264, 1969). In the present experiment only negative contrast effects were found and these were site specific. Four rats responded (60 Hz, .5 s/bar press) for stimulation delivered to one or the other of the bipolar electrodes implanted in the contralateral lateral hypothalamic regions of their brains. Five intensities (10-40 μA in 4 μA steps) were selected for each electrode (yielding 0-165 RPM). One intermediate intensity, the switch intensity (14-32 μA, produced similar response rates whether it was one of an increasing sequence of 5 intensities (20 min. each) or it was presented alone. However, response rates were reliably slower (t = 5.17, df = 15, $p < .001$) to the switch intensity when it was one of a decreasing sequence of 5 intensities. But this decrease in response rates did not occur if at the switch intensity the site of stimulation was switched (in either direction) to the contralateral electrode. Thus, only negative contrast effects were found and they were site dependent. It seems the negative contrast effect is at most a unilateral phenomenon involving only a reinforcement system on one side of the brain or at least a local effect restricted to only the specific group of neurons directly activated by the electrical stimulus.

91 ANTIBODY TO DOPAMINE AND TYRAMINE. Gregory M. Brown and Lee J. Grota*. Departments of Psychiatry, University of Toronto and University of Rochester.

In order to produce antibody against dopamine, rabbits were immunized with tyramine coupled to bovine serum albumin (BSA) using formaldehyde. This reaction was chosen because coupling occurs at the carbon ortho to the hydroxyl group, so that the portion of the tyramine molecule participating in antibody production is identical to dopamine. Molar ratio of hapten to protein as estimated by ultraviolet absorption at 195 and 280 nm was 78 in the conjugate used for immunization. Antisera were tested for antibodies to the hapten by double immunodiffusion against tyramine coupled to rabbit serum albumin. Dilutions of antisera showing positive precipitin reactions were then incubated with tyramine-H^3 in 1% BSA phosphosaline buffer at pH 6.5 and binding to antiserum was demonstrated on precipitation of antibody with ammonium sulphate. Dilutions of known amounts of tyramine or dopamine incubated with antibody were both capable of reducing the amount of tyramine-H^3 bound. It is concluded that 1) antibody to tyramine and dopamine has been produced and 2) a radioimmunoassay for tyramine and dopamine is feasible. (Supported by MRC grant MA5372, USPHS grant HD08362 and funds from the Grant Foundation)

92 PARAMETRIC ANALYSIS OF PHYSIOLOGICAL PROPERTIES OF CAT DORSAL HORN CELLS RESPONDING TO LIGHT TOUCH. Paul B. Brown, Jannon L. Fuchs, and Daniel N. Tapper. Boston State Hospital, Boston, Mass. and Cornell University, Ithaca, New York.

Dorsal horn neurons responding to light touch on the hindlimb were recorded in segments L_3-S_2 of unanesthetized low spinal cats which had been decerebrated and spinalized under halothane anesthesia. Single units were characterized with respect to receptive field location, receptive field geometry, spontaneous discharge rate, central delay, and convergence of four low-threshold tactile afferent types. Receptive field size increased from the toes to the calf. Length/width ratio increased from toes to calf and decreased from calf to hip. The relation between receptive field size and position on the limb was independent of segmental or laminar location of the neuron. There were also no statistically significant differences among laminae IV-VI with respect to central delay, receptive field shape or size, ongoing discharge, or convergence of the four tactile afferent systems. Monosynaptic cutaneous afferent connections to all three laminae were demonstrated. Central delay was negatively correlated with spontaneous discharge rate and receptive field size.

These data do not support Wall's laminar cascading model of cutaneous processing in the dorsal horn. The relation between receptive field geometry and receptive field position can be interpreted in terms of regional variations in scale factor of the dorsal horn somatotopic map.

93 THE ROLE OF SEROTONIN (5-HT) IN THE DISCRIMINATIVE STIMULUS PROPERTIES OF MESCALINE. Ronald G. Browne* and Beng T. Ho. Texas Research Institute of Mental Sciences, Houston, Texas 77025.

Male Sprague-Dawley rats were trained to discriminate intraperitoneally administered mescaline hydrochloride (15 mg/kg) from saline in a two-lever operant chamber for food reinforcement. Reward was contingent upon responses made greater than 15 sec. apart (DRL-15") on the appropriate lever paired with either drug or saline administration. Following the establishment of discriminative response control by mescaline, the subjects were tested for stimulus generalization produced by mescaline after: a) blockade of peripheral and central 5-HT receptors with cinanserine (15 mg/kg), methysergide (5 mg/kg), or cyproheptadine (5 mg/kg); b) blockade of peripheral 5-HT receptors with xylamidine tosylate (1 mg/kg); and c) depletion of 5-HT with the tryptophan hydroxylase inhibitor *p*-chlorophenylalanine (PCPA) (100 mg/kg daily for three days, then tested 48 hrs. after the last injection). The results show that all three central 5-HT antagonists greatly reduced the discriminability of mescaline while the peripheral antagonist, xylamidine tosylate, was without effect. Furthermore, these agents at the doses employed did not affect the discriminability of saline. Depletion of 5-HT with PCPA potentiated the effects of a sub-threshold dose (7.5 mg/kg) of mescaline and slightly reduced the discriminability of saline. Our results indicate that mescaline produces its discriminative stimulus properties by directly stimulating central serotonergic receptors.

94 CHARACTERISTIC LENGTH AS A FUNCTION OF FREQUENCY: A WHITE NOISE ANALYSIS. Hugh L. Bryant and Jose P. Segundo, Dept. Anat., UCLA, Los Angeles, Calif. 90024.

The characteristic length (CL) or space constant of a neurone is defined traditionally as the distance at which there is an electrotonic attenuation by a factor of 1/e of a D.C. signal. In current neurophysiology, however, it is of interest to know how any neuronal signal (e.g. spikes, PSP's) attenuates with distance and geometry. It is clear, though generally unrecognized, that signal decrement with distance in a neuronal element (e.g. axon, dendrite) depends on the frequency composition of the signal. We measured the CL of the giant cell (R2) in Aplysia californica as a function of frequency using the Wiener gaussian white noise (GWN) technique for systems analysis. Three separate pipettes (K-citrate, 2-10 MΩ) were introduced for current injection in the soma and transmembrane potential recording in the soma and axon at distances of 1-7 mm from the soma. "Distances" refers to the separation between electrode tips. Injecting hyperpolarizing current pulses into the soma, we verified earlier D.C. space constant estimates for this cell of at least 4 mm. Subsequently, a GWN transmembrane current was injected. Spectral analysis of the somatic and axonal transmembrane potentials indicated that, for the lower frequencies (< 5Hz), most of the loss occurs in the conversion of the current to soma potential and that these frequencies are transmitted faithfully thereafter as far as 3 mm down the axon. Injected current frequencies above 5 Hz, while seen in the somatic record, are nearly absent at distances greater than 2 mm. These results suggest the convenience of an expansion of the common usage of the space constant concept, and urge caution in the interpretation of signals seen, or more importantly not seen, with intracellular electrodes. (Supported by USPHS and UCP).

95 RETENTION DEFICIT FOR ONE-TRIAL PASSIVE AVOIDANCE IN MICE PRODUCED BY 6-METHOXY-1,2,3,4-TETRAHYDRO-β-CARBOLINE. Neil S. Buckholtz* (SPON: R. A. Schreiber). Depts. of Biochemistry and Psychiatry and Behavioral Sciences, Med. Univ. of S. C., Charleston, S. C. 29401.

The effects of 6-methoxy-1,2,3,4-tetrahydro-β-carboline (6-MeO-THBC), a drug which has been reported to increase brain serotonin without affecting brain norepinephrine, were tested on one-trial passive avoidance behavior in CF1 mice. In the first experiment animals receiving 6-MeO-THBC (100 mg/kg) 2 hr prior to training had increased latencies compared to saline controls during initial entrance into the shock compartment but had decreased latencies during a retention test 24 hr later. The drug did not seem to affect the animals' response to shock. Brain serotonin was increased 2 hr after injection but returned to control levels 24 hr later. The second experiment showed that animals receiving 6-MeO-THBC (100 mg/kg) had decreased latencies on the retention test regardless of whether they had received foot shock or not during initial training. However, 50 mg/kg 6-MeO-THBC produced a decreased retention latency only for the group that received foot shock and had no effect on training latencies. Thus, the 50 mg/kg dose produced a retention deficit in mice given foot shock without the other behavioral alterations produced by the 100 mg/kg dose. There does, therefore, appear to be a relationship between increased brain serotonin and a deficit in retention of one-trial passive avoidance. Supported in part by NIH grant RR 05420.

96 ORIGIN OF HOMOVANILLIC ACID IN THE LUMBAR FLUID. M. Bulat*, M. Jakupčević*, and Z. Lackovic* (SPON: W.J. Giardina). Institute "Ruder Boškovic", Zagreb, Yugoslavia, and The Chicago Medical School, Chicago, Illinois 60612.

Concentrations of 5-hydroxyindoleacetic acid (5-HIAA) and homovanillic acid (HVA) in the lumbar fluid of patients are generally used as an indicator of 5-hydroxytryptamine (5-HT) and dopamine (DA) metabolism, respectively, in the brain. However, we have shown (Science 173: 738, 1971; Science, in press) that 5-HIAA in the lumbar fluid reflects the metabolism of 5-HT in the spinal cord and not that in the brain. In the present experiments, we have investigated the origin of HVA in the lumbar fluid of cats considering its three potential sources: blood, spinal cord and brain. HVA does not pass from the blood to lumbar fluid under normal conditions. If DA is applied to the spinal cord either by the intravenous or spinal subarachnoid route, HVA appears in the superfusate of the spinal cord. After application of chlorpromazine and probenecid, HVA increases in the lumbar fluid which was separated from the cerebral fluid by a spinal extradural ligature. When the cisternal or lumbar fluid are sampled continuously under negative pressure over a long period of time, the concentration of HVA in the cisternal fluid was several times higher than that in the lumbar fluid. These results indicate that HVA in the lumbar fluid derives primarily from the metabolism of DA in the spinal cord and that little, if any, derives from the brain.
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97 REQUIREMENT FOR CARBON DIOXIDE TO MAINTAIN METABOLIC RESPONSES OF RAT CEREBRAL CORTEX SLICES TO STIMULATION. Richard J. Bull. National Environmental Research Center, EPA, Cincinnati, Ohio 45268

Dual-wavelength spectroscopic measurements of NAD(P) and cytochrome b responses to short periods of electrical stimulation were made in cortical slices. The responses were corrected for light-scatter artifact. In a HCO_3^- (26 mM) medium, the reductive aspect of the responses at both 562-575 nm (cyt b) and 340-374 nm (NAD(P)H) were maintained within 90% of the initial response over a two hour incubation period. Substitution of glycylglycine (30 mM) for HCO_3^- resulted in a relatively rapid degradation of both the NAD(P) and cyt b responses. Media containing both glycylglycine and HCO_3^-, with a compensating decrease in Cl^- content, was found to initially enhance the NAD(P) responses. However, this response decreased at a rate parallel to, but not to the extent of that observed with glycylglycine alone. Paradoxically, cyt b responses were found to increase in magnitude over the same time interval by almost 50%. Periodic measurements of the resting level of reduction in the cytochrome chain were made in these same tissues by scanning the α-band of cytochromes b and c. These measurements revealed that the loss of responses in glycylglycine media was paralleled by a decrease in the level of reduction in the cytochrome chain, whereas a stable level of reduction was maintained in HCO_3^- media over the 30-120 min. time interval. α-band absorbance in the presence of both glycylglycine and HCO_3^- was found to display a greater stability than observed with glycylglycine alone, but was less stable than HCO_3^- alone. The simplest explanation of these results is that CO_2 fixation operates to maintain adequate levels of intermediates for the continued function of the Kreb's cycle with prolonged incubation. Additionally, it appears that the reductive aspect of the NAD(P) response varies directly with the resting level of reduction in the cytochrome chain. The similar response of cyt b, however, varies inversely with this parameter.

98 ANTIPSYCHOTIC DRUGS: POSSIBLE MECHANISMS FOR DIFFERING INCIDENCES OF EXTRAPYRAMIDAL SIDE EFFECTS. Benjamin S. Bunney* and George K. Aghajanian. Depts. Psychiat. & Pharmacol., Yale U. Sch. of Med., New Haven, Ct. 06508.

Many antipsychotic drugs produce pronounced extrapyramidal side effects (EPSE) which many feel are due to a blockade of postsynaptic dopamine (DA) receptors in the neostriatum. Other neuroleptics (e.g. thioridazine, clozapine) have a low incidence of EPSE. To explain these differences, two hypothesis have been suggested: 1) Neuroleptics with a high incidence of EPSE are more effective striatal DA receptor blockers than low EPSE drugs; 2) Neuroleptics with a low incidence of EPSE have anticholinergic properties. Using single unit recording techniques in rats, we have attempted to investigate these two hypothesis. Intravenously administered neuroleptics with a moderate to high incidence of EPSE (e.g. haloperidol, chlorpromazine) increased the activity of substantia nigra zona compacta (ZC) dopaminergic neurons, particularly in unanesthetized preparations. The increased firing rate induced by these drugs may be secondary to blockade of postsynaptic DA receptors in the neostriatum. Those drugs with minimal EPSE (thioridazine, clozapine) do not increase DA cell activity above baseline. Both groups readily reverse d-amphetamine induced depression of these cells presumably by blocking at postsynaptic sites the effects of DA released by amphetamine. Hypothesis 2 was examined by testing the anticholinergic properties of intravenous clozapine on responses of central neurons (e.g. hippocampus, substantia nigra zona reticulata) excited by microiontophoretically applied acetylcholine (ACH). Although scopolamine blocked ACH excitation, clozapine was ineffective at doses much higher than those needed to completely reverse the amphetamine depression of DA cell activity. In the absence of any physiological evidence for anticholinergic activity, our results suggest that all antipsychotics can block DA receptors but those with a lower incidence of EPSE may be less efficacious blockers.

99 DEMONSTRATION OF RETINAL GANGLION CELL PROJECTIONS TO THE LATERAL GENICULATE NUCLEUS AND SUPERIOR COLLICULUS OF THE MONKEY WITH HORSERADISH PEROXIDASE. A.H. Bunt, A.E. Hendrickson, J.S. Lund*, R.D. Lund, and A.F. Fuchs. University of Washington, Seattle, Washington 98195.

Horseradish peroxidase (HRP) in volumes of 0.1 to 0.8µl (100 mg/300µl saline) was injected stereotaxically into the lateral geniculate nucleus (LGN) or superior colliculus (SC) of 5 adult Macaca mulatta monkeys. After survival times of 16 to 30 hours, the animals were sacrificed and the retinae and brains processed for the demonstration of peroxidase. Following injection of HRP into both visual centers, certain ganglion cells (GC's) in the retinae accumulated HRP granules in their somata, indicating retrograde movement of the enzyme tracer within axons of those GC's which projected to the area of the injection site. In each experiment, labeled GC's were restricted to the region of the retina known to project to that area of the LGN or SC immediately surrounding the injection needle tract and tip, even though the brown reaction product due to peroxidase activity extended several mm away from the needle tract. In the case of the LGN injections, GC's of small, medium, and large diameter somata were labeled, including the closely packed midget GC's of parafovea. In the case of the SC injections of HRP, labeled GC's of large, medium, and small diameters were also labeled, although fewer cells per unit area of the retina contained HRP. Following HRP injections into the anteromost portion of the SC, no midget GC's of the parafovea were labeled, supporting previous evidence from degeneration and autoradiographic studies that GC's in the central macular region of the monkey retina lack axonal connections to the SC.(Supported by USPHS Grants EYO-0491, -1311, -1208, -1086, -0596, -0745)

100 INPUT-OUTPUT RELATIONS IN A HETEROGENEOUS POPULATION OF MOTOR UNITS: SYNAPTIC EFFICACY AND TENSION PRODUCTION. R. E. Burke, W. Z. Rymer and J. V. Walsh, Jr. Lab of Neural Control, NINDS, NIH, Bethesda, Md. 20014.

Intracellular recording and stimulation permit assessment of synaptic input to alpha motoneurons in relation to the mechanical output of the individual muscle units innervated by them. The maximum amplitude of composite group Ia EPSPs produced in medial gastrocnemius (MG) motoneurons by electrical stimulation of the MG nerve is closely related to MG motor unit recruitment in stretch reflexes of decerebrate cats (Burke, J.Physiol. 196, 631-654, 1968) and in the present work has been found inversely correlated with maximum isometric tension of MG muscle units in fused tetani (slope =-10.14 gm/mV EPSP; r = -0.746). Assuming that motor units are recruited in sequence according to EPSP amplitude beginning with the largest, a sample of 114 MG units of identified type were ranked by EPSP amplitude and the percent of total population tension added by each unit was plotted as a cumulative sum against EPSP amplitude. The resulting curve relating EPSP size with cumulative tension output had an asymmetrical sigmoid shape which could be approximated by two intersecting linear segments with different slope. "Recruitment" of units with EPSPs in the larger half of the sample range had a gradual slope (approx. 2% tension added / mV EPSP). This part of the curve was dominated by fatigue resistant S and FR units representing about 40% of the total sample but generating only about 15% of the total cumulative tension. The remaining 85% of the theoretical total tension was produced by units with EPSPs in the smaller half of the amplitude range, distributed on a steeper slope (about 18% tension added per mV EPSP) and dominated by fast twitch units (FF + FR) with fatigue resistant FR units "recruited" first. Such theoretical input-output curves suggest that the organization of synaptic input is a critical factor controlling the mechanical output of a motor unit pool.

101 A SECOND SITE FOR BINDING OF THYROTROPIN RELEASING HORMONE TO RAT BRAIN. David R. Burt* and Solomon H. Snyder. Dept. Pharmacol., Sch. Med., The Johns Hopkins University, Baltimore, Md. 21205

In addition to its actions on the pituitary, the tripeptide thyrotropin releasing hormone (TRH) has recently been found to have behavioral effects, suggesting that it acts directly on the central nervous system (Plotnikoff et al., Science 178: 417, 1972). We have sought a possible physical basis for this action by studying the binding of radioactive TRH to membrane preparations of rat brain. Parallel studies were also performed on the pituitary. Previously we described a low affinity binding site (K_D approx. 10^{-5}M) which was unique to brain and exhibited a considerable degree of specificity (Trans. Am. Soc. Neurochem. 5: 77, 1974). We have now detected a second binding site in brain of much higher affinity (K_D approx. 10^{-7} M) and lower tissue concentration, more comparable to the binding site in the pituitary. In contrast to the low affinity site, this site was not found in all brain regions, being absent from the cerebellum. It also exhibited a greater specificity for certain structural analogs of TRH than did the low affinity site. Neither site was affected by a large number of putative neurotransmitters and related drugs at 10^{-5}M concentration. This second binding site appears to be a very promising candidate for the physical basis of TRH actions in the brain. (Supported by USPHS grants MH-18501, NS-07275, and DA-00266).

102 STORAGE AND RETRIEVAL STAGES IN MEMORY AND LEARNING BY CHILDREN AND ADULTS. Herman Buschke. The Saul R. Korey Department of Neurology, Albert Einstein College of Medicine, Bronx, N.Y. 10461.

Repeated recall attempts, without any further presentation of each item after it has been recalled just once, shows storage, retention and retrieval in verbal learning, because such restricted reminding allows the subject to show learning by spontaneous recall without further presentation. Consistent retrieval of an item from long-term storage on all recall attempts (without any further presentation) indicates that the item has been learned as part of a list, in which its retrieval has been integrated with the retrieval of other items (H. Buschke, Science, 1974). Random retrieval from long-term storage does not improve prior to the abrupt onset of consistent retrieval, indicating that such random and consistent retrieval represent different stages of learning. Therefore such learning may be described by a three-state Markov model, and changes in such learning with development and aging can be analyzed in terms of the stages representing item learning and list learning, on each trial: random (item) storage (for inconsistent retrieval); random retrieval from such item storage; initial consistent storage and retrieval (initial list learning); subsequent increase in consistent storage and retrieval (additional list learning). Children show considerably less initial list learning than young adults, and more initial random item storage. Older adults show less initial list learning and more random item storage than younger adults. The number of items from random storage added to the list during learning by children and older adults appears to be similar to that of young adults.

103 ONTOGENY OF ACETYLCHOLINESTERASE (AChE) IN THE NEOSTRIATUM OF RATS. Larry L. Butcher and Gordon K. Hodge* Department of Psychology; University of California; Los Angeles, California; 90024; U.S.A.

Neostriatal acetylcholine, choline acetyltransferase, and AChE in rats are probably localized in neurons organized wholly within the boundaries of the caudate-putamen nucleus. However, these neurons have dense overlapping cellular processes, and, under normal conditions, enzyme synthesis occurs primarily in the processes. These 2 conditions occlude observation of individual AChE somata in pharmacologically unmanipulated adult material. We reasoned that, in addition to basic developmental topography, the morphology of neostriatal AChE neurons could be more readily revealed in developing brains. Rats were sacrificed 3, 6, 10, 15, 20, 29, 60, 75, and 90 days after birth. Their brains were sectioned at 40-80μ and histochemically processed for AChE according to a procedure based on Karnovsky and Roots (J. Histochem. Cytochem. 1964, 12, 219-221). At the 3-day interval, circumscribed islands of AChE activity could be observed associated with clusters of neuron somata (and their processes) staining heavily for AChE and localized preferentially near the lateral edges of the neostriatum. In the subsequent course of development, the original AChE-absent regions of the neostriatum displayed increasing enzyme activity until the entire area stained homogeneously at approximately 15 days. The neuron somata were still detectable against a background of neuropil staining until roughly 60 days after birth. These changes in AChE paralled alterations in the activity of NADH-diaphorase, an oxidative enzyme apparently related to NADH-cytochrome-c-reductase and having a differential distribution in the brain.

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104 QUANTITATIVE ASPECTS OF THE SENSORY COMPONENT OF THE GILL-WITHDRAWAL REFLEX IN APLYSIA. John Byrne*, Vincent Castellucci and Eric R. Kandel, N.Y.U. Med. Sch., P.H.R.I., and N.Y. State Psych. Inst., New York, N.Y. 10016.

A tactile stimulus delivered to the siphon skin causes reflex withdrawal of the gill. This reflex undergoes behavioral modifications including short- and long-term habituation and sensitization. Kupfermann, et al. (1971; 1974) have previously estimated the contribution of the major motor neurons to the reflex. We have developed techniques for assessing the contribution of individual sensory neurons to the reflex. Intracellular recordings were obtained from sensory and motor neurons in the isolated ganglion connected to the siphon skin and the gill. In response to a tactile stimulus to the siphon there is a dispersion of the response latencies of different mechanoreceptor neurons. As a result their synaptic actions could account for much of the duration and amplitude of the complex EPSP produced in the motor neuron. The contribution of a single sensory neuron to the complex EPSP was also determined by using a punctate stimulus (Byrne, 1974) and examining the on-center sensory neuron. A weak stimulus produced a single spike in a sensory neuron and short-latency complex EPSP that fired the motor neuron. By intracellular stimulation of the sensory neuron we found that the monosynaptic EPSP produced by it accounted for a significant fraction of the complex EPSP. With repeated stimulation the sensory neuron spike response remained stable while the EPSP it produced decremented paralleling the complex EPSP elicited in the motor neuron by natural stimulation. By these means we hope to provide a quantitative estimate of how the individual sensory, interneuronal and motor elements account for the total reflex and its modifications.

105 STEREOTYPED DOUBLET AND BURST FIRING PATTERNS OF NEURONS IN NORMAL LATERAL CUNEATE NUCLEUS: A NORMAL SUBSTRATE FOR "EPILEPTIC" FIRING PATTERNS? William H. Calvin and John D. Loeser. Department of Neurological Surgery, University of Washington, Seattle, Washington 98195.

Extracellular recordings from neurons in cat lateral cuneate nucleus (LCN) often show spontaneous firing patterns which include doublets. In a given cell, these doublets may be quite invariant, e.g., 0.8 $\pm$ 0.1 msec between the spikes of the doublet. Sometimes three or more clustered spikes are seen; again, the interspike intervals are often short and stereotyped. When the receptive field of the cell is explored by natural stimulation, the doublet/burst firing pattern often suddenly disappears even though the average firing rate has increased. In many LCN cells, these short interval doublets seem to characterize only the low-level spontaneous activity. This paraxodical finding is strikingly analogous to a similar result in cat spinal motoneurons: doublets there are associated with a large depolarizing hump following each spike, occasionally crossing threshold to give an extra spike. These doublets are seen only near the minimum rhythmic firing rate; an increase in the steady depolarizing drive on the motoneuron will raise the rhythmic firing rate but cause the extra spikes to cease (Brain Res. 69:341). These similarities lead us to postulate postspike humps in LCN cells which give rise to an extra spike more frequently than in motoneurons, and that the humps following the extra spikes may lead to further extra spikes in a regenerative cycle. Stereotyped bursts are often seen in deafferented LCN (Exp. Neurol. 39: 86). Indeed, they are identical to the bursts seen in a subclass of PT cells in chronic epileptic foci; some such cells PT revert to normal firing patterns under behavioral conditioning (Exp. Neurol. 42:448). One type of epileptic burst may thus be due to the augmentation of a normal but often latent mechanism whereby postspike humps elicit extra spikes. (Supported by NIH grants NS-09677 and NS-04053).

106 A LIGHT MICROSCOPY ANALYSIS OF ANURAN RETINAS, WITH SPECIAL REFERENCE TO THE AREAE RETINALIS. Russell G. Carey* and Katherine V. Fite (SPON: Dr. M. V. Edds, Jr.). Dept. Psych., Univ. of Mass., Amherst, Mass. 01002.

Topography maps depicting cell density gradients (cells/angular degree) across the retina for ganglion cells and photoreceptors (red and green rods, single and double cones) are described for four species of frog and two species of toad. Significant differences in the shape and location of the area retinalis exist not only between these families but also among different species within a family, and appear to correlate with species habitat. For example, the area retinalis of the more aquatic frogs (Rana catesbiana and R. climitans) is a horizontal, banded-shaped area above the optic disk; whereas the area retinalis of the more terrestrial frogs (Rana pipiens and R. palustris) is a crescent or circular shaped region above the optic disk. Ganglion cell densities showed a greater increase within the area retinalis of the aquatic frogs and Bufo marinus than occurred in either the terrestrial frogs or Bufo americanus.

Results further indicate that the increase in photoreceptors within the area retinalis is not the same for each photoreceptor type, but rather different receptor types show differential changes in density depending upon the species. For example, double cones and green rods show a greater increase in Bufo americanus, single cones show a greater increase in Rana pipiens, etc. Markedly different convergence ratios (photoreceptor type/ganglion cell) also occur between anuran families, as well as within each family.

These results have implications for understanding the differences in visually guided behavior that distinguish frogs and toads.

107 CHANGES IN MULTI-UNIT SPIKE ACTIVITY IN THE PREOPTIC AREA INDUCED BY MIDBRAIN STIMULATION. Hugo F. Carrer* and Charles H. Sawyer. Dept. Anat., Sch. Med., UCLA, Los Angeles, 90024.

It has been shown (Carrer and Taleisnik, J ENDOCR 48: 527, 1970) that blockade of ovulation and LH secretion can be obtained by electrochemical stimulation of certain areas of the midbrain. The experiments to be reported were designed to gain insight into the electrophysiological effects which such stimulation may exert on neural structures known to participate in the control of gonadotrophin secretion. In proestrous rats anesthetized with urethane (1 g/kg), multiple-unit spike activity was recorded from the medial preoptic area (MPO) through stainless steel electrodes, before and after electrochemical stimulation (100 uA anodic DC through monopolar stainless steel wire for 100 sec) of a site close to the median raphe nucleus. A marked increase was observed in the number of spikes recorded from the MPO at variable times after stimulation. Lesions produced at identical sites by passing the same amount of current through platinum electrodes did not duplicate these results, indicating that activation of the area of iron deposition was responsible for the change observed in the stimulated animals. (Supported by NS 01162 and the Ford Foundation.)

108 ARE CENTRAL DOPAMINERGIC NEURONS SUBSTRATES FOR INTRACRANIAL SELF-STIMULATION (ICS)? D. Carter*, A. G. Phillips and H. C. Fibiger. Dept. Psychology, University of British Columbia, Vancouver, Canada.

A considerable number of experiments have recently pointed to a role for central dopaminergic (DA) neurons in ICS. This conclusion has been based on the fact that destruction of DA neurons by 6-hydroxydopamine or selective blockade of DA receptor sites by neuroleptics is correlated with a decrease in ICS. Virtually none of these experiments have controlled for the possible effects of these treatments on operant behavior in general. Rats were implanted with electrodes in the lateral hypothalamus, put on a 22-hour food deprivation schedule and trained to bar press for ICS and for food reinforcement on a CRF schedule. Haloperidol (0.04 and 0.08 mg/kg) significantly reduced responding for ICS while only the higher dose decreased bar pressing for food. Pimozide (0.22 mg/kg) significantly decreased bar pressing both for food and for ICS. Haloperidol (0.08 mg/kg) did not decrease food consumption on a 15-minute ad libitum test after 22 hours of food deprivation, indicating that the reduction in bar pressing for food did not simply reflect a decrease in motivation for food but was probably due to disruption of operant behavior. In view of the fact that neuroleptics may decrease operant behavior in general, experiments showing reduction of bar pressing for ICS by these drugs cannot by themselves be used as evidence for a dopaminergic substrate of ICS. More sophisticated and sensitive procedures which are not dependent upon operant behavior are required to evaluate the dopaminergic hypothesis.

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109 THE APPEARANCE OF NOREPINEPHRINE IN THE DEVELOPING SPINAL CORD OF THE CHICK. Maria Caserta*, Eugene Johnson*, Leonard Ross. Dept. Anat., Cornell Med. Coll., New York, 10021, Med. Coll. Pa., Philadelphia, 19129.

The spinal cord contains axon terminals of aminergic neurons whose cell bodies are located in the lower medulla. These axons end largely in relation to neurons in the anterior horn and intermediolateral cell column (in the chick the columns of Terni). As part of a study of the development of the descending aminergic pathways and their role in spinal cord maturation, a series of biochemical and histochemical studies were performed on the developing spinal cord and medulla beginning at 9 days in ovo and ending at 4 weeks post-natal. Fluorimetric assays of norepinephrine (NE) at 9 days revealed large amounts of NE (500 ng/gm) in the spinal cord as well as high tyrosine hydroxylase activity. The NE concentration fell to a much lower level at 12 days and remained low until 17 days after which there was an increase until hatching. At hatching the levels decreased but again rose sharply beginning at one week post-natal. This increase continued until about 4 weeks when adult levels are attained (300-400 ng/gm). Uptake experiments utilizing ^{3}H-NE and ^{14}C-sucrose support this pattern with the exception that at 9 days there was little or no uptake. Uptake can be detected at about 15 days in ovo which is 2 days earlier than the rise in endogenous NE levels. Uptake reaches a maximum at hatching, sharply declines and then rises again to approach adult levels. Fluorescence histochemistry (Falck-Hillarp technique) of embryonic spinal cord shows that the noradrenergic varicosities surround cells in the columns of Terni and motor neurons in the ventral horn in a pattern paralleling the rise in NE concentration. These data correlate with reported observations on the onset of somatic and visceral motor activity.

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110 PROCESSING OF SIMPLE AND COMPLEX STIMULI BY THE GLOBULAR AND MULTIPOLAR CELL AREAS OF THE KANGAROO RAT COCHLEAR NUCLEI. D. M. Caspary, A. L. Rupert and G. Moushegian. S.I.U. School of Medicine, Springfield, Illinois 62708, Callier Center for Communication Disorders and U-T Dallas, Dallas, Texas 75235.

The responses of single cells in the multipolar cell area (MCA) and the ventral caudal globular cell area (GCA) were examined using simple (tone bursts) and complex (vowel sounds) acoustic stimuli. Neurons in these areas show low best frequencies (below 1.5 KHz) and tonic responses to tone burst stimulation. Responses by neurons in the MCA and ventral caudal GCA to tonal stimulation, at or near best frequencies, are characterized by tight phase-locking; coefficients of synchronization between 90% and 100% are common. When a series of complex (speech-like) stimuli are presented at near threshold intensities, responses are observed to formants within the neurons response area. Neurons are seen to respond only over selected portions of certain vowel sounds. Responses may or may not be evoked by the frequencies with the highest energy peaks within the complex stimulus. Coefficients of synchronization as well as vector strength measures for MCA and ventral caudal GCA neurons reveal time-locked discharge patterns to portions of the complex stimulus. These portions of the sound are found to have spectral components at or near the neurons best frequency. Neurons in the central region of dorsal cochlear nucleus rarely show time-locked discharge patterns to best frequency components of the complex signal. Neurons in the MCA and ventral caudal GCA may process both temporal and frequency specific information from speech-like sounds. (Supported by Air Force Office of Scientific Research.)

111 FURTHER ANALYSIS OF THE SYNAPTIC DECREMENT UNDERLYING HABITUATION OF THE GILL-WITHDRAWAL REFLEX IN APLYSIA. Vincent Castellucci and Eric R. Kandel. N.Y.U. Med. Sch. and P.H.R.I., New York, N.Y. 10016.

Short-term reflex habituation involves a change in the synaptic efficacy of the excitatory synapses made by mechanoreceptor sensory neurons on to motor neurons and interneurons (Castellucci, et al., 1970). These chemical EPSPs are monosynaptic according to several criteria: short and constant latency, persistence in high divalent cation solutions and increase in amplitude and duration following T.E.A. injection into the presynaptic neuron. With repeated stimulation, at rates that produce habituation, the EPSPs undergo decrement. The percent of decrement is independent of the initial level of transmitter release: the kinetics are similar whether the initial EPSP is 5.5 mV or 100 uV (in 165 mM Mg^{++}). Transmitter release seems essential for the buildup of synaptic decrement. In normal sea water four training sessions of ten stimuli each, applied to the siphon nerve, produce a progressive buildup of the decrement of the complex EPSP in motor neurons (Carew and Kandel, 1973). If transmitter release is blocked during the 2nd and 3rd training sessions with a high Mg^{++} solution (220 mM), the expected buildup does not occur. In somewhat lower Mg^{++} solution (165 mM) the monosynaptic EPSP undergoes apparent failures and quantal fluctuations consistent with a Poisson process. Estimated quantal size varied from 15 to 50 uV. With repeated stimulation the estimated quantal size remains relatively constant whereas the estimated quantal content decreases and the number of failures increases progressively. Because of the poor signal to noise ratio, we cannot be certain that the estimated quantal size represents resolved transmitter quanta. But the fluctuations in the amplitude of the EPSP is consistent with the idea that synaptic decrement, at low levels of release, does not involve a postsynaptic change due to receptor desensitization but a presynaptic one, perhaps reduction in quantal content or branch block.

112 EVOKED POTENTIAL AND REACTION TIME CORRELATES IN MONKEYS DURING A SIMULTANEOUS VISUAL DISCRIMINATION TASK. Leo M. Chalupa, John Rohrbaugh‡ Jay E. Gould*and Donald B. Lindsley. Depts. of Psychology, Physiology and Psychiatry, and Brain Research Institute, UCLA, Los Angeles, Ca.90024

Three Macaca nemestrina monkeys were trained to press and release a setup lever to initiate a discriminative stimulus on one of two lucite panels. The interval between lever response and the dim 10msec flash on one of the panels was 500 msec. A correct response consisted in pressing the lighted panel. The time between onset of panel flash and panel press was automatically recorded as a measure of reaction time (RT). Evoked potentials were recorded from electrodes implanted in lateral geniculate body, inferior and medial pulvinar, midbrain reticular formation, hippocampus and from skull screws over striate and prestriate cortex. When discriminative performance attained 90% criterion level evoked potentials and RTs were recorded for 80 trials, excluding any incorrect trials. Evoked responses were grouped into five categories based on RTs from shortest to longest by means of a PDP-12 computer, and were averaged separately. The computer programs analyzed evoked potentials for amplitude, duration, and peak latency of components and correlated these with RTs. Results showed that there were significant correlations between RT and amplitude and duration of a late positive component of the striate area response (latency about 250 msec). The greatest amplitude and shortest duration of waves occurred with fastest RTs. Similar, but less marked changes were observed in prestriate cortex. Early cortical components and subcortical responses showed only low or inconsistent correlations with RT. These effects are interpreted as due to increased arousal level during short reaction times.

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113 AN INDIRECT TECHNIQUE TO ESTIMATE THE SIZE DISTRIBUTION AND THE NUMBER OF MOTOR UNITS IN HUMAN SKELETAL MUSCLE. H. Chan* and A. Willem Monster. Temple University Health Scs. Cntr., Phila., 19141

The twitch sizes, firing rates and recruitment threshold of 75 motor units of the extensor digitorum communis of the middle finger were determined during an isometric voluntary contraction (6 subjects). The twitch size of an individual unit was measured by synchronizing an evoked response averager with its muscle action potential. The relationship between the recruitment threshold of a unit, in terms of total isometric force F, and its twitch size T, was found to be linear ($T/F \backsimeq .01$). Units increased their firing rate f monotonically with increasing total force ($f/F \backsimeq .12$-$.07$ Hz/gram); T and F were measured at the second digit at the relaxed muscle length and perpendicular to the finger). The relationship between a unit's firing rate (f) and its force-time integral per discharge (ΔF) was measured as well. These relationships define the force production process at a given muscle length. A computer algorithm was developed which, by interpolation, calculates the number of units firing at each contraction level (e.g., 55 units at 200 grams) and the size distribution for the whole muscle up to the maximum value of F that was measured. As these estimates can be made with a relatively small number of measurement points (in the order of 10 to 15 T-F pairs) this technique may be of use in the study of a number of neuromuscular diseases.

114 BRAIN ENERGY METABOLISM: LOCAL AND REGIONAL RECORDINGS OF NADH FLUORESCENCE. Britton Chance, Avraham Mayevsky and Bradley Stuart*. Johnson Research Foundation, University of Pennsylvania, Philadelphia, Pa. 19174.

The monitoring of brain hypoxia and energy metabolism based upon 450 nm fluorescence intensity of NADH has been accomplished by two methods in this laboratory over the past two years. The first, utilizing a light pipe in an implanted cannula connected to a time-sharing fluorometer, integrated mean reflectance and fluorescence over an area approximately 2 mm in diameter. The second recorded NADH fluorescence with a 35 mm camera over a large cortical area with a high degree of two-dimensional spatial resolution. Male Wistar rats were anesthetized and secured in a stereotoxic head clamp. A 6 mm trephine hole was drilled in the right parietal bone and a plexiglass cannula (1) was secured to the skull over the opening with SS screws on either side for EEG recording, and dental cement. The entire left parietal bone was removed to expose an area of the cortex measuring approximately 6.0 x 4.0 mm. The dura mater was left intact on both hemispheres. The bifurcated light pipe was inserted into the cannula and connected to the fluorometer, while the large exposed area was illuminated from the side by 366 nm light from a mercury arc lamp. The camera, furnished with spectrum-analysis film and appropriate filters, was focused through a macro lens on the cortical surface. The animal was inspired with nitrogen, and with the onset of brain anoxia and consequent NADH reduction, photographs were taken of the increasing fluorescence at appropriate times indicated by the fluorometer. Fluorescence intensity increases of 30-40% of the normoxic signal were recorded by the fluorometer; definite increases of NADH fluorescence were also observed on the photographs with significant indication of the regional nature of cortical hypoxia.

1. Advanc. exp. Med. Biol., Vol. 37A, Plenum Press, New York, 1973, pp. 239-244.

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115 CLASSICALLY CONDITIONED EYE BLINK AND CHANGES IN ACTIVITY IN THE PRECRUCIATE CORTEX AND THALAMUS IN THE CAT. Sharon D. Chandler* and Samuel L. Liles. Dept. Physiol., LSU Medical Center, New Orleans, La., 70119.

The conditioned blink to a click using the glabellar tap as unconditioned stimulus (UCS)shows average latencies of 14 and 21 msec for the two EMG components. These experiments test the hypothesis that in a conditioned response with such short latencies some of the integrative functions may be occurring in subcortical areas such as the thalamus. Cats were prepared with chronic electrodes to record EMG activity in the orbicularis oculis, cortical responses in the precruciate cortex, and activity in a number of thalamic nuclei. The animals were then classically conditioned to blink to a 60-100 db click (CS) using a glabellar tap as the UCS. Recordings were made of averaged evoked gross potential activity in the naive, conditioned (500-600 pairings CS-UCS), and extinguished (at least 1000 CS-only presentations) animal. Amplitude shifts in the evoked responses were noted depending on the stage of conditioning. Cortical response increased upon conditioning and decreased with extinction. Thalamic potentials varied with the nuclei studied. Specific nuclei such as the VPM showed an increase in response with conditioning while other areas showed an increase in response with extinction. These amplitude shifts may suggest alterations in aroused state (attention or "fear") or may represent integrative changes concomitant with learning the conditioned response.

116 THE MORPHOLOGY OF THE FOURTH ABDOMINAL GANGLION OF THE HERMIT CRAB, PAGURUS POLLICARUS. William D. Chapple and Elaine S. Hearney*. Biological Sciences Group, University of Connecticut, Storrs, Ct. 06268

The morphology of a typical hermit crab abdominal ganglion was compared with that of the crayfish. Despite the reduction in flexor and extensor muscles, sensory receptors and pleopods on the right side, the two abdominal ganglia are similar. Connective axons are grouped into discrete bundles between which five groups of commissural fibers run to connect left and right sides. The neurites of ventral cell bodies run dorsally in characteristic groups between the connective bundles. The hermit crab has about two thirds as many cells as the crayfish, and the connectives and first two ganglionic roots are reduced, resulting in a lateral compression of ganglionic structures. In addition, the ventral fine fibered neuropil is larger on the left than on the right side reflecting the loss of the right pleopods. It is suggested that this organization permits considerable integrative flexibility within a relatively conservative morphological framework. (Supported by NSF grant GB-12368 to W.D.C.)

117 RECOVERY OF TASTE FUNCTION. MaryLou Cheal and Bruce Oakley. Dept. Zool., Univ. Mich., Ann Arbor, 48104

Crushing or transecting the chorda tympani nerve of the gerbil (Meriones unguiculatus) causes ipsilateral degeneration of taste buds in the fungiform papillae. Within two weeks, some taste fibers regenerate into the tongue and form new taste buds and receptor cells. The recovery process can be monitored electrophysiologically, by acute whole nerve recording proximal to the injury site. In the initial stages of regeneration, the chorda tympani is electrically silent. Spontaneous activity appears within the second week of recovery, but taste, temperature, and touch responses cannot be elicited. Phasic discharges can sometimes be obtained with strong pressure to the tongue. Taste evoked impulses can be recorded from one or a few fibers as early as day 11 (crush) or day 14 (transection). Not one, but several types of fibers are found at this early stage of returning taste function; for example, a) NaCl, b) NH_4Cl, c) sucrose, d) citric acid, or e) several combinations of these. Multi-unit discharges confirm the early return of responses to different chemicals. This rapid emergence of a multiplicity of fiber types and responsiveness to a variety of chemicals in regeneration is inconsistent with the proposition that the relative chemical responsiveness of a receptor cell is strictly a function of its age; young taste receptors have many different response profiles and are potentially capable of responding to any of the standard taste stimulants.

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118 SPATIOTEMPORAL VARIATIONS IN MACROMOLECULAR COMPOSITION OF MEMBRANE FRACTIONS FROM THE TRISECTED MESENCEPHALON OF THE CHICK EMBRYO. Herbert Chen* and Louis Irwin. Dept. Physiol., Wayne State Univ. Sch. Med., Detroit, 48201

The chemoaffinity hypothesis of neurospecificity predicts that chemical variations within an innervated tissue provide a code for the proper geometrical arrangement of neuronal connections. We have tested for the presence of such variations by analyzing the macromolecular composition of membrane fractions from three subregions of the optic tectum at different times during the period when fibers from retinal ganglion cells form locus-specific connections in the mesencephalon. Optic tecta from chick embryos at various developmental stages were cut perpendicular to the longitudinal axis into rostral, middle, and caudal portions which were then homogenized and centrifuged to yield a particulate preparation. Macromolecular heterogeneity, as analyzed by thin-layer chromatography and disc gel electrophoresis, was found to vary as a function of both topological position and stage of development. Protein, sialic acid, and hexose assays indicated spatiotemporal variations in the distribution of membrane fixed charges. We conclude that the macromolecular composition of tectal cell membranes varies both temporally and topologically during the period of active formation of retinotectal connections. (Supported by General Research Grant RRS384-12 from NIH to the Wayne State Univ. Sch. Med.)

119 PROLINE INJECTION MAY IMPAIR DISCRIMINATION ABILITY OF THE CHICK. Arthur Cherkin. Psychobiology Research Laboratory, VA Hospital, Sepulveda, CA 91343 and UCLA School of Medicine, Los Angeles, CA 90024.

The hypothesis that patterned glutamate release transforms incoming patterns of impulses into short-term memory is supported by the finding that IV injected L-proline (PRO), a glutamate antagonist, impaired short-term memory of one-trial avoidance learning in chicks <12-hr old (Van Harreveld, Fed. Proc. 32, 429, 1973; Fifkova, ibid). We studied 44-hr old chicks injected intracerebrally (10 µl of 300 mM PRO per hemisphere) 3 min after being trained to avoid a 3-mm steel bead coated with an aversive liquid. PRO impaired avoidance 1, 4, and 24 hr after training, compared to L-isoleucine-injected chicks but the differences were not significant. We found a significantly higher avoidance of a novel target (3x5-mm lamp) presented 1 min after the 24-hr test to trained chicks injected with PRO, compared to ILE. This effect did not occur in the non-aversively trained control groups and therefore was not due to illness or general peck impairment. The results suggest that PRO may impair the chick's ability to discriminate visual stimuli under our conditions.

			AVOIDANCE SCORE (%)[a]			
TRAINING	TREATMENT	N	1 hr	4 hr	24 hr	Novel Target
Aversive	PRO	30	53	40	33	43[b]
	ILE	29	66	52	55	10
Control	PRO	30	0	17	7	10
	ILE	29	0	7	3	10

[a] Percent of chicks not pecking in 10 sec.
[b] Differs from ILE and controls ($p<0.02$; χ^2 test).

(Supported by Veterans Administration Research Project 1387-02.)

120 CIRCADIAN RHYTHM FOR PLASMA CHOLINE, BRAIN CHOLINE, ACETYLCHOLINE, CHOLINE KINASE AND CHOLINE ACETYLTRANSFERASE. Thomas J. Chippendale*, Feng-Lai Wang*, and Dean R. Haubrich* (SPON: B. Beer) Dept. Psychology, Princeton Univ., Princeton, N.J., and Squibb Inst. Medical Research, Princeton, N.J., 08540.

The concentration of acetylcholine (Ach) has been reported to vary rhythmically throughout a 24 hr period. We have investigated the possibility that components of the cholinergic nervous system which might regulate the rate of Ach synthesis co-vary with the diurnal pattern of this neurotransmitter. The activity of choline acetyltransferase (ChAc), choline kinase (ChK), and the concentration of Ach were measured in brains over a 24 hr interval. The concentration of the Ach precursor, choline (Ch), was measured simultaneously in brains and plasma. Adult male Sprague-Dawley rats were housed in groups in a 12 hr light (0700-1900 hrs) -dark cycle. Rats were decapitated at 9 intervals, 3 hrs apart, and half of each brain was homogenized immediately for the assay of Ch and Ach by the ChK method of Reid et al. (Anal. Biochem., 42: 390, 1970). The remainder of each brain was frozen for later assay of enzyme activities. A peak in the concentration of Ch and Ach occurred during the light phase of the cycle, with Ach concentration reaching its peak after 1 hr of light. Ch concentration rose to a peak 7 hrs after the onset of the light phase, a point corresponding to the nadir of ChK activity. ChAc activity showed no significant rhythm, and plasma choline concentration did not change consistently over the 24 hr period. These results suggest that 1) a rhythm in ChAc activity is not a necessary precondition for a circadian rhythm in Ach concentrations, and 2) ChK may play a role in regulating the concentration of free Ch in the brain.

121 THE RATE OF SYNTHESIS OF TYROSINE HYDROXYLASE AFTER COLD EXPOSURE IN RAT ADRENAL MEDULLA. D. Chuang* and E. Costa, Lab. Preclinical Pharmacol., NIMH, Saint Elizabeths Hospital, Washington, D. C. 20032

An increase of impulse flow in afferent nerves to sympathetic ganglia and adrenal medulla causes a delayed enhancement of tyrosine hydroxylase activity. Using cold exposure as inducing stimulus and the technique of immunoprecipitation, we are attempting to elucidate the molecular mechanisms of tyrosine hydroxylase induction in adrenal medulla. Tyrosine hydroxylase was purified from bovine adrenal medulla essentially according to the procedures described by Lloyd and Kaufman (Mol. Pharmacol. 9: 438, 1973). The purified enzyme yielded a single band on polyacrylamide gel electrophoresis. A specific antiserum to purified bovine tyrosine hydroxylase was produced in rabbit as assayed by agar double-immunodiffusion, immunoenzymatic titration and the formation of antigen-antibody precipitate. The data based on the immunoprecipitation of tyrosine hydroxylase in rats labeled with ^{3}H-leucine indicate that the enhanced activity of tyrosine hydroxylase after cold exposure is associated with an increase in the rate of enzyme synthesis. The increased synthesis of tyrosine hydroxylase is evident 9 hrs after the beginning of cold exposure; however, basal rates of enzyme synthesis are approached at 28 hrs. At this time, maximal increase of enzymatic activity is usually observed. A preliminary experiment using the technique of double labeling with leucine (^{3}H and ^{14}C) shows that the degradation rate of tyrosine hydroxylase is not decreased after cold exposure.

122 ASCENDING PATHWAY FOR SOMATO-SYMPATHETIC AND VASOPRESSOR REFLEXES. Jin Mo Chung* and R. D. Wurster. Dept. Physiology, Stritch School of Medicine, Loyola University, Maywood, Ill., 60153.

Earlier work in this laboratory (Foreman and Wurster, Fed. Proc. 32: 1016, 1973) described the effects of stimulation of the dorsolateral sulcus (DLS) in the cat spinal cord on T2 preganglionic nerve activity and on blood pressure. In some of these experiments, the response to spinal cord lesions, suggested interruption of the ascending pathways for somato-sympathetic and vasopressor reflexes. This laboratory is currently investigating the functional and electrophysiological characteristics of the ascending pathway for somato-sympathetic reflexes. On cats anesthetized with sodium pentobarbital (30 mg/Kg) or alpha-chlorolose (60mg/Kg) systemic arterial blood pressure and T2 preganglionic nerve activity were monitored while stimulating the dorsal roots or DLS in the lower cervical region of the spinal cord. Blood pressure responses due to afferent stimulation were abolished upon bilateral lesioning of the DLS, confirming the early work of Ranson (AJP, 42: 16, 1916). In addition, the present study indicates that about one half of the fibers cross to the contralateral side at the same segment in which they enter the spinal cord. Evoked responses in the T2 preganglionic nerve due to afferent stimulation were also studied to determine the afferent spinal pathway giving rise to somato-sympathetic reflexes. Conduction velocity, central delay time, and localization of this pathway will be discussed. (Supported by NIH Grant HL 08682)

123 CARBOHYDRATE COMPOSITION AND BINDING PROPERTIES OF SYNAPTIC JUNCTIONAL COMPLEX AND POSTSYNAPTIC DENSITY FRACTIONS. L. Churchill and C. W. Cotman. Psychobiology Dept., University of California, Irvine 92664

Synaptic junctional complexes (SJCs), a specialized structure present at central nervous system synapses, and postsynaptic densities (PSDs), a component of the SJC, were isolated by subcellular fractionation from rat brain; the carbohydrate composition and binding properties of these fractions were investigated. Carbohydrates, analyzed by gas-liquid chromatography, make up 3% of the SJC fraction and 4-5% of the PSD fraction. The carbohydrates present in these fractions are sialic acid, fucose, mannose, galactose, glucosamine, and galactosamine, and are mainly protein bound. The concentration of carbohydrates in the SJC fraction are similar to that of the synaptic plasma membrane (SM) fraction except for an increase in galactose and a decrease in sialic acid. For the PSD fraction, the carbohydrates are similar in concentration to that of the SJC fraction, except for a 2-3 fold enrichment in mannose. These fractions possess the unique property of binding radioactively labeled carbohydrates. The SJC fraction binds 5 times more sucrose than the SM fraction, and the PSD fraction binds 10 times more sucrose than the SM fraction. This unique property extends to other carbohydrates as well. C^{14} labeled glucose, fucose, galactose, and Dextran, a glucose polymer, bound significantly higher amounts to the SJC fraction than to the SM fraction. C^{14} labeled fructose and mannose did not bind selectively. In conclusion, the synaptic junctional complex, in particular its constituent, the postsynaptic density, contains carbohydrates that are primarily protein bound and this synaptic structure has the unique ability to bind specific carbohydrates.

124 A QUANTITATIVE STUDY OF SYNAPTOGENESIS IN THE SPINAL CORD OF THE CHICK EMBRYO. I-Wu Chu-Wang*, Ronald W. Oppenheim and Rainer F. Foelix*. (SPON: P. N. Witt). Dept. Mental Health, Box 7532, Raleigh, N. C. 27611.

In order to provide baseline data for comparison with ongoing experimental investigations of synaptogenesis in the spinal cord we have attempted to classify and quantify synapses in the lumbar region of the normal chick embryo. The lateral motor column and adjacent marginal layer (prospective white matter) were examined at several stages between 3-days of incubation and 9-days posthatch. Synapses were categorized according to several characteristics: (a) their location (white or grey matter); (b) the post-synaptic component (axo-dendritic or axo-somatic); (c) membrane specialization (symmetrical or asymmetrical); and (d) morphology of the synaptic vesicles, (F-type, S-type or mixed). At their inception on day 4 nascent synapses were usually found in the marginal zone close to the border with the lateral motor column. These immature synapses were almost always of the axo-dendritic variety with a few S-type vesicles and symmetric membrane specializations, although a few had slight asymmetric membrane densities. About 2-days later the first axo-somatic synapses were found on motoneurons laying adjacent to the lateral marginal zone. These always had symmetric membrane specializations and contained S-type vesicles. After 7-days there were an increasing number of axo-dendritic synapses found in the mantle layer or grey matter. By 12-14 days there were approximately equal numbers of axo-dendritic synapses with asymmetric and symmetric membrane specializations, whereas throughout the period sampled there were considerably more axo-somatic synapses with symmetric specializations. By 7-days some axo-dendritic and axo-somatic synapses exhibit mixed populations of S- and F-type synaptic vesicles. Yet, it wasn't until about 12-14 days of incubation that the first pure F-type synapses were observed.

125 RELATIONSHIP BETWEEN SIZE AND EXCITABILITY IN SPINAL MOTONEURONS. H.P. Clamann Dept. Physiol., Med. Coll. of Virginia, Richmond, Va. 23298

To determine the relationship between the size of motoneurons of a single muscle and their relative excitability, a method was developed to measure the size of active motor axons in short (1.5-2 cm) lengths of ventral root filaments. L7 ventral root (L7VR) was cut near its exit from the spinal cord. A fine filament was separated from the distal portion of this root and placed on a pair of silver wire electrodes about 1 cm apart. Single shocks supramaximal for motoneurons were applied to plantaris (Pl) muscle nerve and monophasic all-or-none potentials indicating the presence of single Pl motoneurons were recorded antidromically. The area under these action potentials was measured electronically. The resistance of a filament was measured by placing a resistor of such value in shunt with the electrode pair that the action potential was reduced by half. It was found that the size of an action potential so recorded varies directly as the square of the axon diameter, and inversely as the resistance of the filament. This was verified by correlating action potential size and conduction velocity. In a second series of experiments the L7VR was cut at its exit from the dura and the proximal portion divided in half lengthwise. Monosynaptic reflexes were recorded simultaneously from the entire pool of responding Pl fibers in one half of the root, and from individual Pl motoneurons in filaments taken from the other half. With the method described above, it was shown that the motoneurons of the Pl pool are recruited in order of their size. Supported by a grant from the A.D. Williams Foundation.

126 SHORT LATENCY JAW MOVEMENT PRODUCED BY INTRACORTICAL MICROSTIMULATION OF THE PRECENTRAL FACE AREA IN MONKEYS. R.W. Clark* and E.S. Luschei* (SPON: J.L. DeVito). Dept. of Physiology and Biophysics, Sch. Med., U. of Washington, Seattle, Wa. 98195.

The face area of the precentral gyrus in monkeys was stimulated intracortically using microelectrodes. Monkeys were awake but mildly tranquilized, trains of stimuli were 150-200 msec. long, and stimulating current was low. EMG activity was recorded from both jaw opening and jaw closing muscles and jaw movements were recorded from a bi-directional position transducer. Short latency jaw movement resulted from stimulation in most locations within the face area. The direction of the evoked jaw movement depended upon the location and depth of the stimulating electrode and upon the specific pattern of activity which was evoked in the jaw muscles. Jaw closer muscles were bilaterally inhibited with a very short latency (10-25 msec.) by stimulation of many locations throughout the face area cortex. However, stimulation of several locations in the more medial portion of the face area produced unilateral activation of specific jaw closers which added a lateral component to the movement. The pattern of evoked activity in the jaw opener muscle (ant. digastric) showed little relation to the activity evoked in closer muscles. The ant. digastric was nearly always activated from the more medial portion of the face area regardless of whether inhibition or activation was evoked in jaw closers and was nearly always inhibited from the lateral portion of the gyrus. The results suggest that the face area cortex may play an important role in producing and/or controlling several aspects of jaw movement.

127 EMG AND MOOD CORRELATES OF MENSTRUAL CYCLE DISTRESS. Karen Clayman* and Lawrence Simkins. Dept. Psych., Univ. of Missouri-Kansas City, 64110

A total of 18 Ss who had regular menstrual cycles participated in the study; 10 of these Ss were using oral contraceptives and eight Ss were either not using the pill or were using other forms of birth control. Each S participated in the investigation for two menstrual months. Mood changes and physical symptoms were assessed by using the Mood Adjective Check List (MACL) and the Mood Menstrual Distress Questionnaire (MDQ). The Ss completed both of these questionnaires on a daily basis and also kept a record of the frequency of their irritations during a constant three hour period each day. The Ss visited the laboratory three times per week during which time their muscle tension from the dorsal forearm was monitored. The results indicated no differences between pill users and non-pill users on most dependent variables, except that pill users reported fewer irritations. In terms of the EMG data, there was a significant triple interaction between experimental groups, menstrual cycle phases, and months. With respect to reported moods there were significant differences on 9 of the 12 factors measured on the MACL and 7 of the 8 factors measured by the MDQ. In a second investigation concerned with the effects of bio-feedback on menstrual tension our preliminary results suggest that there are significant reductions in muscle tension for Ss who are given relaxation training or bio-feedback combined with relaxation training. However, thus far there is little evidence to indicate that reduction in muscle tension is accompanied by any significant reduction in menstrual distress.

128 The Lateral Reticular Nucleus - Afferent Projections to Cerebellar Cortex in the Cat. M.A.Clendenin[1], C-F.Ekerot*, O.Oscarsson* and I.Rosén*. Inst. Physiology, Univ. of Lund, Lund, Sweden.

The extent of the retrograde degeneration in the lateral reticular nucleus (LRN) following lesions in the cerebellar cortex suggested that this nucleus projects to the entire ipsilateral cerebellar cortex, (Acta psychiat. scand. 18 (1943) 171-233). These lesion studies further suggested that the parvicellular part of LRN projects mainly to the vermis, and the magnocellular part of LRN mainly to the hemispheres. The present results represent composite data from 36 experiments in which 282 LRN neurones were identified by antidromic activation and their location within the LRN histologically identified. A wide bilateral exposure of the anterior and posterior lobes of the cerebellar cortex enabled a complete and thorough antidromic search for the axonal termination of isolated LRN neurons which were recorded extracelluarly with most of the neurons being activated from selective ascending spinal paths. The results do not support Brodal's earlier observations but demonstrate that the antidromic activated cells were located throughout the parvi- and magnocellular LRN. The afferent projection of these cells to the cerebellar cortex revealed 1) extensive branching of some of the axons to widely different cortical areas, 2) a bilateral distribution to the anterior lobe and pyramis, and 3) an ipsilateral termination in the paramedian lobule. Essentially no significant distribution was found in the hemispheres. This projection from LRN corresponds well with the classical spinal receiving areas of the cerebellar cortex.

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129 A NEW LAUGHTER HOMOLOGUE, PREDICTED BY SENTIC THEORY. Manfred Clynes, Biocybernetic Institute, La Jolla, Ca., 92037.

The new laughter is a tactomotoric dynamic homologue of "wild" laughter, in which iterated transient finger pressure replaces the voice. In previous studies (Clynes, Ann. N. Y. Ac. Sc., 220(3)55-131, 1973), it was found that the specific dynamic expression of an emotion, called essentic form, was independent of the choice of a particular motor output (principle of equivalence). Applying this principle to laughter (which is composed both of a voice pattern and a breathing pattern), it can be predicted that the specific motor output of the voice could be replaced by another motor output of appropriate degrees of freedom, viz. iterative transient finger pressure, while keeping the breathing pattern (glottis movement) characteristic of laughter. It is found that laughter and funniness is in fact experienced, and with an expressive finger pressure repetition frequency close to 5 per sec. Measurements of 40 subjects of ages 18 to 50 with the sentograph showed mean frequencies of 5.03 per sec. with a standard deviation of 0.18, indicating a highly precise phenomenon. All subjects were able to experience the new laughter, which has the usual properties of laughter, apart from sound. The vector angle and wave form of pressure appears related to the emotional tone of laughter. The frequency was similar whether or not the laughter was also voiced. The new, enjoyable form of laughter lends itself well to measurement, is easy to generate, and to maintain. The finding of this existence illustrates the powers of prediction of sentic theory, and confirms its concepts bridging aspects of experience and neurophysiologic behavior.

130 UNMYELINATED FIBERS IN HUMAN VENTRAL ROOTS. R.E. Coggeshall, T.B. Stubbs, III* and M.T. Sykes*. Marine Biomedical Institute and Dept. of Anatomy, Univ. Texas Med. Br., Galveston, Texas 77550

Approximately 1/3 of the fibers in the human L4 and L5 ventral roots are unmyelinated (Sykes and Coggeshall, Brain Res., 63:490-495, 1973). To determine whether all human ventral roots contain a significant fraction of unmyelinated fibers, C1-S4 ventral roots from one human were obtained at autopsy and examined in the electron microscope. The percent of unmyelinated fibers in each root (calculated as the number of unmyelinated fibers/total fibers in a root) is as follows:

C1 25%	T1 24%	T7 33%	L1 29%	S1 18%
C2 35%	T2 30%	T8 22%	L2 37%	S2 21%
C3 43%	T3 25%	T9 28%	L3 27%	S3 30%
C4 37%	T4 27%	T10 30%	L4 19%	S4 51%
C5 32%	T5 24%	T11 30%	L5 13%	
C6 21%	T6 24%	T12 26%		
C7 22%				
C8 20%				

Note that a significant fraction of every ventral root consists of unmyelinated fibers. By analogy with the ventral root unmyelinated fibers in the cat (Coggeshall, Coulter, and Willis, J. of Comp. Neurology, Vol. 153:39-58), many of these fibers in the human presumably arise from dorsal root ganglion cells.

One other noteworthy finding is that, in occasional places, Schwann cell processes are united by a zonula adhaerens.

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131 REPRESENTATION OF DIRECTION OF EYE MOVEMENT IN ACTIVITY OF RETICULAR FORMATION NEURONS. B. Cohen and V. Henn*. Dept. of Neurology, Mt. Sinai School of Medicine, CUNY, New York, N.Y. 10029

We have proposed that representation of a single vector in the central oculomotor system carrying information about direction and amplitude of eye movement would be sufficient to determine motoneuron firing during saccades and subsequent positions of fixation. We have further proposed that the immediate supranuclear mechanism for generating horizontal saccades and quick phases of nystagmus in the monkey lies in the paramedian zone of the pontine reticular formation (PPRF). If correct, then amplitude and/or direction of eye movement must be represented in PPRF neuronal activity. Amplitude (duration) of eye movement has been shown to be related to activity of some PPRF burst and pause units. We now report that activity of other PPRF burst units varies with direction of eye movement. Frequency changes (ΔF) in these units generally began 12-20 msec before the onset of eye movement, but could be earlier. ΔF occurred, during eye movements in all directions but was maximal during eye movements in specific on-directions. In many units ΔF varied as a function of the cosine of the angle between the direction of eye movement and the on-direction of that unit. Negative parts of cosine curves were cut off. Many PPRF "directional" burst units had on-directions which were horizontal, but in others the on-direction lay in oblique planes. Because of the ambiguous character of the cosine function it would be necessary to have units present in the PPRF whose on-direction was shifted toward vertical or oblique planes in order to precisely determine the direction of any eye movement. This may account for the various types of directional units found in the PPRF. In summary, the data indicate that direction as well as amplitude of eye movement appears to be specifically represented in activity of PPRF neurons. Supported by Grant NS-00294.

132 THE ROLE OF THYROTROPIN RELEASING FACTOR (TRF) AND CYCLIC AMP IN THE DURATION OF AMOBARBITAL-INDUCED NARCOSIS. Major L. Cohn and Marthe Cohn*. Dept. Anes., Univ. Pgh. Sch. Med., Pittsburgh, 15213.

Evidence obtained previously led to the postulate that cyclic AMP is the naturally occurring regulatory agent in control of duration of narcosis and suggests a neurotransmitter as first messenger. However no neurochemical agents tested shortened duration of narcosis although in vitro research demonstrated that many neurotransmitters are potent stimulants of adenyl cyclase. Recent observations that TRF, regulates pentobarbital-induced narcosis in mice suggested that this factor acts in brain through cyclic AMP mechanism. In the present study we investigated the relationship between TRF and cyclic AMP in regulation of narcosis. Intact and thyroidectomized Sprague-Dawley male rats (80-120 g) were used. Amobarbital 80 mg/kg was administered IP, following loss of righting reflex, varying doses of TRF (7.5-50 mg) dibutyryl cyclic AMP (90-180 mg), norepinephrine (NE) (150 mg) and phentolamine (240 mg) were injected centrally. TRF administered centrally shortened duration of narcosis but not dose-relatedly. In both intact and thyroidectomized, anesthetized rats hypothermia was reversed, muscle tone retained. Behavioral symptoms included scratching, motor movements, hyperventilation, blinking reflexes and lacrimation. Simultaneous administration of TRF-NE or TRF-phentolamine blocked all symptoms cited above, including antianesthetic and thermoregulatory action of TRF. Simultaneous administration of TRF-dibutyryl cyclic AMP shortened duration of amobarbital-induced narcosis further than TRF alone. Upon regaining righting reflex, rats treated with solutions of TRF and dibutyryl cyclic AMP demonstrated severe motor incoordination, and disoriented motor behavior lasting for several hours. Based on our behavioral research, TRF does not appear to mimic cyclic AMP closely enough to qualify as first messenger. (NIMH DA-00605)

133 MATHEMATICAL CONSEQUENCES OF DELAYED LATERAL INHIBITION IN THE LIMULUS RETINA. Bernard D. Coleman, Carnegie-Mellon University, Pittsburgh, Pa. 15213, and George H. Renninger, University of Guelph, Ontario N1G2W1.

We here report a study of a general class of non-linear constitutive equations which render mathematical the following two known properties of lateral interaction in the Limulus retina: (1) for an intact undamaged retina in intense spatially uniform illumination, the total inhibitory influence at a given ommatidium can exceed the excitation; (2) the time of delay τ between the response of one ommatidium and the consequent inhibition of another is independent of the distance between them and is circa 0.1 sec. Our calculations show that the response of a healthy Limulus retina to an intense, temporally constant, and spatially uniform excitation should be a sustained (rather than transient) spatially synchronized oscillation of period 2τ. In a broad class of circumstances, the response should be a succession of "bursts" and "rest periods", each of duration τ. (R. B. Barlow, Jr., and A. J. Fraioli have observed such sustained oscillations in their experiments on the intact Limulus eye in situ.) It is also shown that the oscillations can have a "fine structure" in which there is repeated information about the duration and sequence of any short pulses of excitation which occurred within a time-interval of length τ before the onset of steady excitation. Because it is repeated every 2τ seconds, this information remains available in the retina for interaction with subsequent changes of excitation. We hope that experiments designed to detect this "fine structure" will soon be performed.

134 HIPPOCAMPAL AND NEOCORTICAL EEG CHANGES DURING FREE AND OPERANT BEHAVIOR. James R. Coleman* and Donald B. Lindsley. Depts. of Psychology, Physiology, Psychiatry and Brain Research Institute, UCLA, Los Angeles, 90024.

Eight cats with recording electrodes in dorsal and ventral hippocampus and over anterior and posterior neocortex, bilaterally, were studied during periods of free behavior, periods of stimulation of medial and lateral hypothalamic-hippocampal systems, and training in operant behavioral tasks. In general, hippocampal synchrony (theta rhythm) is accompanied by neocortical desynchronization and usually vice versa. In free behavior hippocampal theta occurred during orienting, scanning or searching behavior; desynchronization was associated with postural and attentive fixation. Stimulation at 100 Hz in the medial hypothalamic-hippocampal system caused hippocampal theta and orienting or scanning behavior; stimulation of the lateral system caused hippocampal desynchronization and attentive postural fixation. Water-deprived cats were trained to press a bar for water reward on a continuous reinforcement (CRF) schedule until high response rates were achieved. Next, alternating 10 sec periods of reinforcement (R) and non-reinforcement (NR) were employed (Mix CRF Ext). Lastly, R and NR periods were lengthened and the NR period was cued by tone followed by a discrete flash. CRF training during early stages was accompanied by theta rhythm but as training progressed was replaced by desynchronization. On the uncued mixed schedule theta activity increased during NR periods in early sessions but declined in later sessions. As response rates declined during the NR periods (extinction) low voltage activity increased. In the task when NR was cued theta activity became more prevalent during NR periods as training progressed. In summary, theta rhythm in hippocampus is associated with shifting attention and desynchronization with fixed states of attention related to reinforcement expectancy. (Supported by USPHS grant NS-8552 to D. B. Lindsley)

135 BIOCHEMICAL, NEUROENDOCRINOLOGICAL AND CLINICAL FINDINGS IN MANGANESE WORKERS. J.P. Conomy, H. Mars*, H. Rodman*, and H. Rabinovitch*

Because two men with industrial exposures to manganese dust showed clinical signs typical for manganese neurotoxicity all workers in a small manganese foundry were evaluated. Elevated tissue concentrations of manganese were found in both neurologically normal and impaired individuals. Two hospitalized individuals underwent extensive neuroendocrinologic studies, analyses of biogenic amine metabolism and tests of apomorphine responsivity. No neuroendocrine deficiencies were discovered and hormonal responses to administered L-DOPA were retained. Physiologic responses to apomorphine administration were normal. In a patient with a hypotonic-bradykinetic manganic syndrome cerebrospinal fluid (CSF) homovanillic acid (HVA) was slightly elevated and no abnormality of the L-DOPA metabolic pathway was found. He failed to improve on L-DOPA given over a one year period and tolerated doses of up to 12 grams per day without developing dyskinesias. In a patient with a rigid-bradykinetic manganic syndrome CSF-HVA levels were deficient and failed to rise after probenecid administration. Our studies suggest there may be varieties or gradations of neurotransmitter interference in manganism; that medullary and hypothalamic L-DOPA pathways remain intact in that condition; and that the site of transmitter interference in manganism may be at a striatal receptor level.

136 AUTORADIOGRAPHIC TRACING OF PROJECTIONS FROM PREOPTIC AREA AND ANTERIOR HYPOTHALAMUS IN THE RAT. Lily A. Conrad* and Donald W. Pfaff. Rockefeller University, New York, N.Y. 10021.

Projections of the preoptic area and anterior hypothalamus were traced autoradiographically with tritiated proline and/or leucine in albino rats. Following slow injection of 10 to 50 nanoliters of the isotope, animals were killed after 1 to 14 days. Brains were then perfused, embedded in paraffin, sectioned, mounted, coated with NTB-3 emulsion and exposed for 21 to 35 days. From all injection sites, fibers projected densely and diffusely in a posterior direction through the medial hypothalamus. In many cases, a particularly heavy projection was observed in the region between the ventromedial nucleus (VM) and the fornix, and in a few brains the VM was clearly outlined by a capsule of labelled fibers. The medial forebrain bundle proper contained few labelled fibers except in the area adjacent to the fornix, although the lateral hypothalamus generally received a diffuse projection. Projections to the arcuate nucleus and labelled fibers in the tuberal region were also noted. Label within the posterior hypothalamus appeared in the dorsal and ventral premammillary nuclei and in the supramammillary nucleus. Occasionally labelled fiber bundles in the lateral mammillary nucleus were noted. From the premammillary region in all brains, some labelled fibers swept up bilaterally into the mesencephalic central grey. In all cases, label was found in a small periventricular fiber system ventral and medial to the medial habenula (n. periventricularis thalami). From all but the most medial injection sites, projections in the stria medullaris to the lateral habenula were seen. Labelled fibers were consistently found in the medial division of the stria terminalis, and projections to the medial and cortical amygdaloid nuclei were noted. In most cases, anterior projections were observed to the ventrolateral septum and to or through the bed nucleus of the stria terminalis.

137 DIFFERENCES IN PROXIMAL AND DISTAL CONDUCTION VELOCITIES OF MEDIAL GASTROCNEMIUS NERVE FIBERS. Paula Copack, Erica Felman*, James Lieberman and Sid Gilman. Dept. of Neurol., Columbia University, College of Physicians and Surgeons, New York, New York 10032.

Anatomic studies have shown that branching occurs in peripheral nerve fibers innervating hindlimb muscles. Conduction velocities (CVs) of single medial gastrocnemius nerve fibers were compared proximally and distally to determine the extent to which branching affects axonal CV. A laminectomy was performed to expose ventral roots L_7 and S_1 in the spinal cord of 14 cats. The medial gastrocnemius nerve was separated from surrounding tissues. Two pairs of Ag-AgCl stimulating electrodes were positioned on the medial gastrocnemius nerve at an intercathodal distance of about 20 mm. Ventral root, S_1, was severed at its exit from the spinal cord, repeatedly dissected, and placed on bipolar Ag-AgCl recording electrodes until isolated single units could be identified by antidromic stimulation. Conduction velocities were computed for the proximal and the distal segments. Sixty-one units were recorded, including 10 units with CVs below 50 MPS across the proximal segment and 51 with CVs above 50 MPS. Units with CVs below 50 MPS (probably gamma axons) show virtually the same CV across the two segments. The fibers with CVs above 50 MPS (probably alpha axons) show marked differences in CV across the two segments, in general with slower CVs across the distal segment. We conclude that the CVs of single alpha motoneuron axons decrease near the junction of the medial gastrocnemius nerve with its muscle. The CVs of gamma motoneurons show essentially the same CV across the entire conduction distance. These findings are compatible with the histologic data of Eccles and Sherrington (PRSB 106: 326-357, 1930) which show marked branching of axons as they approach the nerve-muscle junction.

138 AUTONOMIC NERVOUS SYSTEM INVOLVEMENT IN CARDIAC DYSFUNCTION. K.C. Corley and H.P. Mauck.* Dept. Physiol. & Med., Med. Coll. Va., Richmond, Va. 23298

Stress of shock avoidance has been demonstrated to induce severe bradycardia and ventricular asystole. Squirrel monkeys were subjected to 8-hrs "on" alternated with 8-hrs "off" a Sidman avoidance schedule (RS-40"; SS-5") to postpone by lever press a 1.0-sec tail shock (4mA). This schedule was imposed until physical deterioration or the electrocardiogram, which was continually recorded, indicated cardiac abnormalities. Bradycardia which progressed to ventricular asystole was the most consistent cardiac change observed. Because of the rapid onset, these cardiac dysrhythmias were due to autonomic dysfunction. Furthermore, the reversal of the bradycardia by atropine (1 mg/kg) indicated parasympathetic involvement. While myocardial necrosis was associated with the shock avoidance, it was not correlated with the occurrence of bradycardia. To further study the autonomic involvement in this abnormality, monkeys were stressed following bilateral vagotomy. Bradycardia and ventricular asystole continued to be the dominant cardiac response to the experimental manipulation. This result does not exclude a parasympathetic mechanism for this cardiac dysfunction, but without the vagus, bradycardia resulted from withdrawal or inhibition of tonic sympathetic input to the heart. (Supported by USPHS, NIH Grant HE 13454).

139 CORRELATION OF HYPOTHALAMIC OBESITY WITH BRAIN AMINE LEVELS IN RATS. Donald V. Coscina, Damodar D. Godse* and Harvey C. Stancer*. Sect. of Neurochem., Clarke Inst. Psychiat., Toronto, Ontario, Canada M5T 1R8.

Gold has recently suggested (Science 182: 488, 1973) that lesions restricted to the ventromedial hypothalamic nuclei are not causally related to hypothalamic obesity in rats, but damage to the adjacent ventral noradrenergic system is. If this is true, one might expect to find an inverse relationship between the degree of hypothalamic obesity and levels of forebrain norepinephrine (NE) but not serotonin (5-hydroxytryptamine or 5-HT) or dopamine (DA). To test this hypothesis, we induced bilateral lesions of various sizes in the medial hypothalamus of 40 rats using radio frequency heat production (50-60° C for 1 min per locus) at the coordinates reported by Gold. Twenty other rats received all surgical manipulations except lowering the electrode. All rats (female albinos, 230-270 gm at surgery) were maintained in single cages with free access to Gold's high-fat diet and water for 14 days after surgery, then killed by decapitation for fluorometric determinations of forebrain NE, DA, 5-HT and 5-HIAA (5-hydroxyindoleacetic acid) levels. Hypothalamic lesions produced marked ($p < .001$) weight gain (M = 7.4 gm/day; range = 12-3) compared to controls (M = 1.1 gm/day; range = 2.2-0.4), and significant (ps $< .05$) depletions of forebrain NE and 5-HT. Concentrations of brain NE were inversely correlated ($p < .05$) with weight gain in lesioned rats while 5-HT and DA levels showed no correlation with weight gain. However, 5-HT concentrations were positively correlated ($p < .02$) with the amount of NE depletion after lesion, and 5-HIAA levels were inversely correlated ($p < .05$) to weight gain. While these data support Gold's notion that hypothalamic obesity is associated with disruption of the ventral noradrenergic system, it appears that such obesity is concomitantly associated with altered 5-HT metabolism as well.

140 ELECTROPHYSIOLOGICAL EVIDENCE FOR A TOPOGRAPHICAL PROJECTION OF THE NASAL MUCOSA ONTO THE OLFACTORY BULB OF THE FROG. Richard M. Costanzo* and Maxwell M. Mozell. Dept. Physiol., S.U.N.Y. Upstate Med. Ctr., Syracuse, N.Y. 13210.

Three olfactory nerve branches respectively subserving either a medial, middle, or lateral region of the dorsal olfactory mucosa of the bullfrog, Rana catesbeina, were electrically stimulated with bipolar platinum hook electrodes. Extracellular single unit responses from the mitral cell layer in different regions of the olfactory bulb were recorded with metal filled glass micropipettes. The responsiveness of each of the bulbar units to the stimulation of each of the three nerve branches was determined. Many of these units were sensitive to the stimulation of each of the three nerve branches, thus suggesting a wide projection from the entire dorsal mucosa. On the other hand, other units were more selective. Of this latter group, units in the lateral bulb were excited only by the nerve branches subserving the more lateral regions of the mucosa; units in the medial bulb were excited only by the nerve branches subserving the more medial regions of the olfactory mucosa. These data do provide electrophysiological support to the previously reported histological evidence for a topographical projection of the olfactory mucosa onto the olfactory bulb, but further suggest that this projection onto different bulbar cells varies in its degree of specificity. Sponsored by NIH Grant NS 03904.

141 EMG AND MECHANICAL RESPONSES TO LOAD PERTURBATIONS APPLIED TO THE HUMAN ARM. P. Crago, Z. Hasan, and J.C. Houk, The Johns Hopkins Univ. School of Medicine, Baltimore, Maryland, 21205. (Supported by NIH, NS11446)

In decerebrate cats autogenetic reflexes compensate for asymmetries in the mechanical properties of the soleus muscle (Nichols & Houk, Sci. 181:182, 1973). For a stimulated muscle the transient increase in force during stretching is less than the corresponding decrease during shortening, whereas reflex responses are more symmetrical. We designed experiments to test for similar compensation in humans. Subjects grasped a handle attached with a steel cable to a torque motor. The shoulder was stabilized and the wrist relaxed so that motor force was resisted primarily by elbow flexors. Surface EMG of biceps, cable tension, motor current and shaft angle were monitored. Initial load was established by applying a constant motor current, and the subject was required to establish an initial elbow angle. Perturbations in load were applied randomly as step increases or decreases in current. Responses were digitalized (5 msec samples) and stored, and later sorted according to direction of perturbation and averaged. Changes in EMG activity began 35-60 msec following perturbation. Recorded changes in position indicated that after a reaction time (about 200 msec) the subject might or might not initiate a correction to the deflection in elbow position, depending on the instructions. Here we report on responses in which corrections were absent (presumed to reflect segmental reflexes). The mechanical responses to symmetrical increases and decreases in current were approximately symmetrical. EMG responses were approximately symmetrical in the steady state but were highly asymmetrical transiently; large increases occurred when biceps lengthened (increased load) whereas small decreases occurred when biceps shortened (decreased load). The observed asymmetries in EMG together with more symmetrical changes in tension and position suggest that elbow flexors in man have asymmetric mechanical properties that are compensated by reflex mechanisms similar to those in the cat.

142 EARLY FORMATION OF SYNAPTIC NETWORKS IN CULTURES OF FETAL MOUSE CEREBRAL NEOCORTEX AND HIPPOCAMPUS. Stanley M. Crain, Murray B. Bornstein and Cedric S. Raine.* Depts. of Physiology, Neurology, and Pathology, and Rose F. Kennedy Center, Albert Einstein Coll. Med., Bronx, N.Y. 10461

Electrophysiologic studies of 18-day fetal mouse cerebral neocortex and hippocampus explants have demonstrated that complex synaptically-mediated spike-barrage and slow-wave discharges can be elicited by 3 days in culture (Crain and Bornstein, Brain Res. 68:341,'74). These data are consonant with a brief report of complex directly evoked potentials in 1-day-old rat cerebral cortex *in situ* (Armstrong-James and Williams, J. Physiol. 168:19P,'63). Other bioelectric and electron-microscopic studies indicate, however, that neocortex and hippocampus are quite immature in the newborn rodent and characteristic synaptic junctions are rarely seen (see review in C.&B.,'74). Electron microscopy of the same 18-day fetal mouse cerebral explants used in the present bioelectric studies reveals that at least some characteristic, though immature axosomatic as well as axodendritic synapses are present by 3 days in culture. The primitive cerebral synaptic networks appear, moreover, to be under tonic inhibition at these early stages of synaptogenesis *in vitro*, since the pharmacologic procedures which revealed or greatly augmented the complex discharges in immature explants have been shown to produce selective interference with CNS inhibitory mechanisms *in situ*, e.g. picrotoxin, bicuculline, strychnine (*ca.* 10^{-5}M) or chloride-free medium (C.&B.,'74). The data indicate that prominent, organotypic slow-wave discharges can be recorded with extracellular microelectrodes in spite of the sparse distribution of synapses in these immature cerebral explants, and suggest that some types of complex excitatory and inhibitory synaptic networks may already be functioning during late fetal or newborn stages in mouse cerebral neocortex and hippocampus. (Supported by NINDS grants N S-06545, NS-06735, NS-08952 and the Alfred P. Sloan Foundation.)

143 DISTRIBUTION OF SENSITIVITY OF ROD AND CONE SYSTEMS OF THE RHESUS MONKEY. M. L. J. Crawford and Richard Kelly* University of Texas, Graduate School of Biomedical Sciences, Houston, Texas 77025.

Increment-thresholds to small monochromatic test flashes (15' dia.) have been obtained along the horizontal meridian for a range of 12° centered upon the fovea of both the light and dark adapted rhesus eye. Comparable data were obtained for human subjects under the same conditions. In the light adapted rhesus eye, (3,000 troland background) sensitivity to 450, 550 and 620 nm test flashes decreases by 0.38 log units from central fovea to a 6° eccentric retinal location, while man shows a 1 log unit change over the same range. The rhesus eye is about 0.40 log units more sensitive to small 450 nm test flashes in central fovea with this superiority increasing to 1 log unit at the 6° peripheral location. Sensitivity of the dark adapted monkey fovea to a 30', 500 nm test flash demonstrates a decrease as the center fovea is approached. This change is compared with the human eye and is consistent with receptor distribution.

144 STRUCTURAL ALTERATIONS OF THE MOTOR END PLATE IN PSYCHOTIC PATIENTS. J.W. Crayton and H.Y. Meltzer. Dept. of Psychiatry, Pritzker School of Medicine, U. of Chicago, Chicago, Ill., 60637

Previous studies (Meltzer and Crayton, Biol. Psych. 8:(2), Apr., 1974) have demonstrated that psychotic patients show histological evidence for denervation and reinnervation of skeletal muscle in biopsy specimens. To evaluate possible changes in the neuromuscular junctions, histiometric analyses of motor end plates in methylene blue-stained light microscopic preparations and electron micrographs of biopsies of peroneus brevis were performed in 8 normal volunteer controls and 25 psychotic patients. Terminal arborizations tended to be larger in the patients, while individual terminal bulbs were significantly smaller ($t = 5.15$, $p < 0.001$). The Synaptic Index (SI = ratio of the area of the terminal bulbs to the total area of the terminal arborization) was significantly reduced ($p < 0.005$) in the patient group (mean = 0.28 ± 0.06 S.D.) compared with the controls (mean = 0.41 ± 0.05 S.D.). Seventeen patients had SI's of less than 0.34, while none of the controls did (Chi Square = 8.66, $p < 0.005$). Electron microscopic studies substantiated the light microscopic results and also revealed degenerative alterations in some nerve terminals. There was no relationship between end plate alterations an age, sex, race, or psychotropic medication. The end plate alterations could not be related simply to muscle fiber hypertrophy, since there was no correlation between the SI and muscle fiber measurments. There were non-significant trends toward relationships between the SI and both the number of small, atrophic fibers and the extent of subterminal branching. The data indicate that psychotic illness may be associated with distinctive motor end plate alterations.

145 ORGANIZATION OF PRIMARY OPTIC PROJECTIONS IN HETEROCHROMIC RATS. Donnell J. Creel and Roland A. Giolli. V.A. Hospital, Phoenix, AZ 85012 and Dept. Anat., Sch. Med., Univ. of Calif., Irvine, CA 92664.

Anomalous nondecussated retinal projections to the primary optic nuclei including the dorsal lateral geniculate nuclei (LGd) have been demonstrated in albino representatives of eight species of mammals. It has been speculated that an intact pigmental system in the developing optic cup may be necessary for normal formation of the nondecussated optic system. If ocular hypopigmentation is the principal antecedent of abnormal optic projections, then the organization of retinogeniculate projections should differ depending upon whether you enucleate the pigmented or non-pigmented eye of a rat with heterochromia irides. The red eye of each of 4 heterochromic rats, and the black eye of each of 4 heterochromic rats, was enucleated. The animals were killed in pairs 5-8 days later and perfused with saline and formalin. All brains were sectioned horizontally and processed by modifications of the Nauta and Nissl methods. There was considerable variation among all animals in the organization of the retinogeniculate projections. However, the nondecussated retinogeniculate input in all 8 rats, regardless of the eye enucleated, was observed as several laminae of pericellular fiber degeneration resembling the fragmented organization of the LGd described for albino rats by several investigators. The nondecussated retinogeniculate projections in none of the animals in which a black eye was enucleated resembled the normal, nonfragmented LGd as described for black rats with both eyes normally pigmented. It appears that at least in this strain of heterochromic rat, derived from a King-Holtzman hybrid with a restricted (fawn) hood phenotype, than an intact pigmental system in the eye is not the only prerequisite for normal formation of the nondecussated primary optic system.

146 PRIMARY ROLE OF THE NIGRO-STRIATAL DOPAMINE PATHWAY IN THE MEDIATION OF AMPHETAMINE RESPONSES IN THE RAT. Ian Creese* and Susan D. Iversen* (SPON: A. Goldberg). Dept. Psyc., Cambridge Univ., England and Dept. Pharm., Johns Hopkins Univ. Med. Sch., Baltimore, 21205.

The anatomical and pharmacological substrates of the amphetamine (AMP) responses, locomotor activity (LA) and stereotypy (ST), were investigated by lesions to central dopamine (DA) and norepinephrine (NE) pathways with 6-hydroxydopamine (6OHDA). Bilateral 6OHDA lesion to the caudate nucleus which depleted DA levels by 90% abolished the ST response to AMP but did not alter the LA response. Bilateral 6OHDA lesion to the substantia nigra (SN) which depleted striatal DA levels by 80-90% also abolished ST and altered the time course of the LA response. However, 6OHDA lesion to the SN which depleted striatal DA by 99% abolished both the ST and the LA response to AMP. These rats showed an enhanced ST and LA response to the direct DA agonist apomorphine suggesting that the denervated striatal DA receptors were supersensitive. These rats were anorexic but not aphagic. These lesions also resulted in depletions of forebrain NE. However, bilateral 6OHDA lesions to either the dorsal or ventral NE pathways, which resulted in similar NE depletions, did not abolish either the ST or LA response to AMP. It was concluded that the ST and LA responses to AMP are dependent on the functional integrity of the nigro-striatal DA pathway.

147 THE DEVELOPMENT OF RETINO-TECTAL CONNECTIONS IN THE CHICK. W. J. Crossland*, W. M. Cowan and L. A. Rogers* (SPON: M. T. Price). Dept. Anat., Washington University Med. Sch., St. Louis, Mo. 63110

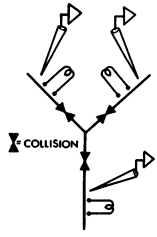
The normal pattern of development of retino-tectal connections has been studied in a series of chick embryos which were injected intraocularly with ^{3}H-proline at different stages in development. Using the autoradiographic method for tracing axonal connections, the pattern of invasion of the outermost layer of the optic tectum, the *stratum opticum* (SO), by the fibers of the optic nerve has been found to be essentially similar to that reported by others using reduced silver methods. The fibers first reach the tectum towards the end of the sixth day of incubation and then progressively spread across the tectal surface from its rostro-ventral aspect to its caudo-dorso-medial pole during the course of the next six days. However, the invasion of the outermost cellular layers of the tectum (the outer layers of the *stratum griseum et fibrosum superficiale:* SGFS) does not seem to follow this simple pattern. As far as can be determined, the earliest region to be occupied by terminals of the retinal ganglion cell axons is the central portion of the antero-ventral quadrant of the tectum, in the region which appears to correspond to the projection of the first group of retinal ganglion cells to be generated. The retinal axons first leave the SO to enter the SGFS in this region on the tenth day of incubation. Over the next six to eight days the portion of the SGFS occupied by terminals of the retinal fibers spreads more-or-less radially from this focus and finally comes to occupy the caudo-dorso-medial pole of the tectum two or three days before hatching.

148 SPINAL AFFERENT PROJECTIONS TO THE BRAINSTEM OF THE OPOSSUM. J. L. Culberson and A. J. McDonald*. Dept. of Anat., West Va. Medical Center, Morgantown, W. Va. 26506.

The total projection pattern of spinal afferent pathways to the opossum brainstem was studied by the evoked potential method; this was done to permit comparison of these sensory systems in this generalized metatherian mammal to those of more specialized therian mammals. In Dial-Urethane anesthetized adult opossums, the entire brainstem was explored systematically with a bipolar concentric recording electrode while electrical stimuli (0.5 Hz, 0.5 msec) adequate to evoke maximal muscle contraction were delivered to a major hindlimb or forelimb nerve. Responses evoked were correlated with histologically identified sites. Responses with shortest latency were recorded from the medial lemniscus (ML) which ascends contralaterally in a characteristic ventral position to reach the ventral posterior thalamus. The antero-lateral system (ALS), a slower pathway ascends through the ventrolateral medulla, shifting dorsally at low midbrain levels. It is activated by ipsi- or contralateral stimulation and also reaches the ventral posterior thalamus, overlapping there with ML. Dorsal offshoots of ALS comprise a spinotectal projection while the central tegmental fasciculus (CTF) seems to be a medial extension of ALS, beginning in the low midbrain and extending to the parafascicular nucleus. These results suggest a more diffuse ALS system in the opossum compared to other mammals which have been studied, and a corresponding reduction in the relative size of the ML system. Within ML also, hindlimb representation is much smaller than forelimb; this correlates well with previous studies of primary afferent projections to dorsal column nuclei and studies of body representation at thalamic and cortical levels. This study was supported by NIH-GRS grant #5-S01-RR05433

149 BILATERAL BRANCHING OF SINGLE GANGLION CELLS. T. J. Cunningham* and John A. Freeman. Depts. Psychology and Anatomy, Vanderbilt Univ., Nashville, Tennessee 37240

Previous studies (Lund, Cunningham and Lund, 1973; Cunningham, 1974) have shown that following removal of one eye from newborn rats, the projection from the remaining eye expands extensively to innervate the ipsilateral optic tectum; each locus of the remaining retina is thus represented bilaterally. We find that a significant part of this new projection comes from collateral branches of crossing retinal axons, as opposed to non-branching direct ipsilateral fibers. Evidence for branched collaterals was obtained in adult hooded rats which had one eye removed at birth. The single optic nerve and its two post-chiasmatic branches from a "Y": it was possible, by appropriately pairing stimuli to any two branches (e.g., stratum opticum of one tectum and optic nerve), to block impulse conduction down the third branch by collision (see figure). A significant fraction of fibers at the optic chiasm were thus shown to be branches of the same parent axon. Moreover, short latency (< 0.7 msec) responses, presumably mediated by axon reflex, were recorded in the stratum opticum of one tectum following stimulation of the opposite tectum. We also find that similar branches supply the more restricted uncrossed pathway of normal rats. In both groups of animals, the major proportion of branched axons are fast fibers rather than slow fibers. We suggest that the limited uncrossed pathway found in the normal rat arises as the result of competitive interaction between developing fibers from each eye. (Supported by N.I.H. Grants EY 54,034, 1-R01-EY 0117, and K04-EY 40240.)



150 SPONTANEOUS UNIT ACTIVITY IN CAUDATE NUCLEUS. Nachum Dafny, Neurobiology, The University of Texas Medical School at Houston, Houston, Texas 77025.

Several investigators have reported that spontaneous single unit activity in the cat caudate nucleus is rare and, when it does exist, has a very low firing rate. The present studies were initiated to investigate the spontaneous activity of single units in the rat caudate nucleus and the effect of extrapyramidal and sensory stimulation on this activity.

115 units in the head of the caudate nucleus demonstrated spontaneous activity as recorded extracellularly with glass micropipette electrodes in anesthetized rats. These neurons showed a wide range of spontaneous activity (0.1 - 15 spikes/sec). 71%, 83%, 66%, 84%, and 70% of these populations of cells responded significantly to substantia nigra (SN), brachium conjunctivum (BC), amygdaloid complex (Amyg), acoustic (AC) and motor cortex (MC) stimulation respectively by change in their spontaneous activity. Only 21 of the 115 neurons demonstrated driven spikes to Amyg stimulation, 7 with a latency of 5-10 msec and 14 with a latency of 12-23 msec. Three units did not show spontaneous activity but responded to SN stimulation by driven spikes with latencies of 12-25 msec.

In the caudate nucleus of rats anesthetized with urethane, 115 cells showed a large variety of spontaneous activity. The responsiveness to the five above stimuli was marked. About half of the responsive neurons increased or decreased their activity in response to the above 5 stimuli. Driven responses which indicated mono- or oligosynaptic connections were recorded only from cells which fired spontaneously following Amyg stimulation and following SN stimulation in cells which had no spontaneous activity. This may indicate that three populations of cells were recorded - 1) cells in the caudate nucleus which demonstrated spontaneous activity and have mono- and/or oligosynaptic connections with the Amyg complex, 2) cells which exhibit spontaneous activity but didn't respond to Amyg stimulation by driven spikes, and 3) those that exhibit no spontaneous activity, but respond to SN stimulation by driven spike.

151 RESPONSE OF THE ANTENNAL CHEMORECEPTORS OF THE MOSQUITO, Aedes aegypti, TO L(+)LACTIC ACID. Edward E. Davis* and Phillip G. Sokolove* (SPON: C. S. Rebert). SRI, Menlo Park, CA, 94025.

In seeking a blood meal, the female mosquito will orient its flight toward the source of a flow of warm, moist air containing, among other things, CO_2 and lactic acid such as that emanating from man. The antennae and maxillary palps of the mosquito are the major site of its olfactory receptors, and 3 types of receptors have been reported on the female: humidity, CO_2, and temperature. This paper describes a receptor for lactic acid. Single-unit, extracellular responses were recorded from the antennal chemoreceptor sensillae of restrained female mosquitos. Chemical stimuli were generated by saturating an air stream with a test substance and directing it over the mosquito. D or L lactic acid, propionic acid, acetic acid, CO_2, or water vapor were the test substances. Stimulus intensities ranged from $1.0 \cdot 10^{-9}$ to $2.0 \cdot 10^{-7}$ moles/sec. A1 type sensilla trichodea did not respond to any of the compounds tested. Similarly, none of the 3 types of A2 sensilla trichodea nor the sensilla coeloconica responded to these stimuli. When examining the sensilla basiconica (A3), different response patterns were obtained from at least 2 different sensory neurons. One neuron was inhibited by both D and L lactic acid, propionic acid, and acetic acid, whereas the second neuron was excited only by L lactic acid. The degree of inhibition or excitation was proportional to the stimulus intensity. CO_2, either alone or in combination with lactic acid, elicited no response from either neuron, indicating that the behavioral synergism of CO_2 and lactic acid occurs in the insect's CNS and not at the peripheral receptor level. Studies are in progress on the response of the lactic acid receptors to behaviorally repellent compounds.

(Supported by NIH Grant IA 10954.)

152 CONVULSION PRODUCING PROPERTIES OF GLYCOPEPTIDES DERIVED FROM BRAIN GLYCOPROTEINS. Leonard G. Davis*, Javaid I. Javaid*, Miodrag Radulovacki and Eric G. Brunngraber. University of Illinois Medical Center, Depts.Biol. Chem. and Pharm. and Illinois State Psychiatric Institute, Chicago, 60612.

Radulovacki and Brunngraber (Neuropharmacology 13:139, 1974) reported that the dialyzable glycopeptides from whole rat brain when injected into the lateral ventricle of the cat produce clonic-tonic convulsions. We have fractionated the total glycopeptides from whole rat brain by affinity chromatography on a Sepharose-Concanavalin A column. The glycopeptides which do not bind to the Con-A obtained from ten rat brains contains about 3.5 mg hexose, 3.5 mg hexosamine and 1.2 mg N-acetyl neuraminic acid. This fraction was injected into the lateral ventricle of the cat via a cannula system. It produced immediate clonic convulsions which persisted for about one hour. The convulsive effect of glycopeptides which did not bind to the Con-A appears to be specific for this fraction, since other preparations did not produce the observed effect in either behavior or electroencephalogram (EEG) pattern. Partly supported by NSF Grant GB-33624.

153 MORPHINE AS A REINFORCER: INFLUENCE OF CENTRAL NOREPINEPHRINE DEPLETION AND CHOLINERGIC BLOCKADE. W. Marvin Davis and Stanley G. Smith. Dept. of Pharmacol., Sch. of Pharm., Univ. of Mississippi, University, MS 38677.

Positive reinforcing properties of small (60 µg/kg) i.v. doses of morphine sulfate (MS) were studied in rats both by self-administration behavior and by the establishment of a conditioned reinforcer (buzzer) through repeated pairings with MS infusions as previously described (Davis & Smith, Life Sci. 12: 185, 1973). Involvement of central noradrenergic mech's. in such reinforcement was indicated by its inhibition after α-methyltyrosine (Davis & Smith, op. cit.), but not after 0.5 mg/kg haloperidol (Smith & Davis, Psych. Rec. 23: 215, 1973). Male albino rats treated with inhibitors of dopamine-β-hydroxylase (DBH), diethyldithiocarbamate or U-14,624, caused complete block of primary reinforcement from MS by both test procedures. As behavioral tests in the conditioned reinforcement paradigm were performed after immediate actions of both MS and DBH inhibitors were dissipated, non-specific bases for the effects are largely precluded. A dependence of MS as a reinforcer on central noradrenergic mech's. is indicated. Similar studies using pretreatment with atropine sulfate (0.3, 1.25, 5.0 mg/kg, i.p.) showed a dose-related inhibition of responding in behavioral tests for MS reinforcement. Methylatropine was found ineffective. The data suggest an influence also of central cholinergic mech's. on reinforcement function.

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154 ACTIVITY OF SIMIAN MLF FIBERS RELATED TO EYE MOVEMENT AND ADEQUATE VESTIBULAR STIMULATION. W. Michael Davis-King*, Stephen G. Lisberger*, Albert F. Fuchs, and L. Craig Evinger*, Dept. Physiology & Biophysics and Regional Primate Center, University of Washington, Seattle, Washington 98195

Since the medial longitudinal fasiculus (MLF) is a major fiber tract linking vestibular and oculomotor brainstem areas, it has been implicated in the generation of both vestibular and voluntary eye movements. To assess their oculomotor role, activity of single MLF fibers (verified by histological reconstruction) was related to both eye movement and to horizontal or vertical sinusoidal rotation in monkeys trained to a visual tracking task.

MLF fibers respond either to both vestibular and eye movement stimulation or to eye movement alone. Fibers with both vestibular and eye movement sensitivity discharge sinusoidally during rotation with a phase shift relative to angular velocity which is similar to that recorded for vestibular nucleus neurons. They also discharge spontaneously in the absence of vestibular stimulation and pause during saccades in one or more directions. Furthermore, those fibers responding to vertical rotation also increase their discharge in relation to vertical eye position beyond a threshold. If a fiber increases its discharge for upward head rotation alone, it also increases its discharge for downward eye positions in the absence of head movement. Similar to motorneurons, horizontal eye movement fibers exhibit a burst of activity preceding saccades in a preferred direction and a steady firing rate linearly related to eye position. No fibers were observed which discharged only in relation to vertical eye movements.

These results provide single unit evidence that the MLF may play a role in the generation of horizontal saccades and horizontal and vertical fixations as well as horizontal and vertical vestibular eye movements.

155 IN VITRO NEUROPHYSIOLOGICAL STUDIES OF THE DEAFFERENTED HIPPOCAMPUS. Sam Deadwyler, Gary Lynch, Ed Stanford*, Greg Rose* and Carl Cotman. Dept. Psychobiol., Sch. Biol. Sci., UCI, Irvine, 92664.

The perforant path provides the major afferent to the outer 2/3's of the molecular layer of the dentate gyrus. This tract originates in the ipsilateral entorhinal cortex and in its most rostral extension also carries fibers from the contralateral entorhinal ("crossed temporo-ammonic tract"). Following lesions of the ipsilateral entrohinal area, the crossed fibers sprout ventrally into the outer segment of the molecular layer which has been dennervated by the lesion (Steward, Cotman, and Lynch; Exp. Brain Res., 1974). While complete lesions of the entorhinal-cortex dennervate the dentate gyrus along the entire septo-temporal axis of the hippocampal formation, only the rostral-most aspects of the dentate gyrus receive sprouted inputs from the crossed entorhinal fibers. The question investigated in the present experiments was whether any fiber system sprouts into the outer molecular layer of the dentate gyrus in those aspects of the structure caudal to zones reclaimed by the crossed temporo-ammonic fibers. To examine this possibility we prepared 450 micron thick explants of adult hippocampus from various levels along its septo-temporal axis. These were taken from normal rats and from animals which had received entorhinal lesions 3-20 days prior to the experiment and maintained for up to 12 hours during in vitro neurophysiological experiments. Our results show that after a minimum of 8 post-lesion days, stimulation of the perforant path was capable of producing extracellular field potentials and driven unit activity in the dentate gyrus. These results suggest that fibers from an unknown source invade the degenerating perforant path and gain the deafferented dentate gyrus in those regions caudal to the area re-innervated by crossed temporo-ammonic fibers.

156 EFFECTS OF SUPEROXIDE DISMUTASE AND O_2 ON THE GROWTH INHIBITOR ACTION 6-HYDROXYDOPAMINE ON NEURONAL AND NONNEURONAL CELLS IN CULTURE. Lawrence E. De Bault. Department of Psychiatry, University of Iowa, College of Medicine, Iowa City, IA 52242.

Previous work (De Bault and Millard, Cancer Res. 33:745, 1973) showed that an acute treatment (1 hr.) with 6-hydroxydopamine (6-HD) inhibited the growth of cultured cells of sympathetic (neuroblastoma, NEB), glial (C_6) and fibroblast (L929) origin. The degree of inhibition was cell line dependent (most inhibited was NEB > C_6 > L929) and was correlated with permeability of cell membrane to 6-HD-^{14}C. Heikkila and Cohen (Sci. 181: 456, 1973) have shown the oxidation of 6-HD results in two very reactive chemical species, the superoxide radical (O_2-) and hydrogen peroxide (H_2O_2) in addition to the quinone. In an effort to understand the mechanism of 6-HD growth inhibition on cells of neuronal and nonneuronal origin, cells were treated (1 hr.) with 100 µg 6-HD/ml in the presence of N_2, O_2 or superoxide dismutase (SOD) an enzyme known to inhibit quinone formation from 6-HD. Growth inhibition was based on cell counts 1, 2 and 3 days after treatment. The growth of NEB and C_6 cells treated with 6-HD in the presence of N_2 was inhibited 40% to 80%, day 1 and 3, respectively. L929 cells were less affected and recovered by day 3. Treatment in the presence of O_2 or with oxidation products of 6-HD resulted in greater growth inhibition; highest in $C_6 \geq$ NEB >> L929. Treatment in the presence of SOD resulted in 80% inhibition for C_6 which was sustained for 3 days. NEB and L929 cells were only inhibited 35% on day 1 and recovered by day 3. Though the exact mechanism of action of growth inhibition by 6-HD is still unclear, these experiments suggest that 6-HD as well as its intermediate oxydation products can inhibit the growth of cells in vitro and the degree and time course of inhibition are cell line dependent. (Supported in part by Research Grants #GM-18966 from NIH and #DA-0048 from NIMH.)

157 EXCITATORY EFFECTS OF CERTAIN INDOLEAMINES IN THE HIPPOCAMPUS OF THE CAT. J. F. DeFrance and H. Yoshihara*, Morin Memorial Laboratory, Dept. Anat., Sch. Med., Wayne State Univ., Detroit, Michigan 48201.

The effects of 5-HT, DMT, and 5-OHDMT were studied on evoked field potentials and extracellular unitary discharges in region CA1 of the cat hippocampus. Pyramidal cells in CA1 were activated antidromically by stimulation of the alveus and orthodromically by microstimulation of region CA3. 5-HT, DMT, and 5-OHDMT were administered electrophoretically in CA1, and L-tryptophan, 5-HTP and DMT were introduced intravenously. Power and paired-stimulus testing paradigms were utilized to study evoked responses in CA1 before, during, and after various drug applications. It was found that indoleamines reduced response thresholds to antidromic and orthodromic activation and facilitated the test response with paired-stimulus testing. This suggests that these indoleamines have an excitatory effect upon CA1 pyramidal cells. These results parallel those in the septal nuclei where indoleamines were seen to have an excitatory effect in regions within the CA3 distribution. (Supported by NSF Grant 35532 and NIH Grant NS00405.)

158 CATECHOLAMINE METABOLISM IN METHADONE WITHDRAWAL. Haroutune Dekirmenjian, John M. Davis, David L. Garver, Frank D. Jones*, G. N. Pandey*, I. Inwang*, and R. Watkins*. Ill. State Psychiatric Inst. and Univ. of Chicago, Dept. of Psychiatry, Chicago 60612.

There is considerable evidence from animal studies that catecholamine synthesis is increased with acute morphine administration, returns to baseline levels during chronic treatment and is decreased during withdrawal. Furthermore, presently it is accepted that 3-methoxy-4-hydroxyphenethylglycol(MHPG)is the major metabolite of brain norepinephrine (NE) metabolism. 3-methoxy-4-hydroxymandelic acid (VMA), normetanephrine (NM) and metanephrine (M) may reflect peripheral NE metabolism. The determination of urinary MHPG in conjunction with VMA, NM and M should permit conclusions in respect to the effect of methadone on central and peripheral NE metabolism. Eleven former heroin addicts, free of medical or other major psychiatric illness and wishing to detoxify, were hospitalized on a metabolic research unit and placed on a VMA exclusion diet. Twenty-four hour urine specimens were collected serially during (1) a two week stable methadone maintenance period, (2) the gradual detoxification period, (3) and two weeks after complete withdrawal. On methadone maintenance period there were no significant differences in the urinary excretion of MHPG, NM, M and HVA between these patients and a group of controls assayed for the same metabolites. Also, there were no significant differences in MHPG excretion on methadone maintenance and methadone withdrawal. There was approximately 50% decrease in the excretion of NM and M between methadone maintenance and complete withdrawal periods. Also there was approximately 25% decrease in the excretion of homovanillic acid (HVA) during these same periods. Above data in conjunction with determinations of VMA and cyclic AMP may signify a difference in the synthesis and disposition of catecholamines in brain vs peripheral tissues.

159 DIFFERENTIAL LABELING OF GROWTH CONE VESICLES BY ELECTRON DENSE TRACERS. Manuel del Cerro. Cent. Brain Res., Med.Sch., U. of R., Rochester, N.Y. 14642

The ultrastructural identification of neural growth cones as terminal or subterminal dilations populated by electron-lucent vesicles (Bodian, 1966, del Cerro et al., 1968) raised questions concerning the functional meaning of those "growth vesicles" and the participation, if any, that they may have in the elongation and guidance of the growing fiber. On this issue opinions have been sharply divided. To study whether the vesicles participate in the processes of endo- or exo-cytosis, moving towards or away from the plasmalemma, electron dense tracers (ferritin, horse-radish peroxidase, and iron saccharate) were injected into the cerebellum of 9 to 12 day-old rats. The animals were sacrificed after survival intervals ranging from 10 min. to 24 hours, and the cerebella studied by electron microscopy. Three types of growth cones, axonal, dendritic, and glial can be easily identified in the developing cerebellum. "Growth vesicles" which are present in all three types of cones became labeled with the tracers, but there were pronounced differences in the rate of labeling. Independent of the tracer used, most of the vesicles in the glial cones, and immature end feet, some in the dendritic cones, and only a few in the axonal cones contained tracer. As pinocytosis was practically absent in the cones, and centrifugal transport from the somas does not seem to play a significant role, it is hypothesized that vesicles become labeled with tracer from the intercellular clefts as they fuse with and open into the membrane of the cone. If this assumption were correct, then the differences in the rate of labeling between neural and glial vesicles could indicate a differential rate of membrane flux reflecting a differential rate of growth. (Supported by Grant #NS-06827-07S1)

160 EYE MOVEMENTS AND POSTURAL CHANGES EVOKED BY ELECTRICAL STIMULATION OF THE FISH BRAIN. Leo S. Demski and Diana G. Bauer*. Dept. Anat., Sch. Med., Univ. of New Mexico, Albuquerque, N.M. 87131.

Monopolar electrical stimulation of the brain using a 50Hz, 2Ms and 50μA or less biphasic square wave was carried out in lightly anesthetized, partially immobilized sunfish, Lepomis cyanellus. The sites from which specific eye movements were evoked at lowest current levels were identified histologically using the Prussian blue marking technique. Conjugate rolling movements defined as rotation of the eyes about the interpupillary axis have been evoked from areas related to the third and fourth nerves in the midbrain tegmentum and valvula of the cerebellum. These responses appear similar to those observed when an unoperated fish is made to pitch forward or backward. Conjugate movements of the eyes similar to those resulting from rotation of an unoperated fish about its long axis (tilting to the side) were evoked by electrical stimulation in areas that appear to coincide with the vestibular nuclei as described for the trout (Pearson, J. comp. Neurol. **65**:201, 1936) as well as in the granular layer of the cerebellum within and adjacent to the eminentia granularis. These eye movements could still be elicited by medullary stimulation after removal of the telencephalic lobes and at least the major portion of the optic lobes and cerebellum. Rolling movements have also been evoked from similar areas of the medulla and cerebellum in goldfish, Carassius auratus. The areas from which eye movements have been elicited in anesthetized fish have also been stimulated in several free-swimming unanesthetized sunfish. Stimulation in the medullary area has resulted in tilting and spiraling while stimulation of the midbrain near the oculomotor nuclei has produced pitching and backward looping movements. Thus it appears that at least some of the areas controlling eye movements in sunfish may also be involved in the integration of related locomotor and postural responses. Supported by AFOSR Contract 73-2491.

161 UNILATERAL PERIARCUATE LESIONS CAUSE LOSS OF MOTOR HABIT. Ruthmary Deuel. Dept. Peds., Univ. of Chicago Sch. Med., Chicago, Ill. 60637

16 Rhesus monkeys were given neurological exams, assessment of bimanual pulling and dexterity, and were trained in a go-no go motor task with unimanual response to the ipsilateral ear contingent upon visual cues. After retention testing, animals were divided into four groups: a control group (C) which remained unoperated, a biparietal group (BP), a bilateral periarcuate group (BA), and a unilateral periarcuate group (UA), in which lesions were placed contralateral to the trained hand. The postoperative neurological findings differed between the BA and UA groups, but neither exhibited loss of strength or bimanual pulling. The UA group demonstrated a contralateral sensory neglect syndrome. On the acquired motor task the C animals maintained a high level of performance for months, and BP postoperative retention was excellent. There was severe loss of the motor habit in the BA as well as in the UA group. It was surprising that the UA deficit was as severe as the BA deficit, since compensation via intact commissures would be anticipated. That such compensation did not occur suggests that the deficit in both the UA and BA animals depends upon an intrahemispherically operating system which modulates sensory-motor interaction solely within one hemisphere. Such a system, operating within each hemisphere independently, could allow for diversity of activity between hemispheres with equivalent functional capacities. That is to say such a system could afford a setting for hemispheric dominance of function which is observed in its most developed form only in man.

162 A NORMALLY LAMINATED AFFERENT PROJECTION TO AN ABNORMALLY LAMINATED CORTEX: OLFACTORY CONNECTIONS IN THE REELER MOUSE, M. Devor*, V.S. Caviness, Jr. & P. Derer* (SPON: S.L. Chorover) Dept. Psychology, M.I.T. Cambridge, Mass. 02139 and E.K. Shriver Inst., Harvard Medical School, Waltham, Mass. 02154

The reeler mutation in mice gives rise to a cytoarchitectonic anomaly of olfactory projection cortex characterized by inversion of the relative positions of its two principal cell classes. The polymorph cells, which occupy the deepest cortical stratum in the normal, lie in the mutant in a superficial plane extending well into what would normally be the plexiform layer. The pyramidal cells, on the other hand, are positioned in a broad field deep to the polymorph cells. In the normal mouse, fibers leave the olfactory bulb in the lateral olfactory tract (LOT), course over the surface of the cortex, and terminate in the outer zone of the plexiform layer on the distal portion of pyramidal cell dendrites. Golgi impregnations establish that this same zone in the reeler is occupied by polymorph somata and dendrites as well as by ascending dendrites of deep lying but normally oriented pyramidal cells. Other pyramidal cells are anomalous in both their position and their alignment, and send apical dendrites in a direction tangential to the cortical surface. Following olfactory bulb removal in the mutant, Fink-Heimer impregnations show that, in general, LOT axons continue to terminate in a sharply confined superficial lamina, presumably on those apical dendrites of pyramidal cells that happen to extend into the synaptic zone. Apparently fibers do not 'seek out' remote, abnormally located pyramidal dendrites. Furthermore, since the terminal zone also contains anomalously located polymorph cells and processes, it is possible that anomalous synaptic contacts are formed with these elements. Together, the data suggest that the trajectory and zone of termination of axons of the LOT are determined by factors independent of those which control the relative positions of target cells in the cortex.

163 ISOLATION AND LIPID COMPOSITION OF BOVINE PERIKARYA. George H. De Vries and Mae Elizabeth Howell*. Dept. of Biochem., Health Sciences Div., Va. Comm. Univ., Richmond, VA 23298

Perikarya were isolated from bovine cortex by the method of Poduslo and Norton (Science 167:1144, 1970) modified by substitution of 0.1% (instead of 1.0%) trypsin used to disaggregate the cells. The yield of cells per gram wet weight of cortex varied from 3.7×10^6 to 9.0×10^6 with an average yield of 6.0×10^6 cells. The perikarya preparation was over 90% pure as estimated by particle count, and contained cells ranging from 5μ to 15μ in diameter with the expected neuronal morphology. On a dry weight basis 23.0% of the perikarya was lipid comprised of 16.3% cholesterol, 10.5% glycolipid (gangliosides, cerebrosides and sulfatides) 73.1% phospholipid comprised of 19.0% ethanolamine phosphatides (11.6% phosphatidyl ethanolamine, 7.4% phosphatidal ethanolamine) 4.9% phosphatidyl serine, 6.0% phosphatidyl inositol, 34.5% choline phosphatides (CP) (32.0% phosphatidyl choline, 2.5% phosphatidal choline) 3.7% sphingomyelin (SPH) and 5.0% unidentified phospholipid. This lipid composition is distinct from that which we have determined for axons also isolated from bovine brain (J. Neurochem. 22:259,1974). Compared to axons, bovine perikarya have a higher percentage of lipid with more CP, less SPH, a lower content of plasmologens and about one-half the glycolipid content. We conclude that the lipids of the neuron are not uniformly distributed throughout the cell but that each particular area of the neuron such as the axon and perikaryon has its own distinctive lipid composition which may be related to its specialized function. (Supported by NIH grant NS 10821-01.)

164 DISSIMILAR EFFECTS OF CYCLIC AMP AND CYCLIC GMP ON CHOLINERGIC STIMULATION OF THE RAT NEOSTRIATUM. R.E. Dill, W.L. Davis* and I. Thonnard-Phillips*, Department of Anatomy, Baylor University Graduate School, Dallas, Texas 75226.

N. Goldberg (Proc. Fifth Int. Cong. Pharmacol. 5:146-169, 1973) has suggested that the nucleotides cAMP and cGMP may have opposing effects in the nervous system. The tentative assumption has been that cAMP is involved in adrenergic mechanisms and cGMP cholinergic mechanisms. We tested the ability of these two nucleotides to alter dyskinesias induced in rats by cholinergic stimulation of the neostriatum.

Twenty rats were bilaterally cannulated in the caudate/putamen complex and subsequently injected unilaterally with carbachol (1μg), carbachol + cGMP (2-10 μg), or cGMP (0.5-10 μg) only, carbachol + cAMP (0.5-10 μg) or cAMP (10 μg) only. The resulting dyskinesias were then ranked on a scale from 0 to 6 and groups compared by the Wilcoxon matched-pair signed-ranks method. cAMP alone produced no effect nor any alteration of carbachol-induced dyskinesia. cGMP alone produced no effect but effectively ($P<0.01$) blocked carbachol-induced dyskinesia. Thus cGMP produced effects more closely resembling adrenergic drugs than cholinergic while cAMP was without effect. These results differ from those obtained by other methods from other areas of the nervous system.

165 ULTRASTRUCTURAL RESPONSES OF CEREBRAL TISSUE FOLLOWING PERIODS OF ISCHEMIC INSULT. Ronald F. Dodson and Yukio Tagashira* Dept. of Neurol., Baylor Coll. Med., Houston, Tex., 77025

Early changes in brain parenchyma of squirrel monkeys after periods of experimentally induced ischemia (1/2, 1, 2, 3, and 4 hrs., respectively) have been reported. Following the selected period of occlusive insult (1/2 hr, 2 hr, 3 hr, or 4 hr) involving middle cerebral artery occlusion, information was sought which would provide further clarification of tissue response in animals at respective post occlusive periods of three days or one week.

The animals were subjected to whole body perfusion with a 3% glutaraldehyde in 0.1M phosphate buffer and post stained with osmium tetroxide and embedded in Spurr plastic.

In all areas (cortical, and basal ganglia) within the territory of middle cerebral artery, edematous changes were more advanced in the three day post-occluded animals than in those perfused immediately after the removal of the clip from the artery. However, in those animals studied at one week after the occlusive insult, less edema was noted in the cortical areas as compared with the three day post occlusion animals. On the contrary, those areas studied of the basal ganglia (globus pallidus, caudate, and putamen), contained comparable or more advanced involvement at the one week period, as compared with those areas at the three day period. This data indicates a more effective morphological recoverability (following temporary ischemia) in cortical tissue than in the areas of the basal ganglia.

166 POPULATION RESPONSE PROPERTIES OF NEURONS IN HINDLIMB SENSORIMOTOR CORTEX OF THE CAT. Gernot S. Doetsch. Dept. Surg., Sec. Neurosurg., and Dept. Physiol., Med. Coll. Ga., Augusta, Ga., 30902.

Extracellular responses were recorded from single neurons in the post-cruciate hindlimb cortex of cats. About 70% of the cells, classified as sa elements, responded only to stimulation of the contralateral hindlimb (CHL) and had small receptive fields. The remaining cells, classified as m elements, responded to stimulation of the CHL plus at least two other limbs, and had large bilateral receptive fields. The sa cells were distributed throughout higher cortical layers with a maximum concentration 0.7mm below the cortical surface. The m cells were located deeper in the cortex with a maximum density 0.9 mm below the surface. After an electrical shock to the CHL, the sa cells discharged earlier in time than the m cells; the m cells fired with more spikes per discharge, had lower thresholds, and were able to follow higher rates of stimulation than the sa cells. When natural stimulation was used, about 60% of the sa cells responded only to hair deflection, 30% responded to touch, and 10% to both hair and touch stimuli. About 85% of the m cells were sensitive only to hair movement and 15% to both hair and touch stimulation. Following electrical stimulation of the CHL, the population response of the sa cells reached a peak 16-18 msec after the stimulus, at a depth 0.6-0.8 mm below the cortical surface. The m cell discharge attained a peak about 20 msec after CHL stimulation, at a depth 0.8-1.0 mm below the surface. In response to stimulation of the other three limbs, the m cell discharge began later in time, built up more gradually, and persisted longer than the discharge following CHL input. It is concluded that s and m cells constitute two functionally distinct neuronal subsets within hindlimb sensorimotor cortex. (Part of this work was done in Dept. Physiol and Biophys., Univ. Wash., Sch. Med., Seattle, Wash., 98195. Supported by USPHS Grant NS05082 and GRS Grant 10-16-04-4010-13 from Med. Coll. Ga.)

167 ELEVATED PIPERIDINE AND CADAVERINE CONTENTS IN THE BRAIN OF DORMANT MICE. Hana Dolezalova* and Matej Stepita-Klauco. Department of Biobehavioral Sciences, University of Connecticut, Storrs, Conn. 06268.

Piperidine can be derived physiologically either from pipecolic acid or from cadaverine, both products of lysine metabolism. Here we report that during apparent sleep in mice both piperidine and cadaverine are elevated in the brain as well as in the blood.

Three-month old inbred female mice (C57Bl/6) were assayed for the piperidine and cadaverine contents of their brain and blood. Their concentrations in behaviorally active mice were compared with those in sleeping animals. The mice were killed by decapitation, the whole brain and blood samples were homogenized in perchloric acid, the homogenate was dansylated and separated by thin layer chromatography on silica gel, DANS-piperidine and bis-DANS-cadaverine TLC fractions were mass spectrometrically identified by their molecular ions (m/e 318 and m/e 568) and quantified by comparing their integrated ion currents during a 'flash' evaporation in an AEI MS902 machine with those of added internal standards of DANS-pyrrolidine (m/e 304) and bis-DANS-hexamethylenediamine (m/e 582).

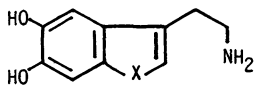
	Dormant		Active	
	Piperidine	Cadaverine	Piperidine	Cadaverine
Brain	36.6±6.35	1.48±0.44	2.00±0.55	0.30±0.07
Blood	50.2±7.81	0.89±0.21	5.60±0.97	0.24±0.07

(Concentrations in pmole/mg wet tissue.)

Our results indicate that the physiologically occurring cadaverine in the brain and blood of mice might participate in the biosynthesis of piperidine. Supported by a grant from the University of Connecticut Research Foundation and by NIH grant 1RO1NS11716-01 to M.S.K. and H.D.

168 POSSIBLE STRUCTURAL SPECIFICITY FOR THE NEUROTOXIC ACTIONS OF 5,6-DIHYDROXYTRYPTAMINE. Alan C. Donelson*, Talmage R. Bosin* and Roger P. Maickel. Dept. of Pharmacol., Med. Sci. Prog., Indiana Univ., Bloomington, IN 47401.

The selective neurotoxic effects of 5,6-dihydroxytryptamine (5,6-DHT) on serotonergic systems have been the subject of many recent studies (J. Neurochem. 19:1587, 1972). As part of a continuing series of studies on structural analogs of indolic compounds, we have synthesized and tested the benzo[b]thiophene analog of 5,6-DHT (5,6-DHT-S); the comparative structures are as indicated:



5,6-DHT, X = NH

5,6-DHT-S, X = S

When administered into the lateral ventricle of the rat brain at doses of 40-80 ug/animal, 5,6-DHT produces a significant and long-lasting reduction in serotonin. In contrast, 5,6-DHT-S, under similar conditions, evokes bizarre behavioral responses with virtually no effects on serotonin metabolism. When given to rats at doses of 30 mg/kg, i.p., 5,6-DHT produces a long-lasting reduction of serotonin levels in peripheral tissues such as spleen. Again, at a similar dose, 5,6-DHT-S was without effect. Both 5,6-DHT and 5,6-DHT-S caused a reduction in heart levels of norepinephrine when given i.p. These data, in light of other findings from this laboratory, suggest that the indolic nitrogen is a site for structural specificity of serotonergic systems. (Supported in part by USPHS grants K02MH-41083, MH-18852 and NS-09672.)

169 SEPTAL LESIONS AND BEHAVIOR: EFFECTS OF PRESURGICAL REARING AND STRAIN OF MOUSE. Peter J. Donovick, Richard G. Burright*, John L. Fuller, and Perry R. Branson*. Dept. Psychol., State Univ., N.Y., Binghamton, N.Y. 13901

Male mice (C57BL/10J or SJL/J strains) were reared in either enriched social cages or restricted individual cages from 25 days of age until they underwent septal or control surgery one month later. Enrichment differentially altered septal or control behavior as measured by: fluid consumption/bodyweight of water, saccharin, and quinine; performance on a rotorod; and the acquisition of an active avoidance task. The interactions of presurgical history with brain damage were manifested differently in the two strains of mice. For instance, only lesioned SJL mice reared in enriched cages showed enhanced reactivity to shifts in palatability, but failed to alter water intake. In the C57 mice, both septal groups drank less water than control animals but lesioned animals were generally more reactive to palatability. We contend that the septum is one portion of a comparator mechanism which integrates immediate sensory and need state information with past experiential data in the modulation of species specific response patterns of the organism. The results found in this experiment reinforce our contention that it is essential to attend more to genetic and presurgical history in attempts to define the effects of brain damage on behavior and to determine the function of brain structures.

170 RECEPTIVE FIELDS AND TOPOGRAPHIC REPRESENTATION IN MOUSE VISUAL CORTEX Ursula Drager* (SPON: P.B. Dews). Dept. Neurobiol., Harvard Medical School, Boston, Mass. 02115

Mouse visual cortex was studied in the C57 Bl/6J strain by recording from single units, and a topographic map was constructed. 44% of striate-cortex neurons responded best to oriented line stimuli moving over their receptive fields; they were classified as simple, complex and a few hypercomplex cells. Of all preferred orientations, horizontal was most common. 56% of receptive fields were circularly symmetric: these were on-center, off-center, and homogeneous on-off in type. Optimal stimulus velocities were much higher than those reported in the cat, varying between 20° and 100°/sec. Receptive field diameters ranged between 4° and 60°. The field of vision common to the two eyes projected to more than 1/3 of the striate cortex. Although the contralateral eye provided the dominating influence on cells in this area, about 2/3 of cells could also be driven through the ipsilateral eye. The topography of area 17 was similar to that found in other mammals: upper visual field projected posteriorly, the most anterior part mapped onto the lateral border. Here the projection did not end at the vertical meridian passing through the animal's long axis but proceeded for 10° to 15° into the ipsilateral hemifield of vision, so that about 20° to 30° of visual field were represented in both hemispheres. After removal of the contralateral hemisphere, cells normally responding to the ipsilateral hemifield became unresponsive. The magnification in area 17 was rather uniform throughout the visual field. In an area lateral to 17 (18a) the fields were projected as a condensed mirror image to the arrangement in area 17. Medial to area 17 (area 18) a third visual area was again related to 17 as a mirror image.

171 KINETICS OF NOISE-INDUCED REDUCTION AND RECOVERY OF MAMMALIAN COCHLEAR MICROPHONIC RESPONSE. Dennis G. Drescher (Spons. Donald H. Eldredge). Central Institute for the Deaf, St. Louis, Mo. 63110.

Continuous noise of sufficient intensity produces a progressive loss of behavioral auditory sensitivity in chinchillas until a steady state is reached in which auditory sensitivity is stable with continued exposure to noise. Recovery to normal auditory thresholds occurs within 3 to 6 days after cessation of the noise (Carder and Miller, J. Speech Hearing Res. 15: 603, 1972). Such changes in auditory sensitivity are known as asymptotic threshold shifts. Noise-induced reduction of cochlear microphonic (CM) response shows a general similarity to these shifts of auditory threshold. The present studies were undertaken to gain information about the mechanism of noise-induced alteration of cochlear response. Anesthetized chinchillas were maintained in quiet for 24 to 48 hr with virtually no loss of maximum CM voltage or of CM sensitivity. When body temperature was altered in the range from 29° to 39°C, CM showed no significant change in the absence of noise for as long as the animals lived. With the presentation of noise, CM progressively decreased and approached an asymptote at a rate dependent on body temperature. For exposure to octave-band noise with center frequency at 1 kHz at 90 dB SPL overall, the times for half-maximal loss of peak CM response were 5 min, 70 min, and 170 min at 39°, 37°, and 29°C respectively. Values of CM did not differ significantly at asymptote. The CM sensitivity obtained from sound pressure necessary to produce a criterion voltage in the region of linear output showed patterns of temperature dependence largely similar to those for peak CM output. Analysis of noise-induced reduction of CM response indicates that several distinct processes are involved. The same appears true for recovery of CM in the quiet. The temperature dependence observed in these studies makes it difficult to explain cochlear fatigue solely on the basis of simple mechanical alterations of cochlear structure. (NINDS Grant NS 03856.)

172 ESCAPE THRESHOLDS TO NOXIOUS HEAT APPLIED TO THE MONKEY'S FACE. R. Dubner, R. E. Beitel and F. J. Brown*. National Institute of Dental Research, NIH, Bethesda, Md. 20014.

Rhesus monkeys were trained in a reaction time paradigm to detect the termination of an innocuous temperature increase or to escape noxious thermal stimuli. Temperature increases at a rate of 10°/sec were provided by a contact thermode positioned on the face. The monkeys were rewarded with grape juice when a panel switch was released within a fixed time period after the termination of the stimulus. On trials in which the temperature increase reached the noxious heat range (45° to 51°C), the monkey could escape the stimulus by releasing early, but received no reward. When maintained under hydrated conditions in the cage, escape thresholds (probability of early release ≥0.5) were less than 48°C and independent of the adapting temperature (range of 30° to 37°C). Early release latencies in the noxious heat range were dependent on adapting and final temperatures. Lip movements associated with noxious heat stimulation were monitored by a sensitive accelerometer attached to the thermode, and consistent with the behavioral results, occurred only at final temperatures of 48°C or higher. Under water-deprived conditions, escape thresholds were greater than 51°, although lip movements continued to occur at temperatures ≥48°C. These data indicate that escape thresholds in monkey are similar to reflex and reported pain thresholds in humans to noxious heat. Three peripheral nerve fiber populations, (1) warm fibers, (2) A delta heat nociceptive afferents, and (3) C heat nociceptive afferents, exhibit changes in discharge pattern in the 47° to 50°C range and may modify central neuronal activity involved in the monkey's ability to escape from noxious heat stimuli.

173 SHORT AND LONG LATENCY COMPONENTS OF THE VISUAL EVOKED RESPONSE (VER) IN ACQUIRED CHILDHOOD CORTICAL BLINDNESS. Michael S. Duchowny*, NIH, Bethesda, Md. 20014. Ira P. Weiss and Ann B. Barnet. Children's Hospital, Washington, D. C. 20009

Short and long latency components of the VER have been reported to correspond to sensory specific and nonspecific activity respectively. Acquired cortical blindness in children often is coincident with generalized CNS depression and offers a model for the study of the functional correlates of the VER. VERs and clinical evaluations were obtained for six subjects, aged 3 to 26 mos., with cortical blindness secondary to head trauma with impaired consciousness or meningitis. VERs and clinical evaluations were repeated after a period of 3 to 5 years. One second monopolar VERs were rated according to presence or absence of components as well as amplitude and morphology of individual peaks. Three subjects who had no demonstrable visual deficit on follow-up visual examination showed improvement of short latency components over time. In the three patients with visual dysfunction, changes in short latency components were correlated with the nature and severity of the visual deficit. In the one child with no evidence of psychomotor retardation on follow-up examination, long latency components showed improvement over time. In the retarded group, long latency components generally deteriorated. The data suggests that following long term recovery from generalized CNS insult with cortical blindness, changes in short latency components correlate with clinical visual status, whereas long latency components are related to psychomotor status.

174 INNERVATION PATTERNS OF THE HORIZONTAL SEMICIRCULAR CANAL IN RHINOBATOS PRODUCTUS. R. F. Dunn, D. P. O'Leary, and V. Honrubia*, Dept. Surgery, UCLA, Los Angeles, California 90024

The peripheral projections of the horizontal ampullary nerve (hor. amp. n.) suggest that specific regions of the crista are innervated by particular bundles. The hor. amp. n. separates from the utricular nerves as 6-8 bundles that curve and proceed dorsally towards the ampulla. The entire hor. amp. n. contained a mean of 1359 myelinated fibers. The bundles varied in size, but the rostral-most and caudal-most were generally smaller with a mean of 176 fibers, and the central bundles were larger with a mean of 288 myelinated fibers. Individual nerve bundles converged near the ampulla forming a nerve trunk while appearing to retain their relative spatial distribution. The nerve trunk coursed along the major axis (ventral-caudal plane) of the saddle-shaped crista. In section planes through this major axis (hair cells and nerves cut longitudinally), fibers nearest the crista separated and arched towards the hair cells lining the surface of its ventral extremity. The remaining fibers cascaded progressively along the ridge of the crista and finally projected into the dorsal extremity. Hence, fibers from the nerve trunk projected systematically to the crista along its ventral-dorsal axis. A systematic projection of fibers appears also across the crista along its minor axis in a plane with cross-sections of both the nerve trunk and the crista (rostral-caudal plane). Nerve fibers from the caudal portion of the nerve trunk were traced in serial sections to hair cells on the canal (caudal) slope, fibers from the central region to the crest of the ridge, and those from the rostral portion to the utricular (rostral) slope. Hence, a systematic pattern of innervation appears along the major and minor axes of the horizontal crista.

Supported by NIH grants NS-09440, NS-09692 and NS-09823.

175 INTRACELLULAR RECORDING AND STAINING OF OPTOMOTOR NEURONS IN FLY OPTIC LOBE. D.R. Dvorak, L.G. Bishop and H.E. Eckert. Biol. Dept., USC, Los Angeles, 90007

Movement discrimination in insects has been analyzed by taking advantage of the inherent tendency of these animals to follow the angular movement of surrounding visual objects. This stereotypic behavior, termed the optomotor reaction, also has interesting neural correlates. In the fly there are directionally selective motion detecting neurons, the optomotor neurons, whose response (extracellularly recorded spike frequency) and the behaviorally measured optomotor response both exhibit: (1) marked sensitivity to the direction of movement of an object in the visual field, and a similar dependence upon (2) the angular velocity at which a black and white striped pattern is moved, (3) the spatial wavelength of the pattern, (4) light intensity, and (5) the contrast of the pattern. By combining intracellular recording and iontophoretic injection of the fluorescent dye, Procion Yellow M4RS, we have now been able to study the function and structure of these optomotor neurons in much greater detail. Resting potentials of -60 mV, action potentials of 90 mV in amplitude, and correlations between subthreshold activity and direction of pattern movement have been frequently observed. Extracellularly vs. intracellularly recorded spike frequencies as a function of direction and angular velocity of movement of a black and white striped pattern, spatial wavelength of the pattern, and light intensity have also been investigated. Processes from individual optomotor neurons have been traced from the medial portion of the optic lobe to the midbrain, a distance of over 1000 microns. Average fiber diameters were 2-5 microns. Support: AFOSR-71-2112.

176 EFFECTS OF AMPHETAMINE ON AVOIDANCE BEHAVIOR IN ENUCLEATED BALB/cJ MICE. Robert S. Dyer and Douglas A. Weldon*. Dept. Psychol., Towson State College, Baltimore, Md. 21204.

Peripherally blinded BALB/cJ mice are more active and better in avoidance performance than normal controls. To test the effects of amphetamine treatment on this hyperactivity, the present experiment employed a 2 x 2 x 6 factorial design with vision (blind vs normal), drug (d-amphetamine vs saline) and days of training as factors. Mice were trained in a shuttle avoidance task for six days at 25 trials per day, and were injected with 10 mg/kg amphetamine or saline 30 min before each day's trials. A trial consisted of the tone being presented for 10 sec with pairing of .25 ma shock during the last 3 sec. When a response was made the trial was terminated, and if the cross was made during the first 7 sec an avoidance response was recorded. During intertrial intervals spontaneous crossings were recorded as a measure of general activity in the avoidance situation. Amphetamine treated normal animals were more active than saline treated normal animals throughout training. Enucleated saline treated animals began at the normal saline level and reached the normal amphetamine level by the end of training. Enucleated amphetamine treated animals were initially hyperactive (at the level of the amphetamine treated normal animals) but decreased to the level of the saline treated normal animals by the end of training. Avoidance data paralleled the crossing data in nature. Analyses of variance indicated the vision x drug x days interaction to be statistically significant ($p < .01$) for both dependent measures. It is suggested that the visual system exerts a regulatory influence on the reticular formation. It has been stated by Isaac (Physiol. Behav. 6: 157, 1971) that the influence upon arousal occurs through the superior colliculus onto the reticular formation.

177 THE GOLDFISH BRAIN AND OPTOKINETIC NYSTAGMUS (OKN). Stephen S. Easter, Jr., Gary E. Landreth* and R. Glenn Northcutt. Dept. Zool. and Neuroscience Program, University of Michigan, Ann Arbor, Michigan 48104.

We have carried out an experimental surgical, behavioral, and histological study on goldfish (Carassius auratus) in order to assess the relative importance of the optic tectum and diencephalon on performance of OKN.

In the first experiment, the ipsilateral tectum and eye were removed from eight fish. Since the visual projections are entirely crossed, this procedure left the remaining eye with no tectum. The animals were restrained, unanesthetized, in a transparent, water-filled container, with a striped drum rotating externally. All animals made normal OKN. Two of them died before histology, but examination of the other six brains (paraffin methods, H and E staining) showed that tectal removal was complete. We conclude that the tectum is not essential for OKN.

In the second experiment, one eye was removed and a small lesion was made in the ipsilateral diencephalon of four goldfish. Three of these animals failed to make OKN, while the fourth responded normally. All four made normal saccades and stretch movements. The brains were examined histologically; the three animals which failed to make OKN lacked the entire pretectal area (n. rotundus, n. corticalis, and area pretectalis), while the fourth, normally responding, animal had an intact pretectal area. We conclude that the pretectal area of the diencephalon is essential for OKN. (This work was supported by PHS Grant EY-00168.)

178 "WHITE NOISE ANALYSIS" OF CELLS IN THE VISUAL PATHWAY OF FLIES: A QUANTITATIVE DESCRIPTION OF NONLINEAR TRANSFER CHARACTERISTICS. H.Eckert and L.G.Bishop. Information Science,Caltech,Pasadena,91109 and Dept.of Biol. Sciences,USC,Los Angeles,90007.

The goal of this investigation was to determine the dynamic transfer characteristics of neurones in the visual system of flies.Gaussian white noise modulated stimulus light was provided by a glow modulator tube.Intracellular (retinula cells) and extracellular recordings (spikes;ON-sustained,ON-OFF fibers in the chiasma externa) were obtained from the flies Calliphora (mutant chalky) and ( )Phaenicia.The linear and nonlinear transfer characteristics can be determined from such experiments and are characterized by the n-th Wiener kernel (shown for retinula cells in fig.1).For frequencies between 5 and 30 Hz the receptor potential bears a linear relationship to light intensity rather than the log-linear relationship reported previously (based on steadystate responses to light flashes).For lower and higher frequencies the response becomes increasingly nonlinear.A significantly higher nonlinearity was observed in the responses of ON and ON-OFF fibers.Furthermore,they show a lower cutoff frequency than the retinula cells.

Support:NIH,USPHS grants NS-03627,GM-15537; AFOSR-71-2112, NSFGB-30733.

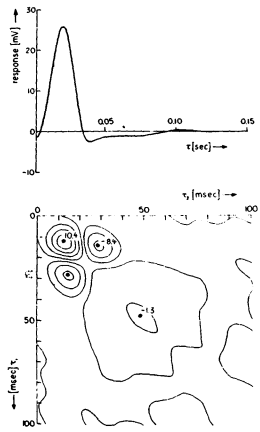


Fig.1:First and second order Wiener kernels for retinula cell system

179 RESPONSE OF MUSCLE CHOLINESTERASE TO ENDURANCE TRAINING. V. R. Edgerton, J. L. Crockett*, and R. J. Barnard* (SPON: E. Eldred). Neuromus. Res. Lab, Dept. Kines., UCLA, Los Angeles, Cal. 90024

The morphology of the neuromuscular junctions of different fiber types seems to be related to neurophysiological properties of the fiber types and to the muscle's metabolic capacity. Cholinesterase (ChE) activity was studied in muscles of endurance-trained and non-trained rats to determine the responsiveness of this postsynaptic enzyme to chronic neuromuscular hyperactivity in each of three muscle fiber types. The muscles studied were the soleus (SOL) and red and white portions of the vastus lateralis (RVL, WVL) which are composed predominantly of slow-twitch oxidative (SO), fast-twitch oxidative-glycolytic (FOG) and fast-twitch glycolytic (FG) fibers, respectively. Eight rats were used as controls and seven were trained 5 days/week for 15 weeks on a motor driven treadmill. The exercise program consisted of 60 min of daily running. On alternate days, the training included 35 min of 30 sec sprint running with 30 sec walk intervals. Endplate (EP+) and non-endplate (EP-) regions of trained and non-trained muscles were used for measurement of ChE activity. For the three fiber types, EP+ and EP- sections combined, mean ChE activity ± SEM in the WVL, RVL and SOL was 6.90 ± 0.20, 4.92 ± 0.17 and 3.21 ± 0.15 moles of acetylthiocholine iodide hydrolyzed/min/g tissue x 10^{-7}, respectively ($P < 0.001$). As expected, ChE activity of EP+ areas of tissue was higher than EP- areas. A significant increase in ChE was found in the WVL EP+ samples (6.70, controls vs. 8.41, trained), indicating a selective effect of the endurance training program on the FG fibers. Although evidence suggests that FG fibers are used the least in endurance exercise, a selective compensatory increase in EP+ ChE in FG fibers may be due to a greater stress on the FG motor units than on the FOG or SO units. This theory is supported by earlier findings of a decrease in EMG amplitude in FG units with fatigue compared to the relatively fatigue-resistant FOG and SO units.

180 EFFECTS OF ELECTRICAL STIMULATION OF THE LATERAL ASPECT OF THE PREFRONTAL CORTEX UPON ATTACK BEHAVIOR IN CATS. Henry M. Edinger, Allan Siegel and Miles Dotto*. Depts. Physiology, Anatomy and Neuroscience, N.J. Med. School, Newark, N.J. 07103

In a previous study we demonstrated that electrical stimulation of the medial aspect of the prefrontal cortex suppressed attack behavior in the cat (Brain Res. 66:467-479, 1974). The present experiment investigated the role of the lateral aspect of the prefrontal cortex upon predatory attack elicited by electrical stimulation of the hypothalamus of adult cats upon anesthetized rats. Electrodes for stimulation and recording were implanted aseptically into the lateral prefrontal cortex and hypothalamus. Cats were given paired trials of single (hypothalamic) and dual (hypothalamic and prefrontal cortex) stimulation. Latency of attack following single stimulation was compared to latency following dual stimulation. The results indicate that stimulation of the prefrontal cortex produces a powerful suppression of the hypothalamic attack response. Stimulation at 8 prefrontal cortical points was capable of producing complete suppression of hypothalamic attack behavior. Effective sites were located in the grey matter of the lateral aspect of the prefrontal cortex. Neuroanatomical studies revealed that the fibers from this region of cortex project principally to the mediodorsal nucleus of the thalamus and not to the hypothalamus. (Supported by NIH Grant NS 07941-05 and by the Benevolent Foundation of Scottish Rite Freemasonry, Northern Jurisdiction, U.S.A.)

181 FIRST-ORDER INTERNEURONS: SENSITIZATION AND HABITUATION. M. David Egger and Constance H. Cone*. Dept. Anat., Sch. Med., Yale Univ., New Haven, Conn. 06510.

The spinal reflex elicited in cats by moderate tactile or electrical stimulation of the plantar cushion (PC) shows both sensitization and habituation during repeated stimulation. In cats with acute spinal sections below T13, anesthetized with Nembutal, paralyzed with Flaxedil and artificially respirated, the PC reflex magnitudes were monitored by recording from S1 ventral root. At the same time, extracellular recordings were made from interneurons receiving monosynaptic connections from primary afferents of PC. First-order interneurons responding to adequate stimuli for the PC reflex increased in the number of firings per stimulus during sensitization of the PC reflex, and decreased in firings per stimulus during habituation of the PC reflex. When parameters of stimulation were adjusted so that the PC reflex showed only habituation, these interneurons showed only a decrease in firings per stimulus. During habituation, the latencies of firing of first-order interneurons tended to increase, e.g., by 0.5 msec following 500 stimuli at 5 Hz and 3X threshold for the reflex. These first-order interneurons were found in the most medial part of the L7 dorsal horn, in Rexed's lamina IV. Because the magnitude of the afferent volley arriving at the dorsal root entry zone did not change appreciably during repeated stimulation, the changes in firing patterns of the first-order interneurons must be mediated within the spinal cord. Furthermore, because these first-order interneurons presumably mediate the PC reflex, changes in firing of these interneurons mediate, at least in part, the changes simultaneously observed in the magnitude of the PC reflex.

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182 GENETIC FACTORS MODULATING THE ACTIONS OF MORPHINE IN MICE. Eduardo Eidelberg and Richard Erspamer*. Div. Neurobiology, Barrow Neurological Inst., Phoenix, 85013.

Mice of four strains were used to evaluate the actions of morphine upon locomotor activity, analgesia and acute tolerance and dependence. Morphine at lower doses ($\leq$20 mg/kg) produced locomotor depression and "analgesia" with no differences between strains. Higher doses of the narcotic induced severe "running fits" in BALB/c and none in ICR mice, C57BL/6J and Swiss-Webster animals showing intermediate responding. There were also definite differences in the intensity of tolerance and precipitated abstinence. The possible relationship between these variables and the turnover of dopamine in brain will be discussed.

Supported by NIDA Grant DA 00029.

183 DISSOCIATION OF SHOCK-MOTIVATED COMPARTMENT AVOIDANCE AND DRUG-INDUCED FLAVOR AVERSIONS FOLLOWING SELECTIVE OLFACTORY SYSTEM LESIONS. Ralph L. Elkins and Stephen H. Hobbs. Veterans Adm. Hosp., Augusta, Ga. 30904.

Garcia and Ervin (CBB A-1(6): 389, 1968) hypothesized that illness-induced flavor aversions and shock-motivated escape or avoidance responses are mediated via anatomically discrete neural networks. Appropriately placed brain lesions might therefore disrupt one type of aversion while sparing the other. This has been reported following septal lesions, which disrupt the conditioning of shock-motivated passive avoidance, but spare flavor-aversion acquisition (McGowan, Garcia, Ervin & Schwartz; PB 4: 907, 1969). However, the literature fails to describe a lesion which disrupts flavor-aversion acquisition while leaving intact avoidance conditioning based on shock. The present experiment evaluated the hypothesis that anterior olfactory bulb lesions disrupt flavor aversion acquisition, but spare shock-motivated compartment avoidance. This prediction was based on the following observations. Studying stepdown passive avoidance based on shock, Sieck (PB 10: 731, 1973) found that total bulbectomies in rats disrupt avoidance acquisition, but smaller lesions restricted to anterior portions of the bulbs do not. Also, total bulbectomies are known to disrupt flavor-aversion acquisition. Bulbectomized, anterior bulbectomized, sham operated and normal rats were therefore tested on the acquisition of shock-motivated compartment avoidance and on the development of cyclophosphamide (Cytoxan^{R}, Mead Johnson) induced flavor aversions. Typical anterior bulbectomies destroyed the anterior third of the bulbs bilaterally. Like total bulbectomies, anterior bulbectomies attenuate flavor-aversion acquisition. However, unlike total bulbectomies, anterior bulbectomies fail to disrupt shock-motivated compartment avoidance. These findings are consistent with Garcia and Ervin's hypothesis of neuroanatomical diversity.

184 MINICOMPUTER MONITORING OF SOCIAL BEHAVIOR PATTERNS IN COLONIES OF HIPPOCAMPAL-LESIONED CBA MICE. Daniel L. Ely* and Ernest G. Greene. Dept. Physiol. and Dept. Psychol., Univ. So. Calif., Los Angeles 90007

A detailed 24 hr/day behavioral analysis was made of dominant-subordinate relationships in 4 groups of socially interacting 4-month-old male CBA mice during a 24-day period. The 4 groups were: hippocampal lesioned (H); cortical-lesioned controls (CLC); sham operated (S); and normal controls (NC). Each male was magnetically tagged and each transaction was sensed, using Hall Effect detectors located at portals to each of the 8 boxes in the population cage. These detectors interfaced with a minicomputer which recorded and tabulated the time and location. The H-males differed from the other groups in the following parameters: (1) They had greater activity in each of the specific locations (food, water, activity wheel, female nesting areas, and male living areas); activity peaked at 8 days and approximated control values after 16 days. All comparisons were made with respect to the other 3 groups. (2) They exhibited 4 times more entry-exits into the same box during days 1-16. (3) A greater percentage of their time was spent in the food area (50%) which declined to control values after 12 days (20%); however, the food area remained a focal point for activity throughout the 24 days. (4) They showed a trend toward decreased time in the female areas during the first 2 weeks. (5) H-males showed a greater number of patrol patterns (specific activity requiring entry into 3 or more different boxes in <1 min between boxes) during days 1-16; each patrol had a greater number of box entries. (6) They showed the most consistent circadian activity rhythm which peaked from 1800-2400 hr and had the greatest crest-trough amplitude. (7) Less aggression was observed in the H-males as determined by fewer body scars. (8) They failed to develop a social hierarchy with dominant-subordinate relationships.

185 DRUGS MODIFYING PRESUMED ISCHEMIC DAMAGE OF SKELETAL MUSCLE. W. King Engel and E. Carolyn Derrer*. NIH, Bethesda, Md. 20014.

Combination of two subthreshold lesions, vascular structural (aorta-ligation) plus a vasoactive substance (5-hydroxytryptamine 5-HT, or norepinephrine NE) has been proposed as a model-in-principle of the pathokinesis of human Duchenne muscular dystrophy on the basis of similar histological and rise-of-plasma-muscle-enzymes (PME's) features (Nature 239:522, 1973; Science 172:1143, 1971). In quest of potential therapeutic agents we have in 673 model rats sought drugs pretreatment with which will prevent rise of PME's. Five days post aorta-ligation, various daily doses of imiprimine, chlorpromazine, or phenoxybenzamine (I 1.25-20, C 2.5-10, P 2.5-20 mg kg^{-1}) were given for 3 days. Eight hours after the last drug injection, the animals were given either 5-HT or NE (10 or 3.25 mg kg^{-1} respectively). Twelve hours following 5-HT or 5 hours after NE they were terminally bled for PME assay (creatinine phosphokinase CPK, glutamic-oxaloacetic transaminase GOT, glutamic-pyruvic transaminase GPT, lactic dehydrogenase LDH). Strikingly prevented was the usual 5-HT-provoked elevation of all 4 PME's, in a consistent relation to dose level, by prior I, C, or P. C and P were also inhibitory when given before NE; I in low doses (1.25-2.5 mg kg^{-1}) before NE inhibited PME rise, but in higher dosage (20 mg kg^{-1}) significantly enhanced CPK and LDH rise (and had no net effect on GOT and GPT). This animal model (a) appears useful for screening interactions of drugs affecting muscle, probably via the muscle vascular system, (b) identifies 3 drugs for possible therapeusis, but (c) indicates need for caution because of some dose-variant effects.

186 STRESS RESPONSIVENESS IS A FUNCTION OF THE CIRCADIAN RHYTHM OF ADRENOCORTICAL ACTIVITY. W.E. Engeland*, M.F. Dallman*, J. Shinsako*, C.M. Winget* and J. Vernikos-Danellis* (SPON: H.L. Fields) U.C. San Francisco, San Francisco, Ca., and NASA-Ames Research Center Moffett Field, Ca.

The adrenocortical system has a prominent circadian variation in basal activity that is related to lighting and sleep-wake cycles. There is general agreement that in rats basal adrenocortical activity is lowest in the morning at lights on, and highest in the evening just before or at lights off. However, it is far from clear whether there is a circadian rhythm in responsiveness of the system to stress. Studies of this point are divided, reporting greater responses in the morning, or in the evening, or equal responses to stress throughout the 24 hr. The majority of these studies has relied on changes in adrenal or plasma corticosterone (B) at a single time after application of the stress, to determine responsiveness. We have chosen to reinvestigate the problem measuring circulating ACTH and B (by radioimmunoassay and competitive protein binding respectively) in female rats before and, 2.5, 5, 7.5, 10, 15, 30 and 60 min after saline injection stress or 2.5, 7.5, 15 and 60 min after histamine injection stress at 0000, 0600, 1200 and 1800 hr. The results with both stressors show that the system is more responsive in the morning than at night. After saline the 0600 responses are faster (peak ACTH 2.5, peak B 15 min) than at 1800 (peak ACTH 7.5, peak B 30 min), and the integrated ACTH and B responses are greater in the morning than at night. After the much more intense stress of histamine, the ACTH response at 0600 was significantly ($p \leq 0.002$) greater at 7.5 and 15 min than the response at 1800 (7.5 min: 503±41 vs 288±35 pg/ml; 15 min: 403±24 vs 286±19 pg/ml). The results suggest that at the peak of circadian adrenocortical activity, elevated corticosterone levels act to inhibit stress-induced CRF and ACTH secretion. (Supported in part by NIH grant NS09528 and NASA NCAR-665-401.)

187 DEPRESSION OF TRANSMITTER RELEASE AND ACCUMULATION OF EXTRACELLULAR POTASSIUM AT THE SQUID GIANT SYNAPSE. Solomon D. Erulkar and Forrest F. Weight. Dept. of Pharmacology, Univ. of Penna., Philadelphia, Pa. 19104 and Lab. of Neuropharmacology, NIMH, Washington, D. C. 20032.

Depression of transmitter release by repetitive stimulation was investigated at the squid giant synapse, in vitro at 6-10° C, by intracellular recording in the presynaptic terminal and postsynaptic axon. Repetitive stimulation of the presynaptic axon at 10 to 40 Hz for durations of 1 to 10 sec resulted in an initial facilitation followed by a depression in the amplitude of the EPSP, a reduction in the presynaptic spike after-hyperpolarization (A.H.; positive phase) and a depolarization of the presynaptic membrane potential (M.P.). These observations indicate an accumulation of $[K]_o$ in periaxonal spaces (J. Physiol. 131, 341, 1956). Increasing $[K]_o$ of the artificial sea water (to 10.5 - 15 mM) resulted in a depression of EPSP amplitude, a decrease in the amplitude of the presynaptic spike A.H. and a depolarization of the presynaptic M.P. These data suggest that an accumulation of $[K]_o$ may contribute, at least in part, to the depression of transmitter release produced by repetitive presynaptic stimulation. Antidromic repetitive stimulation of the postsynaptic axon at 20 to 40 Hz for durations of 2 to 40 sec also resulted in the signs of $[K]_o$ accumulation around the giant axon, as well as a decrease in the amplitude of the presynaptic spike A.H., a depolarization of the presynaptic M.P. and a reduction in the amplitude of the EPSP. These data indicate that repetitive firing of the postsynaptic axon results in an accumulation of $[K]_o$, not only around the postsynaptic axon, but also around the presynaptic terminal (although to a lesser extent). The accumulation of $[K]_o$ around the presynaptic terminal presumably accounts for the depression of transmitter release produced by repetitive postsynaptic stimulation. (Supported in part by NIH Grant NS 09752.)

188 CRITICAL INTERVAL FOR LOSS OF BEHAVIORAL RESPONSE TO AMPHETAMINE AFTER HYPOTHALAMIC INJECTIONS OF 6-HYDROXYDOPAMINE. G.N.Ervin*,R.C.Young* and G.P.Smith. Dept.Psychiat.,Cornell U. Med. Coll., New York, 10605.

To evaluate the time course for the loss of behavioral response to d-amphetamine after damage of catecholaminergic terminals in the forebrain, rats received amphetamine (2 mg/kg, ip) 7, 15 and 19 days after bilateral hypothalamic injections of 6-hydroxydopamine (6-OHDA) at posterolateral (PL) or anterolateral (AL) hypothalamic sites along the medial forebrain bundle. Behavior was sampled for 30 sec every 15 min for 3 hr after amphetamine and the incidence of 11 behavioral items was recorded. On day 7, behavioral responses were significantly enhanced in AL and PL 6-OHDA rats compared to vehicle rats. On days 15 and 19, behavioral responses to amphetamine were almost abolished in AL and PL 6-OHDA rats, but the behavior of vehicle rats was unchanged from day 7. On days 15 and 19, when AL and PL 6-OHDA rats were unresponsive to amphetamine, the same rats had marked responses to a dose of l-dopa (50 mg/kg, ip) which had been subthreshold for behavior in these rats on day 7. The form of responses to l-dopa differed depending on site of 6-OHDA injection: AL rats displayed locomotion and rearing, while PL rats displayed primarily stereotyped movements. We conclude (1) that the loss of response to amphetamine and the simultaneous hypersensitivity to l-dopa which occurred between day 7 and day 15 was the result of degeneration of forebrain CA terminals during that interval which are critical for the usual behavioral response to amphetamine; and (2) that the different forms of the response to l-dopa in AL and PL rats reflect degeneration of different CA terminal fields after 6-OHDA injections at these sites.

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189 RESPONSE CHARACTERISTICS OF FIRST-ORDER SEMICIRCULAR CANAL NEURONS IN THE CAT. Michael S. Estes*, Robert H.I. Blanks* and Charles H. Markham (SPON: A.D. Grinnell). Sch. Med. UCLA, Los Angeles, CA 90024.

The physiologic responses of first-order semicircular canal neurons, recorded within the internal auditory canal, were studied in 80 anesthetized cats. Three hundred cells innervating the horizontal, anterior, and posterior canals were characterized as to the statistical properties of their resting discharge and their sensitivity and degree of adaptation to in-plane constant angular acceleration. All cells demonstrated a spontaneous discharge at rest and responded to angular acceleration in a fashion predictable from the morphological polarization of the receptor. The properties of the canal receptive field were assessed by applying angular accelerations to the animal in a number of head positions. Response characteristics in each position were consistent with a planar representation of the canal-receptor system; maximum response being elicited with rotation about the canal axis, while no response could be seen with the canal axis oriented 90° to the axis of rotation ('null point'). Planar equations derived from 'null point' measurements in pitch and roll agreed closely with anatomical measurements of canal position in the cat (Blanks et al., Am. J. Physiol. 223:55, 1972). In addition to the expected rotational response, some of the units from each canal were noted to alter their resting rate in a predictable manner as the animal was placed in various head positions. These findings clearly define canal position and sensitivity to out-of-plane stimulation, permitting a more precise control of natural stimulation and an evaluation of brain stem canal-canal interactions. Supported by USPHS Grant No. NS 06658.

190 Morphine as a discriminative stimulus to behavior: Strain variability. Michael W. Etkin*, Jim H. Johnson and John A. Rosecrans. Depts. of Psychol., Anat., and Pharmacol., Va. Comm. Univ., Richmond, Va. 23298.

Male Sprague Dawley (SD) and Wistar (W) rats of the same age were trained to discriminate between morphine and non-drug (saline) states using two behavioral tasks. The morphine cue was easily learned by SD rats when the discrimination task involved a two-lever positively reinforced response (FR-4). However, when the discrimination involved an escape response, none of SD rats learned to discriminate between drug and non-drug states. The reverse was true for the W strain as these rats learned the cue only if the task involved an escape response. Attempts to determine the source of this variability revealed that the SD strain appeared to habituate slower than W strain rats in various activity procedures, and were less likely to learn a sidman avoidance (two-way shuttle) than similar trained W rats. While these animals did appear to differ significantly in certain behavioral paramaters, no differences were apparent when either biogenic amine levels or when the pharmacological effects of morphine were compared. (Supported by a grant from the N.I.D.A., RO1-MH-22261).

191 THE MECHANISM OF GENERATION OF PASSIVE HYPERPOLARIZING POTENTIALS IN GOLDFISH MEDULLA. D.S. Faber and H. Korn*, Dept. of Physiol., Un. Cincinnati, Cincinnati, OH 45219, and Lab. Physiol., C.H.U. Pitie-Salpetriere, Paris.

The validity of the model for the generation of passive hyperpolarizing potentials (PHPs) produced in some goldfish medullary neurons by Mauthner cell (M-cell) action currents (Faber and Korn,1973, Science, 179:577-579) has been investigated with intracellular recording and staining techniques. PHPs can be mimicked by passing cathodal current pulses (0.1-0.3uA) between a microelectrode in the axon cap and a distant ground electrode. The simulated PHPs block both synaptic and direct activation of PHP neurons;they cannot be produced when the current electrode is withdrawn from the axon cap. Thus, current flowing into the axon cap generates the PHPs. Three separate lines of evidence further support the concept that this current is being channeled into the PHP neurons as it returns to the M-cell axon hillock. 1) These neurons have been identified with Procion Yellow; their somata are small (12-20μ diam), but they issue a process of 4-7μ in diam. which terminates in the axon cap. 2) The electrical resistivity of the axon cap is at least twice that of the surrounding medullary tissues. 3) PHP amplitude is dependent upon membrane conductance; when adequately timed with the spike after-hyperpolarization, it is reduced by an amount proportional to the associated conductance increase. One consequence of this model was that PHP neurons could contribute to the previously described electrical inhibition of the M-cell itself (Furukawa and Furshpan, 1963, J. Neurophysiol. 20-140-175). Simultaneous intracellular recordings from PHP neurons and the ipsi-lateral M-cell have confirmed that impulses evoked in some of these cells by transmembrane current pulses produce an extrinsic hyperpolarization of the M-cell. Conversely, the activation of the same neurons is found to be synchronized by the classical "extrinsic hyperpolarizing potential" in the axon cap and by the preceding PHP itself as well.

192 DIFFERENTIAL EVOKED POTENTIAL CHANGES PRECEDING THE DEVELOPMENT OF DRUG-INDUCED GENERALIZED SEIZURES. Carl L. Faingold. Dept. Med. Sciences Sch. Med. Southern Illinois University, Springfield, 62708

Evoked response changes occuring in reticular formation and non-specific thalamic, "centrencephalic", pathways were evaluated during the gradual infusion of either strychnine (ST) or pentylenetetrazol (PTZ). Although PTZ and ST both induce generalized seizures, the pre-seizural actions of these 2 drugs on the EEG of the cat are quite dissimilar. ST induces an early focus of fast (10-20 Hz.) relatively high voltage regular activity in the lower brainstem, which subsequently includes spike activity, before much change is seen in the cortical and thalamic EEG. PTZ induces no consistent focal epileptiform activity but induces generalized sharp wave activity. The excitability changes in these "centrencephalic" pathways induced by ST and PTZ were assessed by monitoring changes in responses to auditory, visual and electrical stimuli. Both PTZ and ST enhance the sensory evoked potentials and often depress responses to reticular stimulation. However, PTZ enhances and ST depresses responses to thalamic stimulation. The differential changes in excitability in these pathways may indicate that sensory enhancement and reticular depression act as possible common mechanisms of drug induced generalized seizures. The opposite effects induced by these two drugs on responses to thalamic stimulation may indicate mechanisms specific to the particular drug.

Supported in part by the Southern Illinois University Foundation.

193 PHYSIOLOGICAL AND ANATOMICAL CORRELATES OF VISUAL AND AUDITORY MODALITIES IN THE INFERIOR CONVEXITY OF ORBITAL CORTEX IN RHESUS MONKEY. James H. Fallon* and L. A. Benevento. University of Illinois, College of Medicine, P.O. Box 6998, Chicago, Illinois 60680.

Extracellular and intracellular recordings were made in the inferior prefrontal convexity of awake rhesus monkeys. Cells responded to on, off and on-off presentations of visual and auditory stimuli. The cells also exhibited binocular excitation and inhibition and responded to moving visual targets of various shapes. Light and sound stimuli were not only presented alone and simultaneously, but were also paired with delays up to 1000 ms. Postsynaptic potentials to either a visual or auditory stimulus could be enhanced or negated by the postsynaptic potentials induced by the other depending upon the delay. These physiological data correlate well with our Fink-Heimer axonal degeneration studies of the afferents and efferents of orbital cortex. Lesions of the occipital cortex revealed a monosynaptic axonal input to the inferior convexity. Lesions of the superior colliculus revealed projections to thalamic nuclei which also project to the inferior convexity. The anatomical studies also show that the inferior convexity projects to visual relay nuclei, e.g., dorsal lateral geniculate, superior colliculus, pretectum; auditory nuclei, e.g., inferior colliculus, superior olivary complex, nuclei of the lateral lemniscus and trapezoid body; thalamic multimodal nuclei, e.g., posterior group; and other regions of the thalamus, brainstem, basal ganglia, and hypothalamus. Thus, anatomical and functional data indicate a basis for additional cortico-subcortical loops associated with the visual and auditory systems. (Supported by NSF Grant 35366X to L.A.B.)

194 CYCLIC NUCLEOTIDE PHOSPHODIESTERASE ACTIVITY IN PHOTORECEPTOR CELLS OF DEGENERATIVE RETINAE OF RATS AND MICE. D. B. Farber* and R. N. Lolley. V.A. Hospital, Sepulveda 91343, and UCLA Sch. Med., Los Angeles, CA 90024.

C3H/HeJ mice and RCS rats possess autosomal mutations which cause photoreceptor degeneration in the retina of the immature animals. Morphological studies show that the mouse and rat photoreceptor cells exhibit different patterns of pathology and necrosis, suggesting that the two diseases may arise from different etiologies. In the C3H mouse retina, a deficiency in receptor-specific cyclic GMP phosphodiesterase (cGMP-PDE) activity occurs before ultrastructural degeneration. Due to the deficiency of this enzyme throughout postnatal life, cyclic GMP levels in the photoreceptor cells become elevated. It is suggested that this metabolic abnormality results in degeneration of the photoreceptor cells. In contrast, the activity of receptor-specific cGMP-PDE in the RCS rat retina is normal during the first two weeks of postnatal life. Thereafter, it declines as the photoreceptor population is depleted by the disease. These data indicate that photoreceptor degeneration in the retina of C3H mice and RCS rats is caused by different biochemical mechanisms. (Supported in part by NIH Grant EY00395.)

195 DYNAMIC CHARACTERISTICS OF RAPIDLY ADAPTING KNEE JOINT RECEPTORS IN CATS. Maria C. Farias* and Spencer L. BeMent. Bioelec. Sci. Lab., Elec. and Comp. Engr. and Bioengineering Prog., U of Mich., Ann Arbor, 48105.

Rapidly adapting receptors in the cat knee joint that responded to changes in the angle between the long axes of the tibia and femur (joint angle) were studied. The joint angle was varied sinusoidally about a reference (bias) angle with a fixed amplitude (excursion) such that the frequency of angular change increased logarithmically between 0.1 and 7 Hz (swept sinusoidal input). The output was instantaneous frequency of single medial articular nerve fiber responses. The swept frequency technique allowed a 128 point swept frequency response profile to be obtained in less than 10 minutes, including the averaging of at least five sweeps. Frequency response profiles for various femur-tibia bias angles and excursions were analyzed as describing functions to characterize the systems response to dynamic inputs. Two types of rapidly adapting responses to step changes in angle were observed: (1) the first type responded to a steady rate initially for about 15 seconds but then its rate gradually decreased to zero after about 3 minutes, (2) the second type responded with a burst of a few impulses only (Pacinian Like). This second type also phase locked at sinusoidal frequencies greater than about 1 Hz whereas no phase locking was apparent with the first type. The first type of response was described over a frequency range from about 0.3 Hz to 5 Hz by a fractional order differentiator model of the form $G(s)=A\cdot s^{k}(s+a)$ where A=0.24± 0.27 impulses/sec/deg, k=0.25±0.05 and a=68±40 rad/sec, based on twelve describing functions. The describing functions for the Pacinian like receptor were of two distinct types that exhibited either 20 or 40 dB per decade slopes in their magnitude portions. Such responses may indicate velocity or acceleration sensitivity at frequencies greater than about 1 Hz or 0.3 Hz respectively. Supported by NIH Grants NS08470 and GM01289.

196 CONGENITAL LACTIC ACIDOSIS: COMPLETE ABSENCE OF PYRUVATE DECARBOXYLASE IN BRAIN AND LIVER. Donald F. Farrell, Arthur F. Clark*, C. Ronald Scott* and Richard P. Wennberg*. Depts. Med. (Neurology) and Pediatrics, Univ. of Wa. Sch. Med., Seattle, Wa. 98195.

The enzyme complex pyruvate dehydrogenase (PDH) consists of at least three individual enzymes, pyruvate decarboxylase (E_1), dihydrolipoyl transacetylase (E_2) and dihydrolipoyl dehydrogenase (E_3) and is an obligate biochemical step by which carbohydrates enter the tricarboxylic acid (TCA) cycle. A mutation causing a complete deficiency of this important enzyme should be either a lethal mutation or lead to severe biochemical and physical alterations. An infant recognized as having congenital lactic acidosis shortly after birth and who died at 6 months of age has been found to have a total deficiency of PDH activity as a result of a complete deficiency of pyruvate decarboxylase (E_1) in both brain and liver. While the activity of pyruvate decarboxylase (E_1) is physiologically controllable (active and inactive forms of the enzyme) it is not the rate limiting reaction of the PDH complex. A series of mixing experiments resulted in an apparent 3-fold activation of PDH activity in the mutant. This apparent activation was not due to activation of any of the individual enzymes, lack of the activating enzyme (pyruvate decarboxylase phosphate phosphatase), lack of soluble cofactors, or presence of any inhibitor, but rather to an interaction of an excess of pyruvate decarboxylase (E_1) from the normal with the pyruvate decarboxylase (E_1) deficient complex of the mutant to form mixed functioning complexes. Since acetyl CoA production in this infant via this important pathway was impossible, other metabolic routes for acetyl CoA synthesis were necessary for entrance into the TCA cycle and concomitant adenosine triphosphate (ATP) production.

197 IDENTIFICATION OF LARGE CELLS IN APLYSIA ABDOMINAL GANGLION BY MEANS OF EXTRACELLULAR WAVEFORM PROPERTIES. R. Feinstein and H. Pinsker, Marine Biomedical Institute, Univ. Texas Med. Br., Galveston, Texas 77550

It will be necessary to uniquely identify specific neurons on the basis of chronic extracellular recordings if we are to record from identified neural circuits under normal behavioral conditions in Aplysia. We have begun experiments in the isolated abdominal ganglion that combine intracellular monitoring of 2 large identified cells (R1 and R2) and extracellular monitoring of their axonal spikes by means of cuff electrodes on the right connective. In each preparation, the two cells are impaled with microelectrodes and each is fired repeatedly (100 action potentials). The extracellular action potentials are recorded on magnetic tape and processed by means of a small laboratory computer with a graphics display. Each action potential for each cell in a given preparation is digitized and then averaged with all others from that preparation. The following average values are obtained for each preparation: (1) maximum peak; (2) minimum peak; (3) peak-to-peak amplitude; (4) peak-to-peak duration; (5) maximum rate of change which occurs between the maximum and minimum peaks. Using these criteria it is possible to discriminate unambiguously between R1 and R2 from extracellular records. We have also examined the frequency components of these waveforms by means of the Fast Fourier Transform. Because of the large differences in peak-to-peak amplitude of the extracellular spikes of R1 and R2 it is easy to distinguish them reliably on the basis of the total power contained over all frequencies. We are presently examining the normalized power spectra of these waveforms and hope to be able to use this information combined with the other criteria to identify other axons in the nerves and connectives of Aplysia. (Supported by NIH Grant NS 11255 and the Moody Foundation of Galveston.)

198 CORTICAL DEPTH PENETRATION OF RADIOACTIVE ACETYLCHOLINE (ACH) AT SEIZURE ONSET. John H. Ferguson, David R. Cornblath* and Pamela A. Havre*. Div. Neurology, University Hospitals, Case Western Reserve University, Cleveland, Ohio 44106

Filter papers with 55×10^{-9} moles H^3-Ach (0.5% concentration) were applied bilaterally to previously neostigminized mid suprasylvian gyri in cats. Intact and chronically undercut preparations were used. Two to twenty minutes after application, or when seizure occurred on one side, the brain was frozen with liquid N_2, 16 u frozen sections cut parallel to the surface, and liquid scintillation counting performed in 6 section lots from surface to white matter.

Results are: 1. In 2 minutes, concentrations in layer I reach 5×10^{-3}% and in white matter, 10^{-5}%; in 3-5 minutes, maximum concentrations of 10^{-2}% and 10^{-4}% are reached at these layers. Concentrations in intermediate layers lie between these values. 2. Although seizure was more frequent in undercut cortex, depth concentrations of H^3-Ach at any given time were similar in seizure and non seizure sides whether intact or undercut. 3. No critical concentrations of Ach for seizure at any depth could be determined.

We have presented a technique for the determination of depth concentrations of topically applied convulsants. Our results indicate Ach diffuses so rapidly to white matter whether or not seizure occurs that other factors must play a more critical role in Ach induced seizure.

199 IN VIVO RECOVERY OF NEUROMUSCULAR RESPONSE AFTER α-BUNGAROTOXIN BINDING. Helen C. Fertuck*, William Woodward*, and Miriam M. Salpeter. Section of Neurobiol. & Behavior, Dept. Phys., Cornell Univ., Ithaca, N.Y. 14850

Neurally evoked muscle contraction was eliminated in vivo by bathing exposed sternomastoid muscles of anesthetized mice with α-bungarotoxin (10^{-6}M). Per cent recovery was determined at daily intervals by comparing the maximum tetanic contraction obtainable by nerve stimulation with that obtainable by direct muscle stimulation. (In control muscle, maximum tetanic contraction is identical for both modes of stimulation and α-bungarotoxin only eliminates the neurally evoked response.) Full recovery of the neuromuscular response was obtained in 4 days. If [^{125}I]α-bungarotoxin was used to label new toxin binding sites present 2 days after the initial block with cold toxin, at which time there has been 40-50% recovery of function, EM autoradiography showed that most of the label was concentrated at the top of the junctional folds (adjacent to the axonal membrane). The localization of α-bungarotoxin binding sites during recovery is thus similar to that reported for normal muscle by Fertuck and Salpeter (PNAS, April 1974) but is in contradiction to the uniform distribution along the junctional folds claimed by Porter et al. (J. Membr. Biol. 14, 383, 1973). The label density is, of course, lower in recovering than in normal muscles. Comparison of the recovery of neuromuscular function with turnover of α-bungarotoxin label will be discussed.

200 RESPONSES OF PRECENTRAL "MOTOR" CORTEX CELLS DURING PASSIVE AND ACTIVE JOINT MOVEMENTS. E.E. Fetz, D.V. Finocchio, M.A. Baker and M.J. Soso. Regnl. Primate Res. Ctr. and Depts. of Physiol. & Biophys. and Neurol. Surg. Univ. of Wash., Seattle, Wash. 98195.

The natural stimulus which clearly and repeatably increased cell firing was characterized for 466 precentral cells in leg and arm area of awake rhesus monkeys. 75% of the cells responded to passive movements of one or more contralateral joints; 8% responded to cutaneous stimulation and 17% were unresponsive. Of the cells driven by passive joint movement 69% responded to only one joint, and 75% responded only during phasic movements.

To document whether a cell's sensory response was related to the active movement in which it was involved, we recorded cell and EMG activity during similar active and passive elbow movements with the forearm semiprone in a hinged cast. Both active and passive movements consisted of a rapid change in joint angle followed by one second of maintained position. Activity of 46 cells was averaged (with EMG and position) over equal numbers (at least 50) of active and passive flexions and extensions. Of these cells, 24 responded to either passive flexion (9) or extention (15); 14 responded to both and 8 to neither. Of the 24 cells driven by passive movement in only one direction, the strongest response during active movements was in the same direction for 9, in the opposite direction for 7 and equally strong in both directions for 8. These results suggest a variety of input-output relations for precentral cells related to elbow movements.

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201 Plastic changes in the visual cortex induced by light and monocular deprivation. Eva Fifkova. Calif. Inst. of Technology, Pasadena, Calif. 91109
In monocularly lid-sutured albino rats the occluded eye becomes affected by deprivation, the functional eye by light and these changes involve also the visual cortex. Changes in the cortex connected with the deprived eye were a mirror image of changes in the cortex connected with the functional eye in comparison to values in unoperated rats. There was a decrease in density (by 9%) together with an increase in size (by 9%) of axodendritic synapses and a decrease in size (by 10%) of axosomatic synapses in the deprived coertex with respect to the unoperated controls. Contrary to this in the undeprived cortex there were more (by 8%) and smaller (by 5%) axodendritic synapses and larger (by 11%) axosomatic synapses. The 16 hr/500 lux as compared to the 8 hr/500 lux of daily light exposure in albino rats causes degenerative changes in the receptors, which consequently reduce the synaptic density in the inner plexiform layer of the retina as well as the density of axodendritic contacts in the visual cortex. Eventhough the 16 hr illumination regimen affects the receptors, it does not change the magnitude of the difference between the deprived and undeprived cortex as compared to the 8 hr of daily light exposure. It seems, therefore, that synaptic changes in the undeprived cortex, which were opposite to those in the deprived cortex (in which diminished excitability has been demonstrated physiologically) were caused by enhanced stimulation of the functional eye before light caused damage to the receptors. (Supported in part by NSF Grant GB 6698).

202 SERIAL CORTICAL LESIONS AND RETENTION OF A DIFFICULT TACTILE DISCRIMINATION. Stanley Finger, Julian Puretz* and Daniel Simons*. Department Psychology, Washington University, St. Louis, Mo. 63130.

Four groups of rats with lesions of the somatosensory cortex were compared to each other and to animals with sham operations for retention of a difficult groove-smooth tactile discrimination. Two groups of rats experienced serial lesions, in one case with interoperative retraining to criterion. The remaining animals had one-stage lesions matched in time to either the first or the second (30 days later) of the serial ablations.

The results were as follows: (1) The five groups of rats displayed equivalent preoperative learning scores; (2) Testing after a unilateral SS lesion resulted in a small impairment in relearning; (3) Bilateral SS removal severely retarded relearning in all four lesion groups.

The rats that received sham operations then were subjected to removal of a large amount of neocortex anterior and posterior to the SS areas. This only marginally affected performance. SS cortex was then ablated and severe performance decrements resulted. Interestingly, removal of additional neocortex in rats that originally learned after SS lesions resulted in extremely poor retention.

These data show the importance of SS cortex in mediating tactile discriminations, and suggest that non-SS cortex may in some way play a role in recovery after SS lesions. Failure to differentiate between Ss with one-stage and two-stage lesions of the SS cortex is believed to reflect the difficulty of the present tactile discrimination.

203 ADVANCED DEVELOPMENT OF PROSTHETIC ARM CONTROL BY PATTERN RECOGNITION. By F. Ray Finley, * Roy W. Wirta, * and Donald R. Taylor, Jr.* (SPON. John S. Way) Department of Rehabilitation Medicine, Temple University Health Sciences Center, Philadelphia, Pa. 19140.

A first prototype of a prosthetic arm, externally powered and controlled by pattern recognition of myoelectric signals, has been designed, assembled, and tested. The prototype is an advanced design of an engineering model presented a year ago at the Society for Neuroscience meeting in San Diego. The prosthesis enables an above-elbow amputee to control and coordinate eight movements about four axes. The new model presents improvements in socket and harness attachment, weight, electronics packaging, and physical dimensions of the articulating segments. These improved mechanical properties facilitate the system's movement control quality and are therefore consistent with a major design objective, to assure control that is effected in a natural physiologic manner. Previous work on the artificial arm system had assured compatibility between central nervous system requirements for smooth control and the control electronics operation.

The conceptual rationale underlying the arm's design and function will be discussed, and a motion picture depicting the present level of performance will be presented.

204 PRECURSOR DEPENDENT TURNOVER MEASURES OF PROTEINS IN MYELIN AND MYELIN-LIKE MATERIAL DURING DEVELOPMENT. Carolyn A. Fischer* and Pierre Morell, Dept. Neurology, Albert Einstein Coll. Med., Bronx, N.Y. 10461 and Dept. Biochem. and Biol. Sci. Res. Ctr., U.N. Carolina, Chapel Hill, N.C. 27514.

Mice 15 days of age were injected intraperitoneally with C^{14} glucose at a dose of 20 μC/g, divided into 4 injections given at 12 hour intervals. Pairs of animals were decapitated at 30, 45 and 60 days of age. The glucose labeled animals remaining at 60 days were labeled with a second isotope (H^3 leucine at 60 μC/g, injected as above) and sacrificed at 80, 100, 120, 150 and 180 days of age. Crude myelin was isolated from individual animals on discontinuous sucrose gradients. Myelin was separated from the associated myalin-like material by osmotic shock, the two fractions were purified by differential centrifugation and isolated on a continuous CsCl gradient. The basic, proteolipid, and high molecular weight proteins of each subcellular fraction were separated by gel electrophoresis and specific activities determined with respect to H^3 and C^{14}. On the basis of radioactivity derived from C^{14} glucose, the turnover rates of basic and proteolipid proteins of myelin were about 45 days and that of the high molecular weight proteins about 40 days (results similar to those of M.E. Smith, 1972, Neurobiol. 2, 35). The half life values derived from H^3 leucine were about 95 days for myelin basic and proteolipid proteins, in confirmation of our previous results (Brain Res., in press). The corresponding result for half lives of high molecular weight myelin proteins was 40 days. In each case the myelin-like proteins turned over more rapidly than the corresponding myelin proteins. The apparent half lives of myelin proteins vary depending on the particular radiocompound used as precursor, as well as the age of the animal when the isotope is integrated into protein. (Supported by Public Health Service Grants NS-09094, NS-03356, MH-06418 and a grant from the Alfred P. Sloan Foundation.)

205 BINOCULAR VISION AND PREY-CATCHING BEHAVIOR IN THE LEOPARD FROG, RANA PIPIENS. Katherine V. Fite and Marie Rego*, Dept. Psychol., Univ. of Mass., Amherst, Mass., 01002.

The total binocular field-of-view in anurans is the most extensive yet described for vertebrates (Fite, 1974). Rana pipiens has an unusually large frontal, lateral, superior and posterior binocular field and is capable of detecting and orienting to prey (live mealworms) located anywhere along a 360° circumference surrounding its body. Systematic observations have shown an increasing number of pre-strike bodily orientations for prey located from 45° to either side of the frontal midline, reaching a maximum at 180° (directly behind the body). Prey-catching error rates--hit or miss on the first strike, are approximately 1% under these conditions.

Monocular blinding (unilateral enucleation) produced a marked change in the number of pre-strike orientations for those prey locations which would normally fall within the frontal and lateral binocular field-of-view. A marked increase in first-strike error rate was also observed, from 20-25%. Neither effect of monocular blinding appeared to recover with time or "practice", contrary to previously published reports.

Central correlates (retinotopic projections, anterior thalamus lesions, and tectal commissural section) provide further relevant data for understanding the role of central binocular pathways in orienting and prey-catching behaviors in anurans, and may further serve as an important model for elucidating the role of binocular vision in visually-guided behaviors in non-mammalian vertebrates.

206 EVIDENCE FOR A TIME VARYING PROCESS THAT DETERMINED MEMBRANE CONDUCTANCE IN THE INTERSPIKE INTERVAL. J. Fohlmeister*, R.E. Poppele and R.L. Purple. Lab of Neurophysiol., Univ. of Minn., Minneapolis, MN 55455

In modeling repetitive firing in tonic sensory neurons, the assumption that the membrane behaves like an RC integrator in the subthreshold region has been sufficiently successful to indicate that an RC type of loading is consistent with observed behavior. Further studies showed that the value of equivalent RC is a function of the duration of the interspike interval. The charging curve of an RC circuit follows $\dot{V} = -\gamma V + I/C$ (V = voltage, I = current and $\gamma = (RC^{-1})$. Assuming that the dominant changes in the interspike occur in a voltage and time dependent R, deep hyperpolarizing pulses of 3 msec duration were placed at different points in the interval. With the same constant current I, the tonic firing frequency first increased and then decreased as a function of pulse position with the crossover point around 10 milliseconds into the interval. Since the effect of a hypolarizing pulse is to reduce γ, this result was interpreted that γ is large immediately following a spike and small for the remainder of the interval. γ was therefore modeled to follow $\dot{\gamma} = -B\gamma + DV$ with γ ($t=0$) large and appropriate values for B and D. Small amplitude sinusoidal currents were then superimposed on constant I and gain and phase data as a function of sinusoid frequency were derived for both the model and the neurons. Phase data, which are particularly sensitive to variations in γ indicated the model to be in agreement with cell behavior. (Supported by NIH grants EY-293 and NS-11695 and by AFSC-1221.)

207 RESPONSES OF SQUIRREL MONKEY AUDITORY CORTEX NEURONS TO VOCALIZATIONS: CHANGES PRODUCED BY MICROIONTOPHORESIS OF PUTATIVE NEUROTRANSMITTERS. Stephen L. Foote, Robert Freedman* and A. Paul Oliver. Lab. of Neuropharmacology, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032

The effects of the putative neurotransmitters norepinephrine (NE), gamma-aminobutyric acid (GABA), and acetylcholine (ACh) were tested on auditory cortex neurons in awake squirrel monkeys listening to species-specific vocalizations. 5-Barrel glass electrodes were used to record the activity of single neurons in the superior temporal gyrus and to apply NE, GABA, or ACh microiontophoretically. Post-stimulus time histograms and raster displays of neuronal responses to the vocalizations were computed before, during, and after transmitter application. Dose-dependent inhibition of spontaneous and vocalization-evoked discharge rates was seen with NE and GABA. Excitation was generally observed with ACh. A given dose of NE or GABA reduced spontaneous activity by a greater proportion than activity evoked by the vocalizations. Within a response, segments with lower discharge rates were reduced proportionately more than segments with higher discharge rates. In several cases this differential inhibition resulted in an alteration of the "pattern" of a vocalization response. The demonstration that small amounts of locally applied NE and GABA substantially alter the specific neuronal activation produced by vocalizations provides additional evidence that these agents may function as neurotransmitters in this neocortical area. Possible sources of synaptic inputs to these auditory cells were demonstrated by retrograde transport of horseradish peroxidase injected into the gyrus. One observed projection from the NE-containing cells of the locus coeruleus is further evidence that this chemical plays a physiologic role in determining auditory responses in the neocortex.

208 Effect of Chronic Protein Malnutrition on Ontogeny of Transcortical Evoked Potentials in Rats. William B. Forbes, Warren C. Stern, Peter J. Morgane, Thomas L. Kemper*, Christopher D. West*, and Oscar Resnick*. Neurophysiol. and Psychopharm. Labs., Worcester Fdn. Exp. Biol., Shrewsbury, MA., 01545.

As an index of cortical maturation, the transcortical evoked potential (TCEP) has the advantages of being independent of sensory receptor processes and a relatively well-defined neuronal etiology. We studied the TCEP in rats born of dams fed either a low (8%) or normal (25%) protein diet beginning 5 weeks prior to mating and throughout gestation and lactation. After weaning, pups were fed the same diets as their mothers. Bipolar (surface vs depth) stainless steel stimulating and recording electrodes were positioned at corresponding loci in right and left sensorimotor cortices (area 10) 2.5 mm anterior to Bregma and 2.5 mm lateral from the midline. TCEPs were measured under urethane anesthesia using twice threshold bipolar pulses of 0.1 msec duration at ages 3, 21 and 60-65 days (adult). At 13 and 21 days the first 3 components of the TCEP showed 5% to 20% longer latencies in low protein rats while at adulthood no latency differences were seen. There were no correlated effects of diet at the young ages upon CNS myelinization based on tinctorial density as shown in Loyez's stained sections. Results to date show that post-stimulation excitability (15-100 msec range) was not affected at adulthood by the dietary treatment. These results are interpreted as corroborating previous reports of a similar nature in rats undernourished during development using sensory evoked potentials. By avoiding the use of extrinsic sensory stimulation the present study demonstrates a dietary effect upon ontogeny of cortical evoked potentials independent of any possible effect on sensory receptor mechanisms.

This research was supported by Grants MH 10625 and NICHD 06364.

209 MULTIMODAL RESPONSIVENESS OF INDIVIDUAL SPINOTHALAMIC TRACT NEURONS IN THE MONKEY. R.D. Foreman, R.A. Maunz, A.E. Applebaum*, J.E. Beall* and W.D. Willis, Marine Biomedical Institute and Dept. of Anatomy, Univ. of Texas Med. Branch, Galveston, Texas 77550

Cells of origin of the spinothalamic tract in the lumbosacral spinal cord of anesthetized monkeys were identified by antidromic activation of their axons in the contralateral caudal diencephalon. The responses of the cells to natural stimulation of the skin of the hindlimb were determined. A servo controlled vibrator was used to produce ramp or step deflections of the skin or of individual hairs. A given neuron could often be activated by hair movement, by gentle mechanical stimulation of the skin and also by intense mechanical stimulation of the skin. In addition, there was usually an additional response to intense thermal stimulation. The responses to mechanical stimulation of a given neuron could signal several different properties of the stimulus. For instance, when a single hair was moved, the neuron might discharge only at the onset (and the termination) of a ramp displacement, suggesting that the cell detected acceleration (or a higher derivative of position). The same neuron could respond with a constant discharge during a ramp indentation of the glabrous skin, indicating velocity detection. Furthermore, a substantial maintained indentation of the skin could result in a maintained discharge signaling pressure (or possibly displacement). These results indicate that individual spinothalamic tract cells are capable of coding for a number of different mechanical and thermal signals. (Supported by NIH Grant NS 09743, Training Grants NS 05743 and GM 00459 and the Moody Foundation of Galveston.)

210 MOVEMENTS OF ORGANELLES IN FROG AXONS STUDIED BY TIME-LAPSE CINEMICROGRAPHY AND COMPUTER ANALYSIS. David S. Forman, Ante L. Padjen and George R. Siggins. Lab. of Neuropharmacology,NIMH,St.Elizabeths Hosp., Washington, D.C. 20032.

Spontaneous movements of subcellular particles within axons can be visualized in suitable in vitro preparations by phase, darkfield, or Normarski differential interference-contrast microscopy. These movements are believed to represent the rapid axonal transport of particulate organelles. Particle movements were studied in myelinated and unmyelinated axons teased from adult frog sciatic nerves, and in axons of cultured sympathetic and dorsal root ganglia from adult frogs. The movements were recorded by time-lapse cinemicrography, measured with an L-W Photo-Optical Data Analyzer, and analyzed on a PDP-12 computer. In the teased axons, particles appear to move in "channels" in a saltatory manner. They move in both retrograde and anterograde paths, and may reverse direction, but most particles move in a single direction. The particles show a range of velocities; the fastest ones move at speeds compatible with rapid axonal transport. In the neurites of the cultured ganglia, the moving organelles produce bulges at the surface of the fine fibers. They exhibit saltatory, bidirectional movements similar to those observed in the neurites of cultured mammalian cerebellar neurons (Forman,Siggins and Lasher, Soc.for Neurosci. Third Ann.Meeting: Abstract 13.1,1973). Present computer analyses focus on comparison of the movements of different particles in a single fiber, measuring the velocities of retrograde and anterograde movements, and comparing movement patterns in different types of fibers.

211 HIPPOCAMPAL EEG ACTIVITY AND MOTOR BEHAVIOR IN THE RAT. C. J. Frederickson and K. Asin* Carnegie-Mellon University, Pittsburgh, Pa. 15213

It has been reported that the execution of certain overt movements such as locomotion and bar pressing is invariably accompanied by EEG theta activity (6-12 hz regular waves) in hippocampus of rat. The present experiments were performed to determine whether rats could be induced to perform some of those movements without generating hippocampal theta waves. Adult rats bearing chronically implanted hippocampal and lateral hypothalamic electrodes were used. In the first experiment rats were shaped to bar press for a milk reward on an FR 50 schedule. After up to six weeks running on the task, the rats still showed clear hippocampal theta activity while bar pressing. Thus prolonged practice of the motor act did not seem to affect the appearance of theta. In the second experiment rats were trained to execute body turns for hypothalamic stimulation reward; recorded after up to two months daily running on that task, the animals showed clear theta during body turns. Thus even when not directed towards any external stimulus object, locomotor turning was associated with theta activity. Finally, electrodes aimed at the raphe nuclei were used to produce lesions to produce the symptom of obstinate progression. Animals that developed the symptom showed essentially continuous hippocampal theta during the stereotyped locomotor movements characterizing the symptom. Together these results suggest that in rats theta activity depends closely upon the pattern of motor behavior exhibited by the animal and is largely independent of the environmental and motivational factors precipitating or controlling the behavior.

212 NEUROLEPTIC ANTAGONISM OF CATECHOLAMINE INHIBITIONS IN RAT CEREBELLUM AND CAUDATE. R. Freedman*, B. J. Hoffer*, and G. R. Siggins. Lab of Neuropharmacology, SMR, IRP, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032

Neuroleptics are thought to exert clinical and behavioral effects by interaction with brain monoamine pathways. The potent neuroleptics fluphenazine (FPZ) and flupenthixol (FPT) were tested against two model central catecholamine systems: the noradrenergic inhibition of Purkinje neurons in rat cerebellum arising from locus coeruleus and the dopaminergic inhibition of caudate neurons arising from substantia nigra. FPZ and alpha-FPT antagonized these catecholaminergic inhibitions in over two-thirds of the cells in both systems tested by microiontophoresis. No direct effects nor antagonisms of inhibitions produced by gamma aminobutyric acid (GABA) were noted at doses which block norepinephrine (NE) or dopamine (DA). Chlorpromazine also antagonized DA in caudate, but could not be tested in cerebellum because of local anesthesia. Sotalol (MJ-1999), a beta receptor blocker, antagonized NE in cerebellum, but not DA in caudate. Beta-FPT, the behaviorally inactive isomer, was less effective against NE than alpha-FPT. Parenteral FPZ antagonized adrenergic inhibitions in cerebellum from locus coeruleus stimulation, but did not affect inhibition from activation of basket and stellate cells. NE and DA may act through stimulation of cyclic adenosine monophosphate (cyclic AMP) formation in their target neurons. Iontophoresis of cyclic AMP produced inhibitions in both neural systems which were not antagonized by neuroleptics. This finding is compatible with biochemical evidence that therapeutic neuroleptics can block the catecholamine stimulation of adenyl cyclase and suggests that this action may underlie the behavioral effects.

213 PRESYNAPTIC INHIBITION IN THE RAT OPTIC TECTUM. John A. Freeman and T.J.Cunningham* Departments of Anatomy and Psychology, Vanderbilt University, Nashville, Tennessee 37240

We have recorded long duration excitability changes in the terminals of optic nerve fibers of hooded rats. Excitability changes were tested for in urethane anesthetized rats with visual cortex removed, using Wall's technique (J.Physiol.142,1958),by plotting the increase in the antidromic optic nerve response, or decrease in the orthodromic tectal response following conditioning stimuli delivered to a)optic tract,b)contralateral stratum opticum, or c)ipsilateral tectum. The magnitude of excitability changes was studied as a function of 1)delay between conditioning and test stimuli, 2) stimulus intensity, and 3)rate and duration of tetanizing conditioning stimuli. We found 3 classes of optic nerve fibers; maximum potentiation effects were on the slower two fiber populations,and occurred when the conditioning stimulating microelectrodes were located just below the stratum opticum. Pronounced potentiation of the slow fiber terminals of one tectum were produced by volleys over the fast fiber population supplying the other tectum. The very short onset of the effect suggested that it was mediated by branched optic nerve fibers, via an axon reflex. We conclude that excitability effects, which modulate transmission presynaptically, are mediated by primary afferent depolarization of retinal ganglion cell terminals, which are likely to exert profound effects on responses of tectal neurons. Because synapses onto retinal ganglion cell terminals are apparently lacking in the rat optic tectum (Lund, J.Comp.Neurol. 135,1969) other mechanisms,e.g.,accumulation of extracellular potassium, are likely to account for the effect. (Supported by N.I.H.Grants EY 54,034,EY 0017, and EY 40240.)

214 EVOKED POTENTIAL CORRELATES OF PHONOLOGIC INFORMATION PROCESSING. David Friedman*, Richard Simson*, Walter Ritter* and Isabelle Rapin. Dept. Neurol. Albert Einstein Coll. Med., Bronx, 10461.

The late positive component(LPC or P_3)of the averaged evoked potential elicited by real speech words was recorded from vertex and temporoparietal electrode sites in a vigilance paradigm. Subjects were required to respond(with a reaction-time lift-off)to one word(the Signal)among four words differing by one acoustic segment(e.g., pick, pack, pit, tick). On alternate runs the subject was required to withold his response to the Signal and respond to the Non-Signals. P_3 component latency to the four different words depended upon which word served as Signal and reflected the time of occurrence of the critical segment in the word. Results were the same whether the subject responded to or witheld his response to the Signal word. P_3 latency and reaction time were highly correlated as has been shown by Ritter et al(1972). The findings of this experiment replicated the "information delivery" effect originally reported by Sutton et al(1967)and extended it to verbal material. These data bear on the perception of speech at the phonemic level and on the utility of the late components of the averaged evoked potential in the study of information processing in linguistic experiments.

This research was supported in part by Grants NS 3356, NS 2503, 2T1 NS5325 from NINDS, and MH 06723 from NIMH, US Public Health Service.

215 CATECHOLAMINE HISTOFLUORESCENCE IN TRAUMATIZED SPINAL CORD.
S. J. Friedman*, W. G. Bingham, A. O. Humbertson, Jr. Depts. Anat. and Surg., Ohio State Univ. Med. Sch., Columbus, Ohio 43210

Accumulation of norepinephrine (NE) in injured spinal cord tissue has been implicated as a factor in augmenting the effects of trauma. Fluorescence microscopy was utilized to study this hypothesis in rhesus monkeys. Blunt trauma to midthoracic spinal cord was produced by dropping a 20 gm. weight 15 cm. onto the exoposed dura. Segments of upper and lower thoracic cord and tissue from non-traumatized animals served as controls. One hour after injury the segments were removed, frozen in liquid nitrogen, lyophilized for 1 week, fixed in paraformaldehyde vapor and embedded in paraffin. Sections were examined with a Leitz fluorescence microscope. NE was readily identifiable as green fluorescent varicosities throughout the central gray, particularly intense in the lateral horn. Groups of parallel varicosities were noted especially in the dorsal horn and around the central canal. Trauma obliterated NE fluorescence in areas of hemorrhage and edema. There was no diffusion of catecholamine within or around injured tissue nor surrounding blood vessels. Intense fluorescence of lateral horn was markedly decreased. Results indicate that: 1) NE fluorescence decreases in central gray following trauma; 2) there is no indication that NE activity accumulates or that it augments the pathological changes occurring after injury.

216 EVIDENCE FOR AN AXONAL INFLUENCE, DISTINCT FROM AXONAL SIZE, ON THE THICKNESS OF THE MYELIN SHEATH. Victor L. Friedrich, Jr.* and Enrico Mugnaini. Dept. of Biobehavioral Sciences, Univ. Connecticut, Storrs, 06268.

The axon of the Purkinje cell of cerebellar cortex is myelinated. In the mouse, it can be distinguished from other myelinated cerebellar axons by its content of abundant, flattened cisternae of agranular endoplasmic reticulum. By contrast, the cerebellar afferents, mossy and climbing fibers, generally contain little agranular endoplasmic reticulum in their myelinated parts.

The myelin sheaths of Purkinje cell axons are significantly thicker than those of nearby climbing and mossy fibers of the same size. In intrafolial white matter of 400-day-old mice, the sheaths of Purkinje cell axons 0.8–1.0 μ^2 in cross section averaged 24 lamellae (S.D. = 3.4; n = 19). The sheaths of mossy and climbing fibers (pooled) of the same cross section averaged 12 lamellae (S.D. = 2.5; n = 24; $p < .005$ by t-test). Comparable differences were found in other size classes. Linear regression analysis of sheath thickness versus axonal size for each population yielded similar slopes, but the intercepts differed.

Similar differences between Purkinje cell axons and cerebellar afferents occur in the cerebella of chickens and turtles.

The thickness of the myelin sheath has previously been correlated with axonal size. These results show that sheath thickness can also depend on other properties of the target axon. Such properties might be the distance from the perikaryon, the time of onset of myelination, the degree of axonal branching, or axonal metabolic or surface characteristics.

(Supported by NIH Grant NS-09904.)

217 PATTERN OF THALAMIC PROJECTIONS TO THE NEOCORTEX OF NORMAL AND REELER MUTANT MICE. D. O. Frost* and V. S. Caviness* (Spon.: W. J. H. Nauta). Dept. Psych., M. I. T., Cambridge, Mass. 02139, and E. K. Shriver Inst., Harvard Medical School, Waltham, Mass. 02154.

The neocortical malformation in reeler mutant mice is characterized by the absence of a subpial cell-free zone and inversion of the relative position of polymorph and pyramidal cell classes; granule cells are segregated at a normal intermediate level within the pyramidal cell field. The relative prominence of homologous cell and fiber elements is similar in corresponding cortical areas of normal and reeler. Lesions were placed in the dorsal lateral geniculate nucleus (LGd) by a transcerebellar approach; after 4 days, animals were perfused, and the brains were stained using the Fink-Heimer method. In both normal and reeler, the projection from LGd is restricted to the cortical region considered from cell and fiber criteria to be area 17. In the normal mouse, geniculocortical axons pass from the central white matter to traverse the deepest, or polymorph, cell stratum before ascending to reach their major zone of termination, the granule cell layer of area 17. In the reeler, the polymorph cell zone anomalously forms the most superficial cortical layer (extending to the pial surface and thus obliterating the plexiform layer); in this strain the geniculocortical fibers ascend in discrete fascicles obliquely through the full thickness of the cortex and, having traversed the polymorph cell zone to area 17, recurve to enter the granule cell layer on a descending curve. Thus, in reeler as in normal mice, thalamic fibers to area 17 traverse the deepest, or polymorph, cell zone before terminating in the granule cell layer, despite the inversion of polymorph and pyramidal cell classes in the reeler. In reeler, the fibers accomplish this by following an abnormal trajectory.

218 SINGLE UNIT FIRING PATTERNS IN THE VESTIBULAR NUCLEI OF ALERT RHESUS MONKEYS ASSOCIATED WITH PASSIVE WHOLE BODY ROTATION, EYE MOVEMENTS, AND ATTEMPTED HEAD MOVEMENTS. J. H. Fuller and F. A. Miles, Lab. Neurophysiology, NIMH, Bethesda, Md. 20014.

Single units were recorded in the medial and superior vestibular nuclei of alert Rhesus monkeys seated in a servo-driven chair which could oscillate about a vertical axis. Animals' heads were bolted to the chair during recording sessions and unit activity was examined in relation to 1) chair oscillation, 2) eye movements, and 3) attempted head rotations (as indicated by strain gauges monitoring torque in the head mounting; even animals whose heads have been habitually immobilized over a prolonged period in the experimental situation still attempt some, albeit weak, head movements, and such gestures are often tightly coupled to eye movements). Many neurons fired strongly in association with these 3 parameters, but since the latter normally show considerable covariance it was necessary to train animals on a visual fixation task which made it possible to set up a variety of behavioral paradigms in which the various factors were dissociated from one another. In these circumstances, it was clear that activity could be related to each of the 3 parameters, most individual units firing consistently in association with only one, but some with two. Among the latter were neurons which seemed to receive a powerful input from the semicircular canals because they modulated nicely in phase with chair velocity during sinusoidal oscillations, yet they also clearly discharged in relation to eye movements or attempted head movements when the chair was stationary, e.g., a neuron might fire both during passive movements of the chair in a particular direction and also when the animal actively attempted to turn its head in the converse direction. These data strongly suggest that neurons in the vestibular nuclei mediate centrally programmed, as well as vestibularly induced, eye and head movements.

219 PREVENTION AND REVERSAL OF 4-CHLOROAMPHETAMINE ACTION BY INHIBITING ITS UPTAKE INTO SEROTONINERGIC NEURONS: EVIDENCE FOR REVERSIBLE AND IRREVERSIBLE PHASES OF BRAIN SEROTONIN DEPLETION. Ray W. Fuller, Kenneth W. Perry* and Bryan B. Molloy*. Lilly Res. Labs., Indianapolis, Ind. 46206

The lowering of rat brain serotonin (5HT), 5-hydroxyindoleacetic acid, and tryptophan hydroxylase by 4-chloroamphetamine was prevented by pretreatment with Lilly 110140 (3-[p-trifluoromethylphenoxy]-N-methyl-3-phenylpropylamine HCl), a specific inhibitor of the uptake pump on the 5HT neuronal membrane. Apparently the inhibitor blocked the entry of 4-chloroamphetamine into the 5HT neuron. In addition, the effects of 4-chloroamphetamine could be reversed by injecting 110140 at a later time. At four hrs after 4-chloroamphetamine, when 5HT and tryptophan hydroxylase levels were lowered, injection of the uptake inhibitor caused 5HT and tryptophan hydroxylase levels to return to normal. The rate of increase in 5HT levels correlated closely with the turnover of 5HT in rats treated with the uptake inhibitor alone, implying that the inhibitor had abruptly terminated the action of 4-chloroamphetamine. These results suggest that continual reuptake of 4-chloroamphetamine into the 5HT neuron is required for the depletion of 5HT levels to persist. Brain 5HT levels in rats treated with 4-chloroamphetamine alone remain low for months. Whereas the depletion of 5HT levels by 4-chloroamphetamine is reversible at early times after 4-chloroamphetamine, progressively less reversibility occurred when the uptake inhibitor was injected at 8, 16, and 24 hrs after 4-chloroamphetamine, and no reversibility was observed when the uptake inhibitor was injected at 32 or 48 hrs after 4-chloroamphetamine. These data indicate there are both reversible and irreversible phases of serotonin depletion after 4-chloroamphetamine treatment. The irreversible long-lasting depletion of serotonin may result from a neurotoxic action of 4-chloroamphetamine or a metabolite formed from it.

220 ELECTROPHYSIOLOGIC AND VASCULAR MEASUREMENTS OF THE CAT'S RETINA EXPOSED TO X-IRRADIATION. C. T. Gaffey, Donner Laboratory, University of California, Berkeley, CA. 94720

Adult male cats are anesthetized with Ketalar (ketamine hydrochloride, 22 mg/kg) and have their pupils dilated with atropine sulfate (1%). A tracheal cannula is installed and animals are ventilated artificially with the onset of paralysis by Flaxedil (gallamine triethiodide, 7 mg/kg/hr) or tubocurarine chloride (3 mg/kg/hr) delivered through an indwelling catheter in the femoral vein. Corneal contact electrodes in each eye detect the electrical discharge of the retina (ERG) to light flashes. The head of each test animal is held immobile in a stereotaxic instrument during photic stimulation, X-ray treatment, and fundus camera studies. Injections of 10% sodium fluorescein permit the use of retinal angiography. A beam of 200 kV X-rays (4 x 6 cm field) intercepts one eye perpendicular to the visual axis; the normal eye serves as a control. Photic stimulation is presented as single, independent flashes and as paired, doubled flashes. The interval between double flashes can be varied from 60 to 300 msec. The b-wave of the ERG is completely suppressed after the absorption of about 3,000 rad of X-rays by the eye. Normal fundus photography and retinal angiography do not support the view that radiation blindness here is a consequence of retinal vascular insult. Experiments employing paired light flashes during irradiation indicate that the retina is most sensitive during the relative refractory period to X-rays.

This work was performed under the auspices of the U.S. Atomic Energy Commission and the National Aeronautic and Space Administration.

221 ACUTE EFFECTS OF TETRAETHYL LEAD ON AVOIDANCE AND WEIGHT IN WEANLING RATS. Michael I. Gage and Donald A. Fox*. U.S. Environmental Protection Agency, Cincinnati, Ohio 45268, and Dept. of Environmental Health, Univ. of Cincinnati, Cincinnati, Ohio 45219

Male rats were injected I.P. with 0, 4, 8, or 16 mg/kg tetraethyl lead (TEL) within one week of weaning. The rats were trained on a one-trial, passive avoidance learning task either 24 or 48 hours after the lead injection or just prior to the injection. During this task, when a rat stepped into a dark compartment from a light compartment it received an electric shock to its feet. Memory of this test was examined 24 hours after training. TEL did not affect retention of passive avoidance learning. The rats did experience weight losses after TEL injections that were dose related. The 16 mg/kg was verified to be just above the LD_{50} value.

222 PERMANENT PERCEPTUAL AND NEUROPHYSIOLOGICAL EFFECTS OF VISUAL DEPRIVATION IN THE CAT. Leo Ganz and M. Ellen Haffner*. Dept. Psychol., Stanford Univ., Stanford, CA. 94305.

The purpose of the present study was to analyze recovery of visual perception in kittens whose deprived eye had permanently lost access to most selective cortical neurons. Twelve kittens were reared monocularly for 3 months or more; then the deprived eye was opened and the experienced eye was shut (cross-suture treatment) in an attempt to push recovery. Monocular training through the deprived eye was administered on a series of discrimination problems and transposition tests. Some recovery from the monocular deprivation was evident. These kittens learned an orientation problem (horizontal vs. vertical stripes) in an abstract manner. However, on the form problem (upright vs. inverted triangle) they were still noteably deficient when compared to normal controls: (1) Acquisition of the form problem was shown to be strongly dependent on flux cues and (2) Interocular transfer was deficient. Microelectrode analysis revealed no discernible recovery. We conclude that form perception with a normal degree of stability in the presence of environmental changes appears to depend on cortical neurons with form-selective receptive fields.

223 CAUDATE RESPONSES TO NIGRAL STIMULATION AFTER MFB LESIONS. E. Garcia-Rill, M.S. Levine, C.D. Hull, N.A. Buchwald and A. Heller. Depts. of Psychiatry & Anatomy, Ment. Retard. Res. Ctr., UCLA, NPI, Los Angeles, Calif. 90024 and Dept. of Pharmacology, University of Chicago, Chicago, Ill.

Unilateral lesions were made in the medial forebrain bundle (MFB) of cats. These were designed to interrupt all nigrostriatal fibers in this region, and to deplete dopamine (DA) in the ipsilateral caudate nucleus (CN). Stimulating electrodes were placed bilaterally in the substantia nigra (SN), and computer-averaged evoked potentials were recorded bilaterally from the heads of the CNs. Following recording the CNs were removed from the brain and analyzed for DA. Over 90% depletion occurred on the side ipsilateral to the lesion. Recordings were made at various points within the CN. The greatest amplitude potentials were recorded in the dorso-medial region of the CN. There was little variation between the two CNs. Evoked potentials elicited in the ipsilateral CN by SN stimulation on the lesioned side did not differ significantly in amplitude or waveform from those elicited in the opposite CN by SN stimulation on that side. Comparison with control animals showed that interindividual variations in evoked potentials in lesioned cats were not different from those in control cats. Although the SN is known to account for the high DA concentration in the striatum, pharmacological depletion of DA does not abolish unitary evoked activity in the CN to SN stimulation. Pharmacological treatment, however, does not necessarily block non-dopaminergic transmission within the nigrostriatal bundle. The SN may still influence activity in the SN via a number of anatomically delineated pathways. The possibility of a direct non-dopaminergic nigrostriatal link outside of the MFB also exists.

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224 VOLTAGE-CLAMP ANALYSIS OF THE CONDUCTANCE CHANGE UNDERLYING A CHOLINERGIC IPSP IN APLYSIA. Daniel Gardner and Charles F. Stevens. Dept. of Physiol., Cornell U. Medical College, New York, NY 10021, and Dept. of Physiol. & Biophys., University of Washington, Seattle, Wash. 98195.

Using a voltage clamp, we have studied the acetylcholine-mediated postsynaptic conductance underlying an inhibitory synapse between identified neurons in the buccal ganglia of Aplysia californica. The postsynaptic current (PSC) decayed as a single exponential with time constant τ=12 msec. Both τ and the peak conductance of 0.5 μmho were invariant with membrane potential over a 120 mv range. The IPSP predicted from a PSC and neuron membrane properties was compared to an IPSP recorded in the same cell.

We have attempted to define the rate-limiting step responsible for PSC decay. The Q_{10} of τ was between 3 and 4, suggesting a non-diffusional process for PSC decay. Prostigmine increased τ by 1.7±0.3-fold, without significant effect on peak conductance. The combined effect of prostigmine and cooling increased τ to 150 msec. This greatly prolonged decay suggests that ACh hydrolysis is not the rate-limiting step determining τ, as ACh removal by diffusion would almost certainly be faster. In order to distinguish between transmitter release and relaxation kinetics of the ionic channel as the rate-limiting step, we injected tetraethylammonium ions into the presynaptic neuron. This increased the duration of the presynaptic spike from 2 to greater than 20 msec. Although the PSC peak was concomitantly broadened, τ did not increase significantly. We therefore suggest that the rate-limiting step in PSC decay may be the relaxation of open ionic channels in the postsynaptic membrane. Like other features of these synapses, the time course of a synaptic current may thus be determined by properties of the postsynaptic, rather than the presynaptic neuron. Supported by USPHS grants NS05082, NS05934, NS10492, and NS11555 from NIH-NINDS.

225 FASTIGIAL UNIT RESPONSES IN ALERT MONKEYS TO NATURAL VESTIBULAR STIMULI. Esther P. Gardner and Albert F. Fuchs Dept. of Physiology & Biophysics & Regional Primate Research Center, Univ. of Washington, Seattle, Wa. 98195

To study cerebellar control of the vestibular-ocular reflex (VOR) pathway, we recorded responses of 614 cerebellar nuclear cells in awake monkeys to natural vestibular stimuli and to eye movements. Cells in the rostral part of the fastigial nucleus were excited by contralateral horizontal angular acceleration and inhibited by ipsilateral rotation (Type II_f neurons). <25% of fastigial neurons (FNs) were excited by ipsilateral rotations and inhibited by contralateral rotations (Type I_f). None were sensitive to eye movements. Sinusoidal horizontal rotation (0.2-4.8 Hz) produced distinct sinusoidal modulation of the tonic firing rates of FNs. Excitatory and inhibitory phases of the response were fairly symmetric about the spontaneous level at low stimulus frequencies. High Hz ipsilateral rotations silenced most FNs so that the increase in firing during the excitatory half of the cycle was greater than the decrease below spontaneous in the inhibitory half. The majority of FNs (Type II_f) seem to work in parallel with flocculus Purkinje cells to functionally inhibit Type I vestibular neurons. Fourier analysis was used to compute gains, phase shifts and harmonic distortion. Over a 20-fold stimulus frequency range (0.2-4.0 Hz), mean phase lags of the responses of Type II_f neurons with respect to applied acceleration remained relatively constant; phase lag at 0.9 Hz measured 62±13 deg. Gain decreased with increasing frequency at 18 db/decade. Type II_f FNs therefore provide a signal to the vestibular nuclei which is in phase with the direct input from the 8th nerve, although functionally opposite in sign. Almost all Type I_f neurons had phase shifts greater than 90 deg at 0.9 Hz; their mean phase lag was 108± 30 deg. This small population of FNs has the requisite phase properties to perform the postulated second integration in the VOR pathway.

226 DYSTONIAS ELICITED BY AN ANTIPSYCHOTIC AGENT IN RELATION TO PLASMA AND RED BLOOD CELL LEVELS OF BUTAPERAZINE. David L. Garver, Haroutune Dekirmenjian, John M. Davis, and Frank D. Jones*. Ill. State Psych. Inst. and Univ. of Chicago, Dept. of Psychiatry, Chicago, 60612.

Plasma and red blood cell (RBC) levels of the phenothiazine derivative butaperazine (BPZ) were studied in schizophrenic subjects after an acute 40 mg tablet. RBC levels were studied because RBC's provide an easily obtainable peripheral tissue which might be a better reflection of drug concentration in brain tissue than plasma can provide. Severe dystonic reactions occurred in four of eight subjects 24-30 hours after the administration of the single 40 mg dose of BPZ. Since the half-life of BPZ in these subjects with dystonic reactions was 8.9 hours (plasma) and 8.6 hours (RBC), the dystonic reactions occurred at approximately three half-lifes after administration, at which time RBC and plasma levels were falling from peak levels some 16-28 hours before. This suggests that dystonias are a phenomena which may occur due to rebound or other secondary response late in time after acute drug peak. RBC BPZ levels 24 hours after the single dose of BPZ in those patients with and without dystonias was 11 and 4 ng/ml respectively. Previously at four hours after BPZ, RBC BPZ was 230 ng/ml in the subjects who later developed dystonias and 30 ng/ml in those who did not. Our findings suggest that dystonias are a phenomena which occur late in time after the acute drug peak and may be due to rebound or other secondary response in subjects who earlier developed high RBC levels of BPZ.

227 A NEGATIVE ELECTROGENIC PUMP IN FROG MUSCLE. Donald Geduldig and David R. Livengood. Dept. Biophys., Univ. of Md., School of Med., Baltimore, 21201 and Neurobiology Dept., AFRRI, Bethesda, Md. 20014.

Addition of strophanthidin to the Na- and K-free (tris-substituted) solution bathing Na-enriched muscles results in a large hyperpolarization. If the main effect of strophanthidin in these studies is to inhibit an electrogenic pump, then it must be concluded that before addition of the drug, the pump depolarizes the membrane suggesting a Na:K-pump ratio less than unity. This contrasts with the usual observation that cell membranes generally have hyperpolarizing electrogenic pumps which are caused by a Na:K-pump ratio greater than unity. These direct electrical measurements suggest that the enzyme machinery responsible for the active transport of Na and K is not always obligated to extrude Na out of the cell faster than K is actively accumulated.

228 PHYSIOLOGY AND PHARMACOLOGY OF THE TUBERAL HYPOTHALAMUS IN TISSUE CULTURE. Herbert M. Geller, Margaret A. Brostrom*, and Bruce McL. Breckenridge*. Dept. of Pharmacology, CMDNJ-Rutgers Medical School, Piscataway, N. J. 08854.

Electrophysiological and pharmacological methods were used to characterize properties of cells in explant cultures of medial basal hypothalamus from fetal rats. Extracellular single unit records showed that the distribution of spontaneous neuronal firing rates is close to that reported for this area in vivo, with a mean of 2.2 spikes/sec. Iontophoretic application of putative neurotransmitters produced the following effects on firing rate: glutamate-excitation, GABA-inhibition, glycine-inhibition, acetylcholine-excitation, DL-homocysteate-excitation; these drug effects were noted at characteristic application currents and latencies of onset. Norepinephrine (NE) produced inhibition, and, on occasion, its effects could be blocked with the simultaneous application of sotalol, but never with phenoxybenzamine.

Studies of the accumulation of adenosine 3',5'-cyclic monophosphate (cyclic AMP) in these cultures showed that intracellular cyclic AMP concentrations could be increased at least 20-fold by stimulation with NE, and to a lesser degree by histamine, isoproterenol, epinephrine, and prostaglandin E_1. This increase in cyclic AMP concentration could be reduced by simultaneous incubation with sotalol, or by pretreatment with NE.

These data suggest cultured cells of the ventral medial hypothalamus retain genetically programmed membrane characteristics for generating action potentials and responding to applied hormones. We also propose that the response to certain of these hormones is mediated through adenyl cyclase. (Supported by U. S. Public Health Service grants NS 10975 and NS 11295)

229 FUNCTIONAL PROPERTIES OF PRIMARY AFFERENTS THOUGHT TO SUBSERVE PAIN IN THE PRIMATE GLABROUS SKIN. A.P. Georgopoulos* (SPON: R.H. LaMotte). Dept. Physiology, Johns Hopkins Un. Sch. of Med., Baltimore, Maryland.

High-threshold afferent fibers were selected from the population of axons functionally isolated in fine filaments dissected from the median and ulnar nerves of monkeys; 262 fibers were studied in 31 experiments. 188 $A\delta$ and 74 C-fibers were categorized by observing responses to strong mechanical and thermal stimuli applied to receptive fields in the glabrous skin of the hand. 79 $A\delta$'s and 2 C's responded only to strong mechanical stimuli. 105 $A\delta$'s and 70 C's responded both to strong mechanical and to strong thermal stimuli: 53 $A\delta$'s and 42 C's to heat, 17 $A\delta$'s and 3 C's to cold, and 35 $A\delta$'s and 25 C's to heat and cold. Six fibers responded only to strong thermal stimuli: 3 $A\delta$'s and 2 C's to strong heat only, and one $A\delta$ to heat and cold. Mechanical pressure thresholds (determined using calibrated nylon filaments) ranged from 6.5 bars to 34.1 bars (mode = 18.6 bars). Thermal thresholds (for a response of 3 impulses in the first 3 seconds) ranged for heat from 43°C to over 53°C, and for cold from 26°C to below 6°C. Receptive fields for most fibers were small,graded, with single spots of maximal sensitivity. These experiments demonstrate that there exists a rich diversity of response properties in high-threshold $A\delta$ - and C-fibers, with gradual rather than abrupt change in properties between classes. The two fiber groups ($A\delta$ and C) may serve the dual sensation of pain felt during noxious mechanical or heat stimuli, though these dual sensations may also be attributed to the different central connections of each group. (Detailed psychophysical experiments to test the existence of a dual sensation of 'cold-pain' appear not to have been done.) The discharge rate of a single fiber and probably the number of fibers recruited increase with increasingly strong stimuli and both could contribute to the subjective capacity to estimate the intensity of noxious stimuli. (Supported by WHO and USPHS Grant #5-P01-NS06828 07).

230 **MULTIPLE ORIGINS OF THE HIPPOCAMPAL THETA RHYTHM. L.K. Gerbrandt† J.C. Lawrence† J.R. Fowler† and T.G. Weyand* (SPON: A. Brunse). Dept. Psych., Calif.State Univ.,Northridge.91324**

This study traces the origin of hippocampal theta rhythms with a laminar analysis technique. Rats (N=30) were surgically prepared under ether anesthesia for acute recording of theta rhythms. The rats were then locally anesthetized at all incision and pressure points, curarized,and artificially respirated. Macroelectrodes or microelectrodes were lowered stepwise across the pyramidal cell layer of regio superior of hippocampus. The theta rhythms were phase-lock averaged with a computer of average transients.

The major finding was that the average theta rhythm gradually increased its phase lead, starting at an average of 150 microns above the pyramidal cell layer of regio superior, and attaining a 90 degree phase shift about 200 microns below the pyramidal cell layer. A null point and a complete 180 degree reversal of theta rhythms were not seen within the hippocampus. Below the 90 degree phase shift point, the average theta activity usually shifted to an approximate but not a complete reversal (112-170 degrees). Second dipole reversals in regio inferior were not observed, although small, local phase shifts occurred in this region in some preparations.

These results are interpreted as providing evidence for multiple origins of theta rhythm converging within the regio superior of the hippocampus. It is concluded that more than one dipole of theta activity may originate from the regio superior of the hippocampus.

231 SHORT-LATENCY AUDITORY RESPONSES IN MAN: STIMULUS FOLLOWING TO MONAURAL AND BINAURAL SOUNDS. George M. Gerken, George Moushegian, Robert D. Stillman, and Allen L. Rupert. Callier Center for Communication Disorders, Dallas, TX 75235, and Graduate Program for Communication Disorders, University of Texas at Dallas, Richardson, TX 75080.

The early auditory evoked response recorded from the human scalp may exhibit periodic peaks which follow the frequency of an acoustic stimulus, particularly for frequencies in the lower speech range (Moushegian, Rupert, and Stillman, Electroenceph. clin. Neurophysiol. 35: 665-7, 1973). In the present work, some characteristics of the neural generators underlying this stimulus-following response have been studied. Five subjects with normal hearing were used. Stimuli were shaped tone-bursts (500 Hz) of 20 msec duration. Binaural phase angle was either 0^{o} or 180^{o}. Intensity was constant for each subject (between 60-85 dB above absolute threshold). Averaged evoked responses were obtained using 999 stimulus presentations at a rate of 1/sec. The results indicate that the stimulus-following waveform produced by in-phase binaural stimulation is the sum of the potentials produced by monaural stimulation of the two ears. This is also true if the binaural phase is 180^{o}. There is no evidence of binaural interaction in the generation of these responses, which implies two independent monaural neural sources. The response waveform resembles that of the stimulus for certain sounds. It is not a microphonic-like response, however, since a shaped train of clicks at 500 Hz yields a response waveform similar to the one produced by the shaped 500 Hz sinusoid. A model is presented of the stimulus-following response based on the sum of the distributions of neural activity per stimulus event.

232 CORTICOSTERONE, CORTISOL, AND ESTRADIOL BIND DIFFERENTIALLY TO SPECIFIC CELL GROUPS IN RHESUS MONKEY BRAIN AND PITUITARY. John L. Gerlach*, Bruce S. McEwen, Donald W. Pfaff, Sheila Moskovitz* (SPON:Neal E. Miller) (Rockefeller Univ., New York, NY), Michel Ferin*, Peter W. Carmel*, and Earl A. Zimmerman* (Internat. Inst. for the Study of Human Reproduction, Columbia Univ. Med. Sch., New York, NY).

Localized binding of ^{3}H-corticosterone, ^{3}H-cortisol, and ^{3}H-estradiol to brains and pituitaries of adult female rhesus monkeys was studied by isolation of cell nuclei and by radioautography. Radioautograms were prepared by mounting unfixed, unembedded, frozen sections onto emulsion-coated slides. Plasma levels of radioactivity peaked during the intravenous infusions and were lower but detectable at sacrifice. In adrenalectomized monkeys infused with ^{3}H-corticosterone, cell nuclear isolation revealed that nuclei of the hippocampus concentrated by far the most radioactivity. Binding was much less but significant in the septum, amygdala, hypothalamus, and mesencephalon, and least in the anterior pituitary. Adrenalectomized monkeys infused with ^{3}H-cortisol showed a similar pattern of binding; however, binding was approximately equal in septum and hippocampus. In ovariectomized monkeys infused with ^{3}H-estradiol, binding ranked: Uterus >> anterior pituitary >> anterior half of hypothalamus-preoptic area = amygdala > posterior half of hypothalamus = septum = hippocampus. Radioautograms confirmed the labeling of cells in the hippocampus exposed to ^{3}H-corticosterone, and the labeling of cells in the anterior pituitary and ventral diencephalon (medial preoptic area, ventromedial nucleus, periventricular zone, and arcuate nucleus) exposed to ^{3}H-estradiol. These results correspond to findings in rats and demonstrate nuclear binding of glucocorticoids and estrogens by specific cell groups in the rhesus brain. (Supported by USPHS Research Grants NS 07080, MH 13189, HD 05751, and HD 05077, and by an institutional grant, RF 70095, from the Rockefeller Foundation.)

233 ACTIVITY OF LOCUS CERULEUS UNITS RESPONSIVE TO STIMULATION AT REINFORCING SITES IN ALERT MONKEY. D. C. German and E. E. Fetz. Dept. Physiol. & Biophys., and Regnl. Primate Res. Cntr., Univ. of Wash., Seattle, Wash., 98195

Intracranial stimulation at specific sites can reinforce operant responses. Neuroanatomical mapping of reinforcing sites in the rat, cat and monkey, as well as neuropharmacological experiments support the hypothesis that locus ceruleus (LC) neurons constitute one of the critical neural systems for brain stimulation reinforcement (see German and Bowden, Brain Res. 1974, for review). To test whether LC axons project to reinforcing sites in the septal nucleus (NS) and medial forebrain bundle (MFB), at the level of the lateral hypothalamus, a rhesus monkey was implanted with stimulating electrodes in these and other areas. Three sites supported intracranial self-stimulation (IcSS) behavior: NS, MFB and ventral tegmental area (VTA). Single units were recorded in the region of the ipsilateral LC below the level of the trochlear nerve and near the mesencephalic tract of the trigeminal nerve. Of 19 units activated from reinforcing sites, 16 were excited by MFB shocks only, 1 by NS shocks only, and 2 by both. None of the units tested responded to VTA shocks or shocks through ipsilateral or contralateral non-reinforcing electrodes. Units responded with invariant latencies to shocks near threshold for IcSS (0.5 mA, 0.2 msec biphasic pulses), and followed two shocks at frequencies up to 900 Hz, suggesting antidromic activation. The 18 units driven by MFB shocks responded at latencies between 2.0 and 5.0 msec (mean ± S.D. = 2.78 ± 0.94 msec). Assuming a 13 mm conduction distance, this implies a mean conduction velocity of 5.04 ± 1.31 m/sec. In contrast to many adjacent units, the firing rates of MFB-activated units was uniformly low and steady (16.0 ± 2.0 Hz for 9 units). When the monkey consumed natural reinforcers such as applesauce or raisins, the firing rates often increased (21.9 ± 5.6 Hz for 5 units) but was uncorrelated with chewing. (Supported by NIH grants RR 00166, NS 11027 and NS 05082).

234 ULTRASTRUCTURAL OBSERVATIONS ON MYOGENESIS FROM DROSPHILIA GASTRULAE IN VITRO. Ines Gerson*, R. L. Teplitz*, R. L. Seecof*, Spon. James E. Vaughn City of Hope National Medical Center, Departments of Developmental Biology and Cytogenetics, Duarte, California 91010, U.S.A.

Drosphila embryos at gastrulation were disaggregated and grown in culture. All cells in the initial culture were morphologically undifferentiated. Light and electron microscopic observations have shown that myoblasts originate from some of these undifferentiated cells. This presentation will describe the cytoplasmic changes observed at different stages of muscle development. At 6 hours in culture short, dense filaments (210 A in diameter), appear in cells which show a well-developed R-ER whose cisternae commonly contain a dense material. The dense filaments are similar in appearance to myosin filaments seen at later stages of developing muscle. At 10 hours in culture thick (210 A) and thin (70 A) myofilaments are observed in loose array and myotubes, containing up to four nuclei, are seen at 11-12 hours. The myofilaments tend to appear throughout the cytoplasm, and by 18 hours, typical Z, A and I bands of striated muscle can be identified. In transverse section of these more differentiated muscle cells actin and myosin filaments appear in typical hexagonal arrays, T-tubules can be identified, multiple desmosomes occur between muscle cells, and myotendinal junctions are also seen. Furthermore we have described neuromuscular junctions at this stage. Since developmental changes appear to be similar to those occurring invivo, we believe that this in vitro system will be useful for studying the genetic regulation of myogenesis in Drosophila.

235 INPUT-OUTPUT RELATIONS OF THE FELINE RED NUCLEUS. Claude Ghez, The Rockefeller University, New York, N.Y. 10021

Stimulation of Red Nucleus (RN) is known to produce flexion of contralateral limbs but the fine details of the projection have not been reported. Cats were used to determine (1) the topography and characteristics of muscle contractions elicited by microstimulation in RN and (2) the receptive fields of units activated by such stimuli. In unanesthetized cats, microstimulation within the RN elicited contraction of one or a few muscles of a contralateral limb, separate zones activating flexor, extensor, distal or proximal muscles. The topographic organization of threshold effects was roughly compatible with the anatomical findings of a dorsoventral axis for forelimb and hindlimb representation. Thresholds for muscle contraction (EMG) between 1 and 10 μA were common. Effective zones with 10 μA stimuli extended 0.2 to 1.2 mm vertically. Long trains of stimuli (1-5 sec) invariably gave rise to sustained muscle contraction for the duration of the stimulus (latency = 35 msec). Units within effective zones typically responded sluggishly to diffuse peripheral stimuli applied to one or more limbs. When receptive fields were restricted to one limb, RN stimulation activated muscles in that limb. It is concluded that the rubrospinal system is organized in discrete zones controlling individual muscles irrespective of their functional class. This property is shared by the motor cortex the stimulation of which, however, only rarely results in tonic contraction. The tonic nature of the contraction observed suggests that the RN may play a particular role in slow or low frequency movements. The diffuse and weak peripheral activation of rubral units suggests that impulses to RN are conveyed through polysynaptic paths and that rubral activity is not tightly coupled to peripheral input. (Supported by NIH grant #NS 10705)

236 SENSORY NEURONS IN THE PONTINE NUCLEI. Alan Gibson*, James Baker*, John Stein*, and Mitchell Glickstein. Dept. of Psychology, Brown University, Providence, Rhode Island 02912 and University Laboratory of Physiology, Oxford University, Oxford, England.

Visual, auditory and tactile stimuli can evoke gross potentials on overlapping regions of the cerebellar cortex of cats. These responses are relayed in part via a circuit which includes cerebral cortex and pontine nuclei. Sensory potentials on cerebellar cortex are unstable: they are diminished or blocked by barbiturate anesthesia. These facts raise two questions which we have tried to answer by recording from pontine nuclei of cats. 1) Is there convergence of afferent activity onto pontine neurons? 2) Do barbiturates block sensory input to pontine neurons? We have recorded from 233 units in the rostral part of the pontine nuclei of cats activated by sensory stimuli. Of these, 146 were activated by visual, 16 by auditory and 71 by tactile stimuli. We found no evidence for sensory convergence in the pons. Rostral pontine cells were activated by one and only one sense modality. Barbiturate anesthesia reduced but did not block sensory activation. Qualitative response properties of these neurons remain unchanged under different types and levels of anesthesia. We conclude that convergence of sensory inputs and barbiturate block probably take place at the level of cerebellar cortex.

237 THE USE OF PEROXIDASE TRANSPORT TO STUDY THE CONNECTIONS OF THE CAT'S VISUAL SYSTEM. Charles Gilbert* & James P. Kelly* (SPON: Z. Hall). Department of Neurobiology, Harvard Medical School, Boston, Mass. 02115.

We have used horse radish peroxidase (HRP) to study the cat's visual system, in particular the reciprocal relations between areas 17 and 18 and subcortical structures. HRP, a low molecular weight enzyme, is known to be taken up by nerve terminals. If this protein is injected into the central nervous system, it is later found in the cell bodies whose terminals arborize within the injected region. A histochemical reaction employing diaminobenzedine or 3,3' diaminobenzedine then can be used to demonstrate the enzyme within these cells. For these experiments microelectrodes were filled with 3-4% HRP in 1M NaCl. Conventional recording techinques were used to locate particular sites within the brain that responded to visual stimuli. Injections (0.1 - 0.5μℓ) of HRP were made by pneumatic pressure into the cortex, the lateral geniculate body and the tectum. Following a 1-2 day survival period, the animal's brain was fixed and serial frozen sections over the appropriate regions were prepared for histochemistry. Tectal injections produced labelled cells in layer V of area 17 as well as some labelled layer V cells in the suprasylvian gyrus. After HRP injection into cortical areas 17 and 18, labelled cells were found in the lateral geniculate body (LGB) and in the pulvinar. After injections of the lateral geniculate body, labelled cells were found in layer VI in area 17 and in area 18. Neurons in the mesencephalic reticular formation were also labelled after LGB injections. In the retina, histograms of cells labelled after LGB injections indicate that large (>860μ^2) medium sized (>800-560μ^2) and small (360-40μ^2) neurons project to the geniculate.

238 ANALYSIS OF THE DECAYING POSTSYNAPTIC CURRENT IN THE SQUID GIANT SYNAPSE. Daniel L. Gilbert and Richard S. Manalis. Lab. of Biophysics, NINDS, NIH, Bethesda, Md. 20014, Dept. of Physiology, Univ. Cincinnati, Ohio 45219, and Marine Biol. Lab., Woods Hole, Mass. 02543.

Magleby and Stevens (J. Physiol. 223: 151, 1972) have shown that the decay of the frog endplate current was slowed when the membrane was hyperpolarized. We decided to test whether membrane hyperpolarization had any influence on the decay of the postsynaptic current in the squid giant synapse. For voltage-clamping, a black platinum axial wire was used for current injection and a microelectrode was used for measuring the membrane potential. The preparation was bathed in oxygenated sea water at 10°C. The best fit of the decaying current at each hyperpolarized potential was expressed by a form of the logistic equation:

$$I = \frac{-M}{1 + \exp(C \cdot (t-R))}$$

where I is the current, t is the time, M is the peak current, C is the normalized rate constant, and R is the time when the current has decayed fifty percent from the peak current. Least squares analysis revealed no appreciable dependence of the normalized rate constant on membrane potential. The value of the normalized rate constant for hyperpolarizing pulses of about 10 to 100 mV was approximately 1.3 $msec^{-1}$. The decay of the postsynaptic current in an Aplysia neuron has also been found to be independent of potential (Gardner and Stevens, Fed. Proc. 33: 450, 1974). This equation might imply some cooperativity of the ionic channels in closing.

239 MODIFICATION OF THALAMIC EVOKED ACTIVITY BY DORSAL COLUMN STIMULATION IN THE HUMAN. P.L. Gildenberg and K.S.K. Murthy. Dept. Surg., Coll. Med., Univ. of Arizona, Tucson, Arizona 85724

A patient who had had a previous dorsal column stimulator implant was operated on with stereotactic basal thalamotomy to relieve chronic pain. Prior to making lesions at the base of the intralaminar thalamic nuclei, activity evoked in the same nuclei by sub- and supra- pain threshold electrical stimulation of ipsi- and contralateral median and sural nerves was averaged with a computer. Simultaneous recording was made on an FM magnetic tape for subsequent study. The convergence of peripheral noxious and non-noxious stimuli and dorsal column stimulation at the level of the thalamic intralaminar nuclei was studied. Dorsal column stimulation significantly modified the thalamic evoked response.

240 WHOLE BRAIN BLOOD FLOW AND OXYGEN METABOLISM IN THE RAT. Albert Gjedde*, John Caronna*, Bengt Hindfeldt* and Fred Plum. Dept. Neurol., Cornell Univ. Med. College, New York, N.Y. 10021.

We designed a modification of the Kety-Schmidt wash-out technique to give rapid and repeatable values for whole brain blood flow and metabolism in the rat. Previous measurements of cerebral blood flow in this species have had the disadvantage of being either regional, technically difficult, unreliable, non-repeatable or not providing any means of estimating cerebral metabolic rate. After preparation with 0.75% halothane and local application of xylocaine, 11 curarized, ventilated rats breathed mixtures of 65-70% nitrous oxide, 30% oxygen, 0-5% carbon dioxide and 10 mCi ^{133}Xe. All animals had P_aO_2 greater than 85 mm Hg and mean arterial blood pressure greater than 95 mm Hg. Simultaneous arterial and cerebral venous samples were drawn from a femoral artery and the intracranial portion of the directly exposed left internal jugular bulb using a withdrawal pump. Three sets of continuous samples were drawn into 500 µl airtight calibrated syringes: after saturation with ^{133}Xe; for 24 minutes during desaturation; and for control values after desaturation. Samples were γ-counted and examined for oxygen content. Blood flow was calculated from the integrated av-differences of ^{133}Xe during desaturation. At a mean P_aCO_2 of 41 ± 1 mm Hg (± SEM) CBF was 68 ± 5 ml/100g/min and $CMRO_2$ was 3.1 ± 0.3 ml/100g/min. Repeated measurements of CBF during altered CO_2 inhalation showed that between P_aCO_2 20 and 80 mm Hg, $CMRO_2$ varied insignificantly and CBF increased on the average 2 ± 0.5 ml per mm Hg P_aCO_2. The value agrees with values reported for man and laboratory species. The technique is straightforward and readily adapts the laboratory rat to studies of brain blood flow and metabolism. (Aided by USPHS NS 0-3346 and grants from the Danish MRC and Weimann's Foundation, Copenhagen.)

241 EFFECT OF VENTROBASAL AND POSTERIOR THALAMIC LESIONS ON CATS' SOMESTHESIS. Robert B. Glassman, Michael W. Forgus* and Joan E. Goodman*. Dept. Psychol., Lake Forest College, Lake Forest, Illinois 60045.

Earlier findings have shown that ablation of cat's SI is followed by contralateral postural and motor deficits but not by impairment of cutaneous sensation. On the other hand, ablation of SII together with adjacent tissue causes a cutaneous deficit (Glassman, Physiol. Behav. 5:1009, 1970; Soc. Neurosc. abstr. 50.8, 1972 and in prep.). Others' work has suggested that lemniscal properties may not be crucial for cutaneous sensation (Schwartzman & Semmes, Exp. Neurol. 33:147, 1971). Unilateral electrolytic lesions were made in the ventrobasal complex or posterior group of cats trained in tactile and auditory discriminations and/or tested for orientation-localization of tactile, auditory and visual cues, and postural reflexes. In some cases a second lesion was later made on the other side. Histological examination has been done of 14 brains, as of this writing. Findings are that verified, extensive destruction of the ventrobasal complex causes a severe cutaneous deficit while poorly aimed or smaller, well-placed lesions cause a smaller effect (12 cases). In some cases the forelimb was more deficient distally than proximally. There is no evidence so far that even larger posterior area lesions cause a cutaneous deficit - except in 3 cases where there was extensive involvement of medial lemniscus. There is a good correlation between the learned discrimination and orientation tests. Though cutaneous deficits are usually associated with a deficit in placing, one cat with ventrobasal target showed severe cutaneous discriminative and orienting deficits but little deficit in contact placing. Some animals that failed to orient to cutaneous cues were observed to respond to petting of the same area. (Aided by a grant from the Illinois Department of Mental Health.)

242 PROJECTIONS OF INDIVIDUAL LAMINAE OF THE LATERAL GENICULATE NUCLEUS IN THE PROSIMIAN. Karen K. Glendenning* and Elizabeth A. Kofron* (SPON: T.T. Norton). Dept of Psychol., Duke Univ., Durham, N.C. 22706

Earlier reports show a difference between the tree shrew and monkey in the projections of individual laminae of the lateral geniculate to striate cortex. In the tree shrew, each layer of the lateral geniculate projects to a different horizontal strip of the fourth layer of striate cortex (Harting et al., J. Comp. Neurol., '73). In contrast, each layer of the lateral geniculate of the monkey projects to a vertical band which can be interpreted as a reflection of occular dominance columns (Hubel and Wiesel, J. Comp. Neurol., '72). The present study was undertaken in the hopes that the organization of a prosimian might cast light on the evolution of this geniculo-striate projection system. Two species, Galago senegalensis and Galago crassicaudatus, were selected in which the lateral geniculate consists of two sets of three laminae-- one receiving crossed and one receiving uncrossed retinal fibers. The present results depended on an analysis of anterograde degeneration (Fink and Heimer, Brain Research, '67)in the cortex following both large and restricted lesions of individual laminae. If all the layers of the lateral geniculate are damaged, the main site of the degeneration in the cortex consists of a continuous band which fills all of layer IV. When a lesion is confined to layers 2, 3 and 4 of the lateral geniculate, all of which receive fibers from the ipsilateral eye, the degeneration is confined to patches in the deeper part of layer IV and intercalated between these patches are cortical sectors relatively free of terminal debris. With a restricted lesion of adjacent layers which receive fibers from both eyes, the cortical degeneration appears to be continuous. Thus, the evidence so far suggests that the organization in the galago is more like that in simians than in tree shrews. (Supported by NIMH Grant MH-4849 to I. T. Diamond).

243 DIFFERENTIATED NEURONS IN CELL CULTURES OF FETAL RAT BRAIN. E. Godfrey*, P. Nelson, A. Breuer and B. Schrier. NICHD, NIH, Bethesda, Md. 20014.

Electrically active, morphologically differentiated neurons were obtained in dispersed cell cultures of fetal rat brain. Cultures were biochemically differentiated, as measured by neurotransmitter-related enzymes. A previously reported culture method (Shapiro and Schrier, Exp. Cell Res. 77: 239, 1973) was modified to include a 4 day treatment with fluorodeoxyuridine (FUdR) and subsequent maintenance in medium containing 10% horse serum. Treated cultures had a markedly decreased accumulation of cell protein, correlated with fewer background cells. Cells were examined by phase contrast and Nomarski optics in the living state, and with brightfield after silver impregnation. Complex neurite networks and several morphologic classes of cells were seen. Intracellular electrophysiologic recordings revealed generation of ongoing action potentials and excitatory and inhibitory synaptic potentials in many cells. Both EPSPs and IPSPs could be evoked by stimulation of nearby cells. Iontophoretic application of γ-aminobutyric acid and glycine elicited inhibitory responses. The development of some enzymes of neurotransmitter metabolism was compared in cultures grown with and without the FUdR treatment. This system represents a reliable method for obtaining highly differentiated brain cells and should offer new opportunities for study of the structure and function of CNS neurons.

244 EFFECTS OF POSTTRIAL AMYGDALA STIMULATION ON RETENTION OF AVOIDANCE TRAINING. P.E. Gold, M. Handwerker*, R. Rose*, C. Spanis* and J.L. McGaugh. Dept. of Psychobiol., Sch. Biol. Sci., Univ. of California, Irvine, 92664.

We previously found that posttrial bilateral or unilateral subseizure electrical stimulation of the amygdala produces retrograde amnesia for one-trial inhibitory (passive) avoidance training. The results of those studies suggest that electrical stimulation in or near the basomedial nucleus of the amygdala is more effective in disrupting retention than is stimulation of nearby amygdala areas. A recent series of experiments examined the effects of posttraining amygdala stimulation on retention of one-way active avoidance training and on retention of discriminated avoidance training. In both instances, bilateral subseizure amygdala stimulation produces significant retrograde impairment of retention performance, even when delayed by as much as 1 hr after training. Histological examination of electrode placements revealed that the greatest degree of amnesia for all avoidance tasks is produced by stimulation in or near the basomedial nucleus of the amygdala. In addition, we found that, in avoidance tasks which involve less stress, e.g., inhibitory avoidance training with a weak footshock, posttrial stimulation may facilitate or have no effect on retention. Thus, posttrial subseizure amygdala stimulation appears to affect retention of various avoidance tasks, although the nature of the effect, i.e., whether facilitation or disruption, may depend on the stress elicited by training. We interpret these findings as suggesting that amygdala stimulation modulates time-dependent memory processes, possibly by altering hormonal or arousal systems.

Supported by NIMH grant MH12526 and NSF grant GB42746.

245 RESPONSE DYNAMICS OF PERIPHERAL OTOLITH NEURONS IN BARBITURATE ANESTHETIZED SQUIRREL MONKEY. Jay M. Goldberg and Cesar Fernandez*. Depts. of Physiology and Surgery, Univ. of Chicago, Chicago, Ill., 60637.

Centrifugal force was used to study the response of otolith neurons to trapezoidal and sinusoidal accelerations. Regularly discharging units tend to have flat dynamics. Responses to trapezoids parallel the force profile. Sinusoidal gains are relatively flat over a .006-4 Hz bandwidth; small phase leads are replaced at higher frequencies by larger (5-25°) phase lags. Irregularly discharging units, in their response to maintained accelerations, display a long-term adaptation, reflected by per-stimulus response declines and post-stimulus secondary responses. Phasic responses, suggesting velocity-sensitive dynamics, are observed during force transitions. There is a sinusoidal gain enhancement with increasing frequency; phase leads of 20-50° are encountered throughout the spectrum. A transfer function of the form

$$H(s) = \frac{1 + \tau_L s}{1 + \tau_A s} \cdot \frac{1 + (\tau_V s)^k}{1 + \tau_M s}, \qquad k < 1$$

is suggested. The term $(1 + \tau_L s)/(1 + \tau_A s)$ is an adaptation operator with a tonic component. The operator $[1 + (\tau_V s)^k]$ mimics the velocity sensitivity of irregular units; the fractional exponent k indicates that response is not simply proportional to the velocity of otolith motion. The term $(1 + \tau_M s)$, presumably reflecting otolith mechanics, provides the high-frequency phase lags seen in regular units. Representative values of τ_A and τ_M are 30 and .01 sec., respectively. The other parameters vary from unit to unit, depending on the prominence of adaptation and velocity sensitivity. The results suggest that otolith organs may serve both static and dynamic functions. (Supported by NIH and NASA grants)

246 NEURONAL RESPONSES TO ENVIRONMENTAL STIMULI OF BEHAVIORAL SIGNIFICANCE IN THE THALAMUS AND FRONTAL CORTEX OF THE SQUIRREL MONKEY (Saimiri sciureus). Ruth B. Goldberg and Joaquin M. Fuster. Department of Psychiatry and Brain Research Institute, School of Medicine, University of California, Los Angeles, Calif. 90024.

The purpose is to investigate the participation of dorsal thalamus and frontal association cortex in the integration of behavior contingent on the perception and short-term retention of sensory information. Nerve-cell activity was extracellularly recorded with both roving and indwelling microelectrodes during performance of a spatial delayed response task and during presentation of species-specific vocal calls (registered by Winter and Ploog). A task-trial included: cue (placement of food in one of two randomly alternated positions), delay (opaque screen between animal and bait) and choice-response. The majority of units in lateral prefrontal cortex and in n. medialis dorsalis showed increase of firing during presentation of the cue. In some units this activation extended into the delay. Others showed a brief activation at onset of cue and a reactivation in the delay. Increased firing was also elicited by some of the vocal calls and by visual stimuli unrelated to the task. However, auditory and visual stimuli relevant to performance, including certain variations of cue presentation, were generally more effective in inducing firing change. A few units exhibited a difference in degree of change depending on the side of the cue (right vs. left). These findings are in accord with electrophysiological evidence of confluent sensory inputs upon the regions investigated (Migliaro and D'Anna, 1963; Bignall and Imbert, 1969). Our results suggest that the neural elements in these regions are subject to diverse sensory influences but are particularly receptive to stimuli of immediate motivational significance and may be involved in the acquisition and retention of information conveyed by such stimuli.

247 NEURAL RESPONSES TELEMETERED FROM THE OLFACTORY BULBS OF RATS INVOLVED IN AN ODOR DISCRIMINATION TASK. S. J. Goldberg. Department of Anatomy, Medical College of Virginia, Health Sciences Division, Virginia Commonwealth University, Richmond, Virginia, 23298.

Multiple unit neural activity was telemetered from the olfactory bulbs of rats (with chronic electrode implants) during the acquisition and performance of an odor discrimination task in order to delineate some of the characteristics of olfactory responses in alert, unrestrained animals.

Water-deprived rats were trained to distinguish between amyl acetate (10^{-3} of saturation) and air delivered from an air-dilution olfactometer to localized odor "choice points." The duration and number of times (frequency) that the rats sampled at a choice point, during each trial run, served as an indirect measure of sniffing.

Results: 1) High amplitude neural impulses appearing as "bursts" above the baseline were common while inhibition of baseline activity was rarely seen. 2) Burst durations ranged from 50 to 300 msec. during stimulus sampling and sampling durations ranged from 300 to 700 msec. 3) After a chance correct choice score was exceeded the incidence of bursting during amyl acetate sampling increased, burst events that could be differentially correlated with odor and air were observed and some rats showed increases in the duration and/or frequency of stimulus sampling. 4) Correct choice scores remained at about 80% with overtraining. In some rats the incidence of bursting during stimulus sampling declined with overtraining and could be correlated with decreases in the duration and/or frequency of stimulus sampling. It appears that relevant information regarding stimulus quality is contained in the first 50-300 msec. of neural response and that the response can reflect changes in behavorial variables related to sniffing and learning.

This research was done at Clark University, Biology Dept, Worcester, Mass.

248 EFFECTS OF SPINAL CORD INJURY ON BLOOD FLOW AND CARDIOVASCULAR FUNCTION. H. Goldman, W.G. Bingham and S. J. Friedman*. Depts. Surg. and Pharm., Ohio State Univ. Med. Sch., Columbus, Ohio 43210

Blunt trauma to mid-thoracic spinal cord of rhesus monkeys resulting in paraplegia and hemorrhagic necrosis of central gray matter also altered blood flow distribution. Using an isotope indicator fractionation technique, flow was measured to traumatized and intact segments and the ratio was expressed as a function of time, 5 min. to 4 hrs. post-trauma. Cardiac output and circulating blood volume were determined. Blood pressure, pulse, blood gases and end-expiratory CO_2 were monitored. Blood flow in the injured segment fell to 80% of the control level in 5 min., rose to 110%, then dropped to 75% and remained sub-normal for the remaining time. Discrepancy between blood flow in gray and white matter of injured segments was striking. Trauma caused severe impairment of flow through gray matter. Flow in white matter fell only slightly after trauma, rose and plateaued at 140% for 20 min., dipped and rose again to persist above normal. Mean arterial pressure increased 50% and plateaued while pulse rate decreased 50%. Both returned to pre-trauma levels 10 min. after injury. Cardiac output fell to 35%, rose to 65% in the next 15 min. and leveled off at 50% for the duration. Blood volume paralleled cardiac output: 65% at 10 min., 85% in 1 hr., leveling off at 74%. Data indicate that in the first 4 hrs. post-trauma: 1) flow to injured white matter is intact or augmented; 2) gray matter flow is severely reduced; 3) cardiac output is substantially reduced presumably due to pooling of part of the blood volume.

249 AXONAL TRANSPORT OF SEROTONIN AND MEMBRANE GLYCOPROTEINS IN METACEREBRAL NEURONS OF *APLYSIA CALIFORNICA*. James E. Goldman*, Richard T. Ambron*, and James H. Schwartz. Public Health Res. Inst. and N.Y.U. Med. Sch., 455 First Ave., N.Y., N.Y. 10016.

Serotonin (5HT) is packaged in cell bodies and transported into axons of identified serotonergic neurons of *Aplysia* (Goldman and Schwartz, *J. Physiol.*, in press). We have injected ^{3}H-5HT and ^{3}H-N-acetyl galactosamine (^{3}H-GalNAc) into cell bodies of the two serotonergic metacerebral neurons (GCNs) of the cerebral ganglion in order to study membranes involved in storage and transport of 5HT. The axon of each GCN bifurcates near the cell body to send processes of equal diameter into the ipsilateral lip nerve and cerebro-buccal connective. At various times after the injection, the two axon branches contain equal amounts of ^{3}H-5HT. We cut these nerves into mm sections and found ^{3}H-5HT distributed along axons in several discrete waves, the most distal moving at 40-60 mm/day. Colchicine applied to one of the branches blocks transport only into that branch. To label membranes of serotonergic granules, we have injected ^{3}H-GalNAc intrasomatically. This sugar is incorporated into 6 major membrane-associated components. Comparison of somatic and axonal SDS gel electrophoretic patterns suggests that three of these glycoproteins are transported. Like 5HT, they are partitioned equally between the two axon branches. Electrophoretic profiles of ^{3}H-glycoproteins in the two branches are similar, suggesting that all the terminals of a neuron are supplied with the same glycoproteins. We are now determining if any of the transported glycoproteins are components of serotonergic granules.

250 ULTRASTRUCTURAL LOCALIZATION OF LUTEINIZING HORMONE-RELEASING HORMONE IN THE RAT HYPOTHALAMUS. Paul C. Goldsmith* and William F. Ganong. Department of Physiology, School of Medicine, University of California, San Francisco, Ca., 94143.

The nature of the cells in the hypothalamus that produce hypothalamic hormones is unsettled. To investigate this problem, electron microscopic immunocytochemistry was performed on thin sections of the median eminence of the hypothalamus of proestrous rats, using rabbit antibodies to synthetic luteinizing hormone-releasing hormone (LHRH) (Rab-a-GnRH #38) kindly provided by Dr. G. Niswender. We employed the unlabeled antibody peroxidase-anti-peroxidase (PAP) complex technique (J. Histochem. Cytochem. 21:855-894, 1973). Positively stained PAP complexes indicating the presence of LHRH were found over homogeneously dense granules, most of which measured 110-140 nm in diameter. The cells in which these granules were located appeared to be neurons. Staining was most apparent over granules in the external layer and contact zone in the median eminence midway between the optic chiasm and the pituitary stalk. However, occasional groups of dense granules that also appeared to contain LHRH were found at other levels of the median eminence, including the internal and subependymal layers. Staining was not observed in tanycytes or glial elements. This evidence supports the concept that releasing factors are located within homogeneously dense granules in hypothalamic neurons. (Supported by USPHS Grants AM06704 and AM05613.)

251 REGIONAL ACCUMULATION AND METABOLISM OF INTRAVENTRICULAR ^{3}H-3-METHOXYTYRAMINE (^{3}H-3-MT) IN THE CAT BRAIN. J.H. Gordon* and M.K. Shellenberger, Dept. Pharmacol., Kan. Ctr. Ment. Retard.,K.U.M.C., Kansas City,Kan. 66103

^{3}H-3-MT was injected simultaneously in both lateral ventricles of awake, paralyzed cats. At 10, 20, 30 and 60 min. animals were sacrificed and samples taken for assay of ^{3}H metabolites. Areas sampled were; Caudate (Cd), Thalamus (Th), Hippocampus (Hp), Hypothalamus (Hy), Mesencephalon (Mc), Pons (Pn), Medulla (Md), Cerebellum (Cb), and postlateral-postsuprasylvian cortex (Cx). The highest accumulation of ^{3}H was found in Cd (7.09-19.65 x 10^{3} dpm/mg tissue) and Hy (8.03=19.80 x 10^{3} dpm/mg tissue) at 10 min. Other areas sampled showed a mean accumulation of ^{3}H of 50% or less than that of the Cd and Hy. Comparisoon of ^{3}H to the accumulation of simultaneously administered ^{14}C-Urea produced similar ^{3}H/^{14}C ratios for all areas studied, indicating that the differences in amount of ^{3}H accumulated by the tissue are probably due to physical factors and not affinity differences. The metabolism of ^{3}H-3-MT produced no detectable β-hydroxylated metabolites and only traces of demethylated products. The major metabolic path was deamination to either homovanillic acid (HVA) or 3-methoxy-4-hydroxyphenylethanol (MPT). The ^{3}H-HVA accounted for an increasing % of the radioactivity isolated with ^{3}H-3-MT and ^{3}H-MPT decreasing with time. The rate of decline of total ^{3}H in adjacent areas appeared equal with the lateral and 3rd ventricular structures showing similar rates of decline. The Mc, 4th ventricular structures and Cx also showed similar ^{3}H declines that were slower than those observed for the anterior structures. Although 3-MT is an endogenous compound associated with dopamine, the administration of exogenous 3-MT via the ventricular system is apparently handled by all areas studied in a similar manner with respect to affinity for accumulation, metabolic pattern, and possibly the rate of disappearance.

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252 THE POSTNATAL MATURATION OF THE SEROTONERGIC SYSTEM IN THE OLFACTORY BULB OF THE ALBINO RAT. L. T. Graham, Jr. and John I. Nurnberger. Neurobiology Section, The Institute of Psychiatric Research and the Departments of Psychiatry and Biochemistry, Indiana University Medical Center, Indianapolis, Indiana 46202

The early postnatal development of a number of components of the serotonergic system in the olfactory bulb was studied in albino rats. Enzyme activities involved in the synthesis of serotonin (5-HT), tryptophan hydroxylase (TH) and aromatic amino acid decarboxylase (AAADC), as well as in its degradation, monoamine oxidase (MAO), were measured during the first four weeks after birth. Data were expressed on the basis of wet weight and/or DNA-phosphorus. The maturation of the capability of the tissue to take up (^{3}H) Serotonin by the hi-affinity uptake process was followed as well as the appearance of formaldehyde-induced histochemical fluorescence. Attempts were made to correlate these findings with the known histological development of the olfactory bulb. The various components of the serotonergic system measured follow slightly different time courses during development in the olfactory bulb but in general the data indicate that the serotonergic nerve terminals appear and mature during the second postnatal week. (Supported in part by NSF Grant GB 39853 and the Indiana Association for the Advancement of Mental Health Research and Education, Inc.).

253 SOME AFFERENT CONNECTIONS OF THE OCULOMOTOR COMPLEX IN THE CAT. Ann M. Graybiel, Dept. Psychology, Mass. Inst. of Tech.,Cambridge, Mass. 02139

The retrograde marker, horseradish peroxidase (HRP),has been injected into the oculomotor complex in order to identify the cells of origin of its afferent fiber systems. Following small hydraulic or iontophoretic injections, HRP-positive neurons were found locally in the nucleus interstitialis of Cajal (NIC) and, in smaller numbers, in the nucleus of the posterior commissure. Within the rhombencephalon,the superior and medial vestibular nuclei and cell group "y" of Brodal were marked by dense accumulations of HRP-positive neurons, while smaller numbers appeared in the lateral and descending vestibular nuclei. In addition,HRP-marked cells appeared throughout the length of the nucleus prepositus hypoglossi, and, in large numbers, within the abducens nucleus itself. At medullary levels, a few scattered HRP-positive cells appeared near or interstitial to the MLF but, except for occasional single cells, the paramedian pontine tegmentum was free of HRP-labeled neurons. The lateral tegmentum, however, contained clusters of HRP-positive cells near the nucleus of Kölliker-Fuse and the outgoing trunk of the VIIth nerve.

These observations, taken together with the results of concurrent autoradiographic experiments, suggest that (1) a system for coordinating conjugate horizontal gaze may include, as a major component, a VIth-IIIrd nerve internuclear pathway; (2) the nucleus prepositus hypoglossi may be an important element of the pre-oculomotor mechanism; and (3) tegmento-oculomotor systems, at least as marked out by HRP neuronography, include foremost local cell groups, near the level of the oculomotor complex, and a lateral tegmental system at caudal isthmic levels. Supported by grant GB39857 from the National Science Foundation.

254 LATERAL SPREAD OF LIGHT ADAPTATION IN THE RAT RETINA. Daniel G. Green and Lillian Tong*. Vision Research Lab. and Dept. of Psychology, Univ. of Michigan, Ann Arbor, Mi. 48104

Single unit recordings from optic tract fibers were used to compare the size of the ordinary receptive field (RF) with the spatial spread of light adaptation. The RF sensitivity profiles were measured on the dark adapted eye by moving a small flashing spot across a tangent screen in 1.5° steps and adjusting the intensity of the spot at each position to obtain a just detectable (threshold) response from the unit. The RF's varied in size from 3° to 10° (determined between points .5 log units down from peak sensitivity). Spread of adaptation was examined by placing a small, steady adapting spot in the center of the RF and determining its effect on the RF sensitivity profile. In all 13 units studied, the adapting spot caused a local decrease in sensitivity at and around the position of the adapting spot. Spread of adaptation was quantified on some units by measuring an adaptation receptive field (ARF). This was done by flashing a suprathreshold spot at or near the center of the RF and moving a second adapting spot across the field in 1.5° steps. At each position the adapting intensity which reduced the suprathreshold response to threshold was determined. Of 22 units, 19 had narrower ARF's than RF's, i.e. as the adapting spot was moved laterally the intensity of the adapting spot had to be greater than would be expected from the receptive field sensitivity. These results show that light adaptation occurs at a site prior to the point at which the signals determining the RF are completely summed. Assuming there are no receptor-receptor interactions this site is not the photoreceptor itself since 7 units had ARF's with the most adaptable position displaced from the position of the test spot. We conclude that adaptation spreads laterally, but to a more limited extent than excitation, and that this spread is neural rather than optical. (Supported by NIH Grant EY00379)

255 DEVELOPMENT OF OLFACTORY GUIDED BEHAVIOR IN THE GOLDEN HAMSTER. Estelle H. Gregory. Dept. Psych., Calif. State Univ., Los Angeles, Calif. 90032

The existence of a maternal pheromone by which the young rat recognizes a lactating female has been reported recently. It seems probable that a similar mechanism would operate in other species, such as the hamster. This study was designed to illustrate basic evidence of olfactory guided behavior in the hamster, which may lead to identification of a similar pheromone in the hamster. Hamster pups were tested for an odor preference every day from 1-16 days of age, first with shavings from their home cage versus clean shavings. After they demonstrated a clear preference for their home shavings they were tested for a preference with other odor combinations. The hamster pups showed a clear preference for their home cage shavings by 8 days of age. Tests for preference with other odor pairs indicate that this preference is due to a change in the hamsters rather than a change in the stimulus. In these tests the hamster pups did not demonstrate a preference for their home shavings over shavings in which a non-lactating female had lived. Further tests will have to be done to determine how specific the hamster pup's olfactory preferences are.

256 INHIBITION FACILITATION AND "TRANSMITTERS" IN THE CAT CORTEX. Robert G. Grenell and Eduardo G. Romero, Section of Neurobiology, Dept. of Psychiatry, Sch. of Med., Univ. of Md., Baltimore, 21201

Visual responses evoked in cat association cortex by stimulation of the optic tract can be both inhibited (by septal stimulation) and facilitated (by pulsing tegmental reticular formation 60-80 msecs. prior to the optic tract stimulus). Using the local perfusion technique in a small cortical area, the effects will be described on these responses of small amounts of atropine or scopolamine, as well as of prior cutting of the Median Forebrain Bundle. Observations suggest the existence of "cortical switching" as well as relationships between AcCh and Facilitation, and Noradrenaline and Inhibition.

257 DECREASES IN CEREBELLAR DNA SYNTHESIS INDUCED BY SHORT PERIODS OF POSTNATAL MALNUTRITION IN RAT PUPS. W.S.T. Griffin*, D. J. Woodward, R. Chanda* (sponsored by D. Bickett), Dept. Physiol. Univ. Roch. Rochester, N. Y. 14642

Rat pups were malnourished by raising in litters of 20 (experimental) or well-fed by raising in litters of six (control). In previous work we showed that new born rat pups have little reserve for growth since body weights of malnourished animals were significantly less (19%, $p<.01$) by postnatal day 3 and cerebellum weights were less by day 4 (11%, $p<.05$). In the present study we investigated short and long-term effects of transient phases of malnutrition with the aim of determining how short a time can be significant in determining brain growth. Rat pups were placed in large and small litters for varying periods of time between the day of birth and day 21. Periods of malnutrition as short as 4 days, between day 4 and day 8, resulted in 10% less ($p<.05$) DNA than control assayed at day 21. To characterize further the onset of changes induced by transient malnutrition, we examined the quantitative incorporation of ^{14}C-thymidine into cerebellar DNA, measured 24 hours after single injections into control malnourished rat pups. At 1.8×10^{-9} moles thymidine per gram body weight, single injections resulted in a greater incorporation of total injected thymidine into DNA of malnourished cerebella than control cerebella. This enhanced uptake, an indication of altered DNA synthetic processes, was evident even within two days of malnutrition begun on postnatal day four. We conclude that a significant decrease in DNA synthesis in the cerebellum of well-fed animals can occur even after very short periods of malnutrition. Supported in part by grants USPHS 5ROINS09820 and GM00394.

258 Torque and Angular Dependance of Discharge in Joint Afferent Neurons in the Cat. Peter Grigg Department of Physiology, University of Massachusetts Medical School, Worcester, Massachusetts, 01605

Discharge of slowly-adapting joint afferent neurons has been recorded in dorsal root filaments in Nembutal-anesthetized cats. The left leg was completely denervated except for the posterior articular nerve (PAN). The knee was stimulated by mechanically flexing and extending it while monitoring both angular displacement and passive torque. Discharge was recorded from dorsal root filaments identified as originating in the joint by electrical stimulation of the PAN. Discharge of neurons was related to stimuli applied to the joint, and was observed primarily at extreme angular displacements. Neural discharge was related to both joint angle and joint torque, and was found to be an approximately linear function of joint torque, while a nonlinear function of joint angle. These findings are consistent with the finding that joint-mediated reflexes are similarly related to joint torque and joint angle.

Supported by NIH grant NS-10783.

259 ON THE QUESTION OF THE USE OF ELECTROCONVULSIVE THERAPY (ECT). Robert J. Grimm, Lab. of Neurophysiol., Good Samaritan Hospital, Portland, Oregon.

Electroconvulsive therapy (ECT) is a program of convulsions induced by current passed between external electrodes. Consenting patients are asleep, paralyzed, and respired during seizures. A series of convulsions is given at intervals determined by the therapist. Clinical improvement is determined empirically. ECT aims at relieving severe depressions unresponsive to drugs and as decisive intervention in life-threatening psychoses. Proponents believe that with careful patient selection and administration, ECT is effective, safe, and without lasting intellectual impairment. Neuroscientists asked by students or others about ECT can respond as above, refer questions to those who use ECT, or make use of the following observations: (1) As one branch of medicine (Neurology) labors to protect epileptics from convulsions while another (Psychiatry) gives them as therapy, it raises a unique and unresolved ethical issue which does not obligate the neuroscientist to a pro or con position. (2) Since ECT does alter memory, cognition, and personality over the short run, therapeutic success is a trade-off; the time course, degree, and measure of impairment are in dispute. (3) There is little information to decide if ECT permanently alters convulsive threshold vis a vis mirror foci or "kindling" models (Goddard, Nature, 1967, 214: 1020); this raises practical questions about ECT use in adolescents, epileptics, and non-depressed patients. (4) There is no unanimity among psychiatrists (1973 Massachusetts study) on patient selection, contraindications, current path (transcortical vs. non-dominant hemisphere only), the number of or interval between convulsions, or observations requisite to ECT termination. (5) ECT to provide institutional conformity, subdue the unruly, or as aversion therapy is without standing. Consequently, caution, an elemental requirement for data, and skepticism serve the neuroscientist drawn into ECT discussion.

260 MEDIATION OF THE RELEASE OF ACTH BY THE MEDIAL DORSAL HYPOTHALAMUS (MDH). William E. Grizzle*, Lawrence P. Schramm and Donald S. Gann. The Johns Hopkins University School of Medicine, Baltimore, Maryland 21205.

Because the right atrium has been shown to mediate release of ACTH in response to small hemorrhage, we sought to identify hypothalamic neurons (cat) whose firing rates were modulated by stretch of the right atrial-vena caval junction. Stretch was produced by intermittant (seven or more cycles) inflation of a balloon implanted between the pericardium and the wall of the right atrium. Carotid arteries were bilaterally occluded. Previous results indicate that electrical stimulation of the MDH causes prompt changes in ACTH, but that stimulation in the lateral hypothalamus does not. 53 cells were recorded in the areas of the MDH in which electrical stimulation changed ACTH. Of these, 33 responded to atrial stretch. In comparison, only 1 of 18 cells outside the medial responsive region (e.g., lateral) responded to this stimulus. These two groups of cells are significantly different ($p<0.001$). Of the 33 responsive cells in the MDH, 15 were inhibited, 9 were facilitated and 9 responded with an off response. Cells with excitatory, facilitatory and off responses were frequently recorded in the same limited area; no spatial organization was evident. Six cells were studied with and without carotid occlusion. The response to atrial stretch was decreased or absent in the absence of carotid occlusion. These results suggest that integration of afferent signals from atrial and arterial receptors is occurring in the MDH. Thus the MDH, which mediates both facilitation and inhibition of release of ACTH and which receives neural inputs from cardiovascular receptors, may participate in neural mediation of the release of ACTH in response to hemodynamic changes such as hemorrhage.

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261 DEPRIVATION EFFECTS ON TIME COURSE OF DEVELOPMENT OF RABBIT VISUAL CORTEX. Paul Grobstein, K. L. Chow, and Patricia C. Fox*. Dept. Neurol., Stanford Med. Center, Stanford, California 94305

The receptive field organization of the rabbit visual cortex has not yet attained adult characteristics at the time the rabbit pup opens its eyes, but does so with a known time course over the next several weeks (Science 180: 1185, 1973; Exp. Brain Res. 19: 20, 1974). We have investigated the effects on this transition of deprivation of patterned visual experience by subjecting Dutch-belted rabbit pups to unilateral eye-lid suture before the time of normal eye-opening. Tungsten microelectrodes were used to sample single units in both the deprived (contralateral to the sutured eye) and experienced cortices of the same animals at 20-25 days of age. The experienced cortices were essentially indistinguishable from those of normal rabbits of the same age. The deprived cortices exhibited a total lack of cells requiring oriented bar stimuli, a larger percentage of "indefinite" cells, and a lower percentage of cells responsive to visual stimulation. In these respects the deprived cortices resembled those of rabbit pups just before the time of eye-opening, and differ from those of animals following three months of visual deprivation (Exp. Neurol. 42: 429, 1974).

262 NOCTURNAL MYOCLONUS AND 5HTP. Christian Guilleminault, Jacques Montplaisir, William C. Dement. Sleep Disorders Clinic, Stanford Medical Center, 94305.

Five patients were discovered with nocturnal myoclonus by several consecutive all night recordings. Nocturnal myoclonus was defined by Symonds (1953) as intense muscular jerks, recorded predominantly in the lower limbs at the onset of sleep and throughout the sleep period. Lugaresi et al (1968) suggested that nocturnal myoclonus might be responsible for severe insomnia. In our patients, the myoclonic jerks were recorded from several 200 micron wires inserted in muscles of the upper and lower limbs. In all patients, the tibial anterialis showed rhythmic activity during the first 2/3 of the night, with a jerk recorded once every 30 to 45 seconds. The jerks were asynchronous but were seen in both legs during the night. These involuntary, shocklike muscular contractions induced movements ranging from a single flexion of a foot to a complete triple flexion of the lower limb. Occasionally, the muscular contractions extended to the upper extremity and induced a violent jerking movement of the whole body. The jerks presented two components=a sudden phasic discharge best recorded in tibial anterialis followed by a sudden muscle inhibition seen in the digastric or hyoidien muscles. This sudden and short EMG suppression is similar to those seen with phasic events of NREM sleep. The jerks were always accompanied by a change of sleep (either K complex or change to lighter sleep or an arousal). 5-Hydroxytryptophan (5HTP), the precursor of serotonin, was given orally to 2 patients for 15 days, with a daily dose of 500 mg. for 4 days, 1000 mg. for 4 days, and 1500 mg. for 7 days. No change in the amount of myoclonic jerks was observed during the course of the trial with 5HTP.

263 THE VISUAL CONNECTIONS OF THE ADULT FLATFISH, ACHIRUS LINEATUS. R. L. Gulley, S. O. E. Ebbesson, and M. Cochran*. Dept. Biol. Struct. Univ. of Miami, Sch. Med., Miami, Fla. 33152 and Dept. of Neurosurgery Univ. of Virg., Charlottesville, Va. 22901.

Metamorphosis in the flatfish is characterized by the migration of one eye around the dorsal surface of the head to a position adjacent to the other eye on the new top side of the animal. The visual connections of the adult flatfish, Achirus lineatus, were examined as a part of a study to determine what changes occur in the projection during the development of the optic tectum. Either the migrating or non-migrating eye was removed and the animal allowed to survive for one to three weeks. Alternate sections of the brain were stained by a modification of the Fink-Heimer technique, or with cresyl violet. The diencephalic visual connections of the flatfish were similar to those of other teleosts with contralateral projections to the nuclei corticalis, dorsomedialis thalami, pretectalis, and the corpus geniculatum laterale. The distribution of the retinal efferents to the optic tectum is unique in the flatfish. In the medial one third of the tectum terminal degeneration was found in three distinct bands over the stratum opticum and the outer portion of the stratum griseum et fibrosum superficiale (SGFS). In the middle part of the tectum, the middle band of degeneration disappears and the two remaining bands are spread over the SGFS. The lateral portion of the tectum receives optic input from the lateral marginal optic tract which enters the rostral and caudal poles of the lateral tectum. Terminal degeneration is distributed randomly in small scattered clusters over the superficial SGFS. The Nissl preparations also reflected the differences between the medial and lateral parts of the tectum. The medial tectum demostrated poorly developed layers with a conspicuously absent large cell layer the stratum griseum centrale (SGC). In contrast the lateral tectum had a typical stratification. Most notable were the large neurons of the SGC.

264 OLIGOPEPTIDE CONTROL OF STEP-DOWN AVOIDANCE IN RODENTS. H. N. Guttman and R. Czuper*. Dept. Biol. Sci., U. Illinois at Chicago Circle, Chicago, Illinois 60680

Concomitant with learning not to step down from a low platform, rodents specifically synthesize a new oligopeptide, catabathmophobin (CATA). We have isolated from rats, and partially purified CATA (MW between 2150-2350). Upon injection into naive subjects, CATA induces step-down avoidance in rats and mice. The effect on recipient rats becomes apparent within 12 hrs after injection and is long-lasting whereas the effect on mice takes almost twice as long to develop and is essentially over 150 hrs after injection. This pattern of action on recipient animals from different species suggests that CATA from rats and mice are quite somilar but not identical. After only one training session on day one, reestablishment experiments show that potential donor animals do not "forget", for more than 15 days, that they will get shocked if they step down from their platforms. However, amount of CATA/brain rises through only 5 reestablishment days and then begins to fall. Concomitant with the reduction in amount of CATA, a new oligopeptide (MW between 540-740) begins to appear and increases in quantity with each additional day of reestablishment. The new oligopeptide is called CATA-modulator (CATA-MOD) because, when injected simultaneously with CATA into recipients, it diminishes the effect of CATA. Our calculations indicate that both peptides are effective in ng/animal (or lower) doses. Thus it is quite possible for any one brain to contain very many specific oligopeptide inducers.

265 EFFECTS OF STIMULATION OF MEDULLARY RETICULAR FORMATION ON ACTIVITY OF INTERNEURONS IN LUMBOSACRAL SPINAL CORD OF THE CAT. L.H. Haber* and I.H. Wagman. Dept. Animal Physiology, Univ. Calif., Davis, 95616.

In view of the suggested importance of n. reticularis gigantocellularis (NRG) in sensory integration and modulation, and the prominence of spinal projections from this area, this study was undertaken to elucidate reticulospinal influences on responses of spinal cord cells to cutaneous adequate stimuli, especially noxious. Unit activity in lightly anesthetized (Halothane), immobilized cats was studied before, during and after NRG stimulation using 100 msec trains of variable pulse frequency delivered at 1/sec up to 20 secs. Effects on spontaneous and peripherally evoked discharge were predominantly inhibitory, expecially for cells responding to noxious stimuli and located in laminae I, V, and VII. Length of post-train inhibition varied, often outlasting NRG stimulation up to 30 secs. One type of inhibition, which we call "progressive inhibition", was characterized by an increased duration of the inhibitory period following each successive NRG stimulus train. Facilitatory influences on spontaneous and peripherally evoked activity were also seen, including NRG-induced "wind-up". The latter was particularly evident in units responding to noxious input. Facilitatory effects were often powerful enough to overcome peripheral inhibitory influences. Besides exclusive inhibition and facilitation of unit activity, NRG stimulation often produced combinations of the two effects. Alterations in these complex patterns were often dependent upon responsiveness to peripheral stimuli. In some mechanoreceptive units with wide dynamic range, reticulospinal effects were selective for either low- or high-threshold input. These findings suggest NRG involvement in adjusting the level of peripherally evoked responses of spinal cells, the degree and direction of which is dependent, in part, on the prior responsiveness of the cell. (Supported by USPHS Grants Nos. NSO7844 and RR00169).

266 γ-AMINOBUTYRIC ACID (GABA) SELECTIVELY BLOCKS PARALLEL FIBER-PURKINJE CELL SYNAPTIC TRANSMISSION IN THE FROG CEREBELLUM. J.T. Hackett. Dept. of Physiol., Univ. of Virginia, Charlottesville, VA. 22901

GABA has well known blocking effects on cerebellar Purkinje cells (PC), but its mode of action and the role it plays in synaptic transmission remains in doubt. Frog cerebellums maintained in vitro (Hackett, Brain Res. 48: 385, 1972) were bathed in Ringer solution to which was added 0.5 to 5mM GABA. The two excitatory inputs to PC, parallel fiber (PF) and climbing fiber (CF), were evoked monosynaptically by selective electrical stimulation, and the responses were recorded intra- or extracellularly with conventional techniques. Blockade of PF-PC transmission occurred within one minute of GABA application and was not due to a decrease in the presynaptic PF volley. With high concentrations of GABA, the PF volley was increased in amplitude and had a shorter latency. $CoCl_2$ (0.5 - 2mM), in accordance with its known presynaptic action, blocked CF-PC transmission; however, GABA was ineffective in this regard. The lack of an effect of GABA on the CF-response indicates that GABA is not increasing the PC membrane conductance. This was confirmed by replacing 87% of the extracellular chloride by the impermeant anions methylsulfate, nitrate, or proprionate without any significant difference in the effect of GABA to block PF-PC transmission. Furthermore, antidromic invasion of PC was not blocked by GABA or $CoCl_2$. The effect of GABA at the PF-PC synapse was not reversed by a fourfold increase in calcium ion nor was it prevented by picrotoxin (2mM) or bicuculline (0.5mM). The most likely explanation for these results is that GABA blocks the PC receptors for the neurotransmitter released from PF.

Supported by NSF grant GB-41177X.

267 CHEMICAL INDUCTION OF GRADED CEREBELLAR PATHOLOGY IN A CARNIVORE. R. K. Haddad. Neuroteratology Laboratory at New York State Institute for Basic Research in Mental Retardation, Staten Island, N. Y. 10314

Methylazoxymethanol acetate (MAM Ac) was given subcutaneously to newborn ferrets. A single injection of 0 (physiological saline), 5, 10, 15, 20, or 25 mg of MAM Ac per kg of body weight was given. Graded effects on cerebellar development were grossly observable within two weeks. The differential dosage effect was even more apparent at weaning (42 days). The heavier dosages (20 and 25 mg/kg) invariably resulted in locomotor ataxia. The medium dosage (15 mg/kg) produced a less severe but still striking cerebellar hypoplasia, but it was not always accompanied by gross motor symptoms. The 10 mg/kg dose produced a lesser degree of cerebellar hypoplasia that never resulted in ataxia. The neuropathological changes produced by the minimal dosage of 5 mg/kg were no longer evident by the time of weaning. The morphology of these brains appeared normal. They could not be distinguished in size or configuration from the brains of normal ferrets. The neonatal ferret thus shows a capacity to recover from early central neuropathology comparable to that previously found in neonatal rodents.

268 EFFECT OF FIGHTING AND DIPHENYLHYDANTOIN ON UPTAKE OF ^{3}H-l-NOREPINEPHRINE IN RETIRED MALE BREEDING MICE. M. G. Hadfield, M. L. Powell* and N.E. Weber*. Div. Neuropath., Dept. Path., Med. Coll. Va., Richmond, Va. 23298

Alterations in central norepinephrine (NE) concentration or metabolism have been observed in various aggressive or fighting animal models. In the present acute study, uptake of ^{3}HNE was markedly increased in synaptosomes obtained from CD_1 male mice retired breeders who were allowed to fight for five minutes as compared with controls. This effect resulted from an increase in the maximum uptake velocity (Vmax) for NE even though there was a decreased affinity of NE for its receptor as indicated by an increased Michaelis constant (Km). Similar findings were reported by Hendley et al. in isolated fighting mice (Science 183: 220-1, 1974).

Diphenylhydantoin (DPH) was used as a pharmacological agent in this study since we had previously found that DPH has a significant effect on the uptake of ^{3}HNE in rat synaptosomes whether administered in vitro (Hadfield, M.G.: Arch Neurol. 26: 78084, 1972) or in vivo (Hadfield, M.G. and Boykin, M.E.; Res. Comm. Chem. Pathol. Pharmacol. 7: 209-212, 1974). Furthermore, it is reported that DPH is able to abolish fighting in electro-shocked animals as well as to control anger, in some instances, in man.

DPH inhibited the uptake of NE in both our control and fighting animals. Kinetic analysis showed that DPH decreased the Vmax, did not change the Km and was a non-competitive inhibitor of NE uptake. This implies that DPH does not interact with the NE receptor but rather affects NE uptake by impeding its transport in some manner.

Since DPH caused an effect on NE uptake (inhibition) opposite to that produced by fighting (stimulation) it is postulated that this mechanism may be related to DPH's ability to alter aggressive behavior.

(Supported by The Dreyfus Medical Foundation)

269 FIRING OF HUMAN TEMPORAL LOBE NEURONS DURING SMELL TESTING. Eric Halgren*, Rebecca Rausch*, Thomas L. Babb and Paul H. Crandall*. (SPON: T. Estrin). Brain Research Inst., UCLA, Los Angeles, 90024.

Discharges from single or a few neurons were recorded from fine wires chronically implanted in 10 temporal lobe epileptics as part of evaluation for surgery (Babb et al, Electroenceph. clin. Neurophysiol., 34:247, 1973). Odors were presented every 60 seconds, for a period of 20 sec. Responses were found in 20 out of 50 amygdala units (10/27 electrodes), 10/31 anterior hippocampus units (8/15 electrodes), 9/12 mid hippocampal gyrus units (5/5 electrodes), 0/7 posterior hippocampus units (0/3 electrodes), and 8/20 posterior hippocampal gyrus units (3/5 electrodes). Both excitatory and inhibitory responses occurred in all sites with about equal frequencies. Across patients and sites, the latency from smell presentation to the beginning of the unit response was about 10 sec, latency to peak response was about 20-25 sec, and duration of the response after the stimulus was removed was about 10-25 sec. The responses appeared equal whether water or an odor was presented, whether a pleasant or unpleasant odor was presented, and whether a strong or a subthreshold odor was presented. The widespread, long latency, nonspecific character of these responses imply that they may be correlated with some active behavioral response to the task. Simultaneous recording of nasal air temperature revealed a much shorter latency for sniffing (about a second), and no correlation with the unit response. A high frequency rhythm recorded in the amygdala (possibly related to sniffing) also had a shorter latency and was confined to the stimulus presentation period. Unlike the unit response, it was strongest with low odor concentrations. Behavioral recognition of the odor, if present, occurred with a shorter latency than the neuronal response. An alternative interpretation of our findings is that the olfactory bulb may act as a nonspecific activator of mesial temporal structures. (Supported by USPHS Grant NS02828)

270 INTRACEREBRAL PROGESTERONE: EFFECTS ON SEXUAL BEHAVIOR IN FEMALE MICE. Nicholas R. Hall and William G. Luttge. Dept. of Neuroscience, Univ. of Florida College of Medicine, Gainesville, Florida 32610.

Progesterone both facilitates and inhibits the sexual behavior of female mice. When given exogenously, progesterone facilitates sexual receptivity in estrogen primed ovariectomized mice. Twenty-four hours after progesterone induced receptivity, females enter a post estrous refractory period during which a second injection of progesterone fails to induce receptivity. In an effort to identify the neuroanatomical loci for these effects crystalline progesterone was implanted intracerebrally in estrogen primed ovariectomized CD-1 mice.

Twenty-seven and 30 gauge stainless steel cannula tubing was used to make and to stereotaxically deliver the hormone pellets. Carbon black was added to facilitate histological verification of the implant site. Extruded pellets were aimed at the interpeduncular region of the anterior mesencephalon, the medial basal hypothalamus, the preoptic area and at other brain regions shown earlier to accumulate ^{3}H-progestins.

Using the lordosis quotient and a qualitative ordinal scale as indicants of receptivity, progesterone has been found to exert an inhibitory effect on estrogen induced receptivity when implanted in the interpeduncular region. This region has been shown to accumulate more ^{3}H-progestin than hypothalamic, limbic or cortical samples in female CD-1 mice. Based upon comparable studies using other species, facilitation of sexual receptivity has been predicted in animals receiving intrahypothalamic implants of progesterone.

These results are discussed in terms of the neuroendocrine control of sexual receptivity in female mice.

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271 EYE MOVEMENTS TO THE PREDICTABLE ASPECTS OF RANDOMIZED TARGET MOTIONS. P.E. Hallett* and A.D. Lightstone*. (SPON.:J.W. SCOTT). Dept. of Physiology & Inst. Biomed. Electronics, Univ. of Toronto, Toronto, Ont., M5S 1A8 Canada.

The predictive aspects of smooth pursuit movement are well known for highly repetitive continuous waveforms, but prediction also occurs for more complicated target motions in the horizontal plane. (1) If the beginning of a saccade always initiates a target step back to the instrument axis further saccadic movement must wait a reaction time - but meanwhile a smooth movement of no appreciable latency is possible. (2) If the target waveform is randomly selected from triangular, sine, haversine and the corresponding truncated waveforms, the saccadic movement to the truncating step must wait a reaction time - but meanwhile smooth pursuit movement reduces the error. (3) The experiment just described includes step-interrupted ramps (sawtooth target motions) in which velocity is constant - the saccadic movement to the step must wait a reaction time but meanwhile smooth pursuit velocity falls and may even reverse until the saccade occurs, after which velocity is once more adjusted in order to match the target. (4) If the target motion is either an accelerating or deccelerating ramp the former typically elicits an immediate smooth pursuit movement whereas the latter does not. It is concluded that human smooth pursuit eye movements are not simple machine-like responses to target velocity. Target position, acceleration and especially predictability are important to the oculomotor pathways, even when the observers perceptions are fairly poor. (Methods: 2 dark-adapted observers; 2 log suprafoveal threshold, blue-green, 10 min arc target; infra-red monitoring of pupil position with SD = 3 min arc; linearity = $\pm$ 5% over $\pm$ 12 deg; 20-50 Hz cut).

272 AN EXPERIMENTAL DEMONSTRATION OF THE FORNIX SYSTEM IN A SNAKE. Mimi Halpern. Department of Anatomy and Program in Biological Psychology, Downstate Medical Center, Brooklyn, N.Y. 11203.

Lesions were placed in the medial cortical zone of the telencephalon of snakes of the genus Thamnophis and the animals permitted a postoperative survival of 2, 4, 8, 10 or 14 days. The resulting degeneration was stained using the Fink-Heimer techniques. Major terminal zones were identified in the ipsilateral and contralateral septum, ipsilateral and contralateral medial cortex and ipsilateral caudal hypothalamus. Degeneration particles in the contralateral medial cortex were concentrated in the inner one-third of the molecular layer. In the septum the degeneration particles were primarily found in the medial septal nucleus ipsilaterally and in the dorsal septum contralaterally. The fornix traverses the medial septum, courses through the medial thalamus and terminates in two caudally situated hypothalamic nuclei, the lateral and medial mammillary nuclei of Crosby and Woodburne (1940). Supported by a Grant-in-Aid from the Research Foundation of the State University of New York.

273 DEVELOPMENT OF RECEPTIVE FIELD PROPERTIES DURING THE CRITICAL DEVELOPMENTAL PERIOD IN CATS. D. I. Hamasaki* John T. Flynn* (SPON: H. Noda). Bascom Palmer Eye Institut. Univ. Miami, Fla. 33136.

To follow the changes in the properties of the receptive fields during the critical period, recordings were made from single optic tract fibers of 5 kittens from one litter. The ages of the kittens were, 3 wk (2), 4 wk, 11 wk and 15 wk. Responses to spots of different sizes, intensities and repetition rates showed a decrease in latency, decrease in receptive field center size, an increase in peripheral inhibition and an increase in the resolution of temporal flicker. The responses of the 15 week kitten were not significantly different from those of adult cats.

274 VISCEROSOMATIC CONVERGENCE ONTO SPINOTHALAMIC TRACT CELLS. M. B. Hancock, R. D. Foreman and W. D. Willis. Department of Anatomy and Marine Biomedical Institute, The University of Texas Medical Branch, Galveston, Texas 77550

The thoracic spinal cord of adult cats anesthetized with chloralose was explored with microelectrodes for spinothalamic tract cells activated antidromically by electrical stimulation in the contralateral caudal diencephalon. The locations of the stimulation sites in the brainstem and the recording sites in the spinal cord were determined by histological reconstructions of electrode tracks. Individual tract cells were examined for responses to electrical stimulation of the ipsilateral greater splanchnic nerve and natural stimuli applied to the trunk. Visceral afferent volleys elicited in the splanchnic nerve were monitored by recording from the thoracic sympathetic chain. Receptive fields for somatic input were determined using natural stimuli. Tract cells were found in the base of the dorsal horn and intermediate gray matter of the cord. Responses were elicited in these neurons by single volleys in the splanchnic nerve at stimulus strengths sufficient to activate the small myelinated, A-gamma-delta, fibers. Spinothalamic tract cells responding to visceral input could also be excited by intense mechanical (noxious) stimulation of the skin of the thorax and abdomen, and in some cells by stimulation of low threshold mechanoreceptors.

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275 THE EFFECT OF LIGHT AND DARK ON THE RECOVERY PERIOD FOLLOWING LATERAL HYPOTHALAMIC LESIONS. Lindy Harrell* and Saul Balagura
Univ. Mass., Amherst,Mass. and Downstate Med. Cen. Brooklyn,NY.

Lesions of the lateral hypothalamus (LH) have been associated with deficits in feeding behavior. However, it has been recently shown that they also cause motor deficits. (Phys. & Behav. 4: 629,1969). We are now demonstrating that it is possible to dissociate the feeding and motor deficiencies. Rats were kept 5 days prior to surgery in 1 of 3 conditions: constant light, constant dark, or in a 12 hour light dark cycle. Following LH lesions the rats were either returned to their original conditions or shifted to constant light or dark. Throughout the experimental period all rats were subjected to certain motor test: horizontal stabilization, step-down, waxy flexibility. It was found that rats maintained in a constant light condition showed typical motor impairments. However, rats kept in constant dark showed no motor impairments after surgery. Rats shifted from constant dark to light had less motor deficits than rats shifted from light to dark. A comparison between constant light rats and those shifted to the dark revealed that the shifted rats were less impaired. All rats remained aphagic throughout the experimental period (8 days +). These results suggest that darkness is able to meliorate and/or prevent motor deficits induced by LH lesions. Since, it is known that modification of certain brain neurotransmitters before or after LH lesions can influence the period of aphagia, it is extremely likely that placing animals in the dark caused some endogenous change in some neurotransmitter specifically related to motor mediation.

276 SELECTIVE ALUMINA EXPOSURE IN EXPERIMENTAL EPILEPSY. A. Basil Harris.
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Experimental epilepsy in monkeys was first produced by supposed subdural application of alumina-filled bakelite discs, but the success of this method was erratic. This study was done to assess the action of alumina on different cells in and about sensorimotor cortex in the genesis of this type of epilepsy. A comparison was made of application sites for clinical and electrical effectiveness and morphological differences. Experimental groups were: subdural alumina-filled teflon discs, subarachnoid injection and intracortical injection. Controls were normals, subdural empty teflon discs and intracortical insertion of inert plastic spheres. Morphologic studies were made on tissues fixed for light and electron microscopy, histochemical stains for alumina and Cajal's Gold Sublimate method for astrocytes. EEG abnormalities and clinical seizures developed only in experimental intracortical and subarachnoid injections being much worse and later onset (up to 6 mo.) in this latter group. Subarachnoid injection resulted in greatest astrogliosis, no noticeable neuronal loss, and more alumina in astrocytes, but none in neurons. The thin arachnoid membrane cell layer excludes subdural alumina from brain, prevents significant astrocytic changes and seizures. Ultrastructurally, all alumina crystals were contained within cells when seizures began. Success for the alumina model appears to depend on contact through the pia-glial membrane with astrocytes and possibly superficial dendrites.

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277 FIRING PATTERNS OF MOTONEURONS AND THEIR SIGNIFICANCE. Dale A. Harris and Elwood Henneman. Dept. Physiol., Harvard Medical School, Boston, Mass. 02115

This study was designed to investigate the possibility that the three types of muscle fibers in the heterogeneous muscles of mammals are innervated by three types of motoneurons, which can be distinguished by their firing patterns. Experiments were carried out on cats with extreme extensor rigidity produced by combined decerebration and decerebellation. The plantaris nerve was stimulated electrically at 1 per 2 sec to elicit monosynaptic reflexes or at 500/sec to evoke repetitive firing and the responses of single plantaris motoneurons were recorded from ventral root filaments. Four aspects of these responses were studied quantitatively: (1) critical firing level (CFL), i.e., the percentage of maximal output of a pool required for discharge of a given motoneuron, (2) maximal rate of discharge, (3) rate of adaptation and (4) duration of repetitive discharge. After 10-15 units had been isolated and characterized in each experiment, each was compared directly with all of the others in a series of simultaneous recordings. These re-examinations minimized the effects of changes in the state of the preparation in prolonged experiments. Our results reveal a correlation between the CFL of a unit and its other response characteristics. Very large units may fire as fast at 100 pps but respond only briefly, whereas very small units may fire no faster than 8 pps for several minutes. Units with similar CFLs, however, often had different firing patterns in direct comparisons. Tentatively, the findings suggest that the properties of motoneurons are in part size-dependent and in part type-dependent.

278 STIMULATION OF STRIATAL TYROSINE HYDROXYLASE ACTIVITY BY DERIVATIVES OF ADENOSINE 3',5'-CYCLIC PHOSPHATE. J.E. Harris*, S. Wheeler* and R.J. Baldessarini, Emory University, Atlanta, Ga. 30322 and Harvard Medical School - Mass. Gen. Hospital, Boston, Ma. 02114.

The effect of cyclic AMP and its derivatives on tyrosine hydroxylase (TH) activity was determined in a crude synaptosomal preparation of rat striata. Incubation with varying concentrations of dibutyrylcyclic AMP (DBcAMP) from 50 μM to 5 mM produced a dose-dependent increase of activity, with max. stimulation (60%) at 1 mM. Stimulation was not observed with either sodium butyrate or dibutyrylguanosine cyclic phosphate while monobutyrylcyclic AMP, 8-methylthiocyclic AMP and 8-bromocyclic AMP produced increases of TH activity. DBcAMP did not alter the uptake of tyrosine into synaptosomes or the activity of dopa-decarboxylase. Stimulation of TH activity could still be demonstrated in washed synaptosomes previously incubated with 1 mM DBcAMP. DBcAMP had only weak dopamine (DA)-releasing action compared with 50 mM K^+ and did not block DA-uptake or alter DA-distribution between the vesicles and cytoplasm. Employing soluble TH with subsaturating concentrations of tyrosine and pteridine cofactor, DBcAMP (0.1 mM) produced a 40% stimulation of activity; the apparent K_m for tyrosine was significantly decreased (54 to 37 μM) without a change in V_{max} and the K_i for DA was increased three-fold (0.09 to 0.28 mM). Thus, DBcAMP may produce an allosteric activation of striatal TH which may be mediated by an increased affinity of TH for tyrosine and a decreased affinity for the endproduct inhibitor DA. (Supported by grants from the U.S. Public Health Service, NIMH, MH-25287-01, MH-16674 and MH-K02-47370).

279 SIGNAL RECOGNITION AS A FUNCTION OF STIMULUS DURATION. Stephen R. Harris and David R. Soderquist* Dept. Psych., Univ. of North Carolina at Greensboro, Greensboro, 27412

In auditory selective attention research, the duration of the signal is crucial with regard to switching between two or more critical bands, CBs. The single-band switching concept depends upon a definite time-span. In order to examine this time-span, an experiment was developed using two noise pulses (713 and 966 Hz) in a 2AFC paradigm. The task of the subject was to determine in which interval the higher pitched signal occurred. The stimuli were presented under 6 duration conditions. When a Least Squares Analysis was performed, the results gave a Temporal Recognition Threshold which averaged 2.54 msec. This result indicates that a signal must be presented for a given time period before recognition can occur. This indicated that in order to differentially respond to auditory signals, these signals must be presented at a duration equal to or greater than the Temporal Recognition Threshold.

280 AFFERENT CONNECTIONS OF THE PULVINAR NUCLEUS IN THE TREE SHREW. John K. Harting* and Vivien A. Casagrande, Dept. of Anatomy, University of Wisconsin, Madison, WI 53706

The origin and organization of afferent projections to the tree shrew's pulvinar have been analyzed using anterograde degeneration and autoradiographic tracing methods. Our data indicate two major sources of pulvinar input: the well developed superior colliculus and the extrastriate visual cortex. A series of small lesions and injections of H^3-proline indicate that the tecto-pulvinar pathway: (1) arises primarily from the superficial layers of the colliculus (2) terminates throughout the entire pulvinar (3) terminates mainly ipsilaterally but also contralaterally and (4) is topographically organized. Lesions of the colliculus involving the representation of the vertical meridian result in degeneration within areas of the pulvinar adjacent to the binocular segment of the dorsal lateral geniculate nucleus. Peripheral vision is represented in regions of the pulvinar most remote from the lateral geniculate nucleus, i.e. the dorsal medial and more caudal limits of the nucleus. Extrastriate visual cortex sends a heavy and organized projection to the whole of the pulvinar, overlapping the tectal distribution. Lesions of the pretectum result in sparse degeneration within the pulvinar, however its principal thalamic target appears to be a subdivision of the lateral group located medial to the optic radiations. No demonstrable projections from the retina, the striate cortex or the inferior colliculus terminate within the pulvinar. (Supportedby NIND #NS-06662, #135 from the Graduate Sch., Univ. of Wisconsin.)

281 **A COMPUTER MODEL FOR QUANTITATIVE TRIGGER-ZONE SIMULATION**

Daniel K. Hartline. Dept. Biol. UCSD La Jolla, Ca. 92037

This model simulates trigger-zone active responses, adaptation (of both an accommodative and an accumulating-refractory nature), various reset conditions, and responses to arbitrary wave-forms of impressed excitation (e.g. PSP's of various shapes). Parallel tests were performed on impulse trains generated by a tonically firing neuron (crayfish stretch receptor) and by the model, whose parameters were fitted to quantitatively simulate aspects of the neuron's responses. Adaptation characteristics of the model produce exponentially declining firing frequencies in response to step depolarizations, with the ratio between peak and plateau frequency controllable through model parameters. Plateau frequency is approximately linear with depolarizing current. Brief pulses of current imposed at various phases of an on-going impulse train produce specific perturbations in firing pattern that are simulated by the model. The model and preparation respond to interpolated antidromic impulses with a phase-dependent lengthening of the following interval. Supported by USPHS grant NS-09477 and NSF grant GB-28620.

282 SQUID OPTIC NERVE RESPONSES. Peter H. Hartline and G. David Lange. Dept. Neurosciences, Sch. Med., UCSD, La Jolla, Ca. 92037.

Single unit recordings from optic nerve fibers in Loligo opalescens show similarities between ERG and optic nerve responses. Both show low pass filtering properties, enhancement of responses by background light, light adaptation, and two-flash facilitation. When the temporal filtering properties are studied at the low frequency end, there are marked differences. Unlike ERG the nerve spike response does show attenuation at low frequencies. This produces a band pass characteristic. This finding is consistent with other evidence for inhibition at the level of the retina. The retinal anatomy is simple. However, excitatory-inhibitory interactions are not simple as is evidenced by on, off, and on-off properties which are complicated functions of the history of illumination. Supported by grants from NIH (NS-09342), NSF (GJ-41809) and the Sloan Foundation.

283 DIFFERENTIATION OF AXON SYSTEMS USING A SPECIFIC AXON PROTEIN MARKER. Boyd K. Hartman* and Ramon Lim. Dept. Psychiat., Wash. Univ. Sch. Med. St. Louis, Mo. 63110 and Dept. Biochem., Univ. Chicago, Chicago, Ill.60637

Antiserum has been prepared to a protein fraction from a membrane preparation of pig cerebral cortical gray (Lim and Goedken, Biochem. Biophys. Acta 322, 359, 1973). Of the several proteins in this preparation, only one (AP22) induced detectable antibody levels. AP22 protein could not be detected in liver nor in soluble brain protein fractions. Electrophoretic mobility in 14% acrylamide gel was 0.22. Its approximate MW was 42,000. This abstract reports preliminary findings on the localization of AP22 in rat brain using immunofluorescence. This protein is exclusively associated with the neuronal elements of brain, where it is localized predominantly to the axon. Glial elements and other non-neuronal elements are AP22-negative. Of greater significance is the fact that only certain groups of axons give a positive reaction with the AP22 antiserum. Fiber pathways in the brain may be differentiated with regard to staining with anti-AP22. For example, fibers in the stria terminalis and stria medularis are AP22-positive, whereas axons in the corpus callosum and anterior commissure are AP22-netagive. The lack of correlation between the degree of myelination of various axons and of staining with anti-AP22 indicates that it is not derived from myelin but instead represents a specific axonal protein. Individual neuron types can also be differentiated with regard to the presence of AP22. In cerebellum, axons derived from basket cells and mossy fibers are AP22-positive whereas climbing fibers and Purkinje cell axonx are AP22-negative. It is hoped that complete mapping of the axons that contain AP22 will lead to a functional characterization of this neuron system. Thus, protein composition may represent a useful additional method for chemically characterizing neuron systems. Supported by MH-70451, MH-21874, NS-09228 and NB-07376.

284 AXOPLASMIC TRANSPORT OF GABA FROM THE CEREBELLAR CORTEX TO THE DEEP CEREBELLAR NUCLEI OF THE RAT. T. Hattori, E. G. McGeer and P. L. McGeer. Kinsmen Laboratory of Neurological Research, Department of Psychiatry, University of British Columbia, Vancouver, Canada.

Concentrated solutions of ^{3}H-GABA (10 µC/µl, specific activity 1-2 C/mmol) were introduced just beneath the surface of the exposed cerebellum of anesthetized rats. Some rats were pretreated with 25 mg/kg of aminooxyacetic acid i.p. After 1-2 hr rats were sacrificed either by cervical dislocation or perfusion with a 4% paraformaldehyde/0.5% glutaraldehyde solution. The deep cerebellar nuclei and injection site were separately dissected except in those animals where half the cerebellum was saved for light microscopic radioautography. Chromatographic analysis showed the radioactivity in both the cortex and deep cerebellar nuclei to be primarily in GABA in the case of unfixed tissue. In tissue which had been fixed by perfusion and then dehydrated, the radioactivity in both the injection area and deep cerebellar nuclei was in an unidentified compound which appeared to be a derivative of GABA. It behaved chromatographically like a derivative of GABA produced by reacting on paper labelled GABA with the glutaraldehyde-formaldehyde perfusion mixture. Light microscopic radioautography showed heavy labelling over the cortical injection site with lesser labelling over the deep cerebellar nuclei and myelinated tracts leading to it. Electron microscopic radioautography showed labelling over myelinated axons and symmetrical nerve endings in the deep nuclei which contained pleomorphic vesicles. The labelled GABA was presumably transported by the Purkinje cells, which form the only projection of the cerebellar cortex to these deep cerebellar nuclei and are thought to use GABA as their neurotransmitter (Fonnum et al., Brain Res. 20, 259, 1970; Saito et al., P.N.A.S. 71: 269 (1974).

285 RETROGRADE FACILITATION OF INHIBITORY AVOIDANCE LEARNING WITH POSTTRIAL INTRAVENTRICULAR INJECTIONS OF NOREPINEPHRINE AND DOPAMINE. John W. Haycock, Roderick B. Van Buskirk*, John Robert Ryan*, and James L. McGaugh. Dept. Psychobiology, University of California, Irvine, CA 92664.

These experiments examined the effects of intraventricular norepinephrine and dopamine injections on retention of different inhibitory avoidance responses in mice. In one training procedure, water-deprived mice were first well-trained to lick from a water spout. They were then given a single footshock for approaching the spout. In the other procedure, non-deprived mice were merely habituated to the training apparatus prior to receiving a single footshock upon leaving the start compartment. Injections were administered immediately after the training trial, and a retention test was given the next day (latencies to lick or to leave the start compartment, respectively). Norepinephrine and dopamine facilitated retention with both training procedures. With the first procedure, norepinephrine was more effective in enhancing retention, whereas with the second procedure, dopamine was more effective. These findings suggest that central catecholaminergic systems may be involved in the modulation of memory storage processes. (Supported by USPHS Research Grants MH 12526 and HD 07981.)

286 POPULATION STUDIES OF CAT JOINT RECEPTORS: TONIC RESPONSES W.J. Heetderks* and W.J. Williams. Bioelectrical Sciences Laboratory, University of Michigan, Ann Arbor, Michigan 48104.

Three response types have been identified in the cat knee joint receptor system (Brain Res. 64:123, 1973; 70:221, 1974). A new multiunit data processing scheme allows simultaneous study of virtually all the units in the medial articular nerve (MAN) that are active under a given set of conditions. These conditions include various combinations of three angular degrees of freedom, a range of frequencies of sinusoidal joint rotation and a range of peak-to-peak excursions of the sinusoidal rotations. Attention has been focused on the tonic, slowly adapting receptor type since it is believed to be of primary importance in position and motion sense in the frequency range 0.01 to 7 Hz. Phasic units can be prevented from responding by using slow, steady rotational velocities. As the joint is rotated very slowly from flexion to extension the active zones of a number of tonic units are observed. Often these active zones are described by the bell shaped curves reported by Skoglund (Acta physiol. scand., 36, suppl. 124:1, 1956). Frequently the response increases monotonically toward flexion or extension. Usually no more than six tonic units are active at any given joint angle. Although the active zones of the tonic units overlap, the exact boundaries of these zones and the shape of the static sensitivity curves change as a function of rotational history. This is due to a hysteresis-like effect observed in the static response characteristics of these units. It is believed that the responses of the tonic units are combined at higher levels, but the hysteresis-like effect remains and acts as a resetting range compression mechanism defining position casually, but providing exquisite motion sensitivity.

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287 ELECTROLOCATION OF OBJECTS IN WEAKLY ELECTRIC FISH

Walter F. Heiligenberg. SIO - UCSD. La Jolla, Cal. 92037

The African Mormyriformes and the South American Gymnotoidei are known to detect objects which distort the electric field associated with their electric organ discharges (EOD). Such distortions are monitored by electroreceptors spread over the animal's body surface. According to the mode of their EOD, electric fish can be divided into wave- and pulse-species. The first fire their electric organ in a sinusoidal manner and at a highly stable frequency, the latter fire their electric organ in short pulses and at rather variable frequencies. Both types of electric fish are found among the African Mormyriformes as well as among the South American Gymnotoidei, two widely separated groups of fish, and thus may have evolved in a convergent manner. The adaptive significance of these two modes of behavior will be investigated. Results obtained so far in one wave- (Eigenmannia) and one pulse-species (Hypopygus) suggest that wave-species require a "private EOD frequency band" which is not shared by near conspecifics, in order to electrolocate with sufficient accuracy. For this reason a fish will shift its EOD frequency to minimize overlap with near neighbors. Electrolocation in pulse-species, on the other hand, is impaired when many successive discharges coincide with extrinsic pulses, whereas pulses not coinciding with the animal's discharges have no adverse effect. For this reason a fish will alter its pattern of discharges to minimize coincidences with discharges of other animals. Whereas the behavior of wave-species can most conveniently be described in the frequency domain , the time domain appears to be more suitable to assess the behavior of pulse-species.

288 ELECTRON MICROSCOPIC CHANGES INDUCED BY LYSERGIC ACID DIETHYLAMIDE (LSD) AND FIXATION TECHNIQUES IN THE CEREBELLUM OF RATS. W.J. Hendelman* and I. Henderson*. (SPON: George Ling). Department of Anatomy, University of Ottawa, Ottawa, Ontario, Canada. K1N 6N5.

The aim of this study was to evaluate whether lysergic acid diethylamide (LSD-25) causes morphologic alterations in the brain of the rat. LSD in saline was injected intraperitoneally into 33 rats (about 300 g). The dose of 1700 μg/K was found to produce, in a companion study, a transient change in the electrical activity of the hippocampus and in behaviour. The ultrastructure of the cerebellum was used to monitor the quality of fixation and any changes induced by the drug. Animals were perfused via the ascending aorta using a pressurized system (90-100 mm.Hg). The optimum perfusion totalled 800 - 1000 ml. over 30 min. The aldehyde, osmium, and wash solutions were all buffered in Millonig's phosphate with added glucose (350 milliosmoles). In well fixed animals treated with LSD the smooth endoplasmic reticulum (ER) within the dendrites of Purkinje neurons became arranged into "stacks" of usually 3-5 lamellae. No changes were seen elsewhere and the synapses were normal. The changes were correlated with the amount of time (hours) which elapsed after giving the drug. Animals which were poorly fixed had the expected poor tissue preservation and also showed stacking of the smooth ER in Purkinje dendrites. Poor fixation occured after (i) delays introduced during the initial 3 minutes, and (ii) reducing the total volume to less than 400 -450 ml. Rats which received LSD and which were also poorly fixed had exaggerated stacking; stacks occured in the soma of the Purkinje cell. Having established the ultrastructural baseline, it is concluded that LSD causes a morphologic alteration in the smooth ER system of the Purkinje neuron. (Supported by grant 419 from the Ontario Mental Health Foundation).

289 TIME LAPSE AND ELECTRON MICROSCOPE STUDIES OF PROCESS FORMATION IN L CELLS: A MODEL FOR MORPHOGENESIS OF PROCESS-BEARING CELLS. M. Henkart, A. Breuer* and P. Nelson. NICHD, NIH, Bethesda, Md. 20014.

Treatment with dibutyryl cAMP changes X-irradiated L-cells from flat polygons to spheres with long processes in 3-4 hrs. Cell remodeling begins as the areas between points of the polygons retract, leaving the points as tips of newly formed processes. The tips then elongate beyond the original limits of the cell while the cell body rounds up. The tips of processes resemble growth cones of neurites. The processes contain microtubules and microfilaments which correspond to radially arranged microtubules and filaments that are present in untreated cells. Processes also contain mitochondria and endoplasmic reticulum (ER). A Golgi apparatus is usually prominent near the base of each process. Several populations of membrane bounded vesicles are distinguishable. Extracellular tracer studies suggest that one population of small vesicles may be a source of new membrane which is inserted into the preexisting membrane at sites of growth. Coated vesicles are generally endocytotic as is a class of larger smooth vesicles formed during retraction of large areas of the cell. ER is extensive in cell bodies and forms appositions with the surface membrane which resemble subsurface cisterns described by others in neurons and certain other cells. Subsurface cisterns regularly occur also at the bases and near tips of processes. We interpret these observations in conjunction with electrophysiological data presented in the preceding paper in terms of a model in which alterations of the cytoplasmic Ca concentration resulting from changes in binding or sequestration by the surface membrane and one or more intracellular compartments is an important factor in regulation of membrane properties and morphogenesis.

290 MODIFICATION OF THE ACTIVITY OF VESTIBULAR UNITS BY VISUAL INPUT. Volker S. Henn*, Laurence R. Young and Charles Finley*. Dept. Aeronautics & Astronautics, Sch. Engr., MIT, Cambridge, 02139

The interaction of visually and vestibularly perceived motion has long been known. Two phenomena, already explored in detail psychophysically, relate to our experiments. During constant velocity rotation about a vertical axis, the sensation of motion quickly disappears when the eyes are closed; however, with eyes open, motion is perceived continuously. When stationary, the sensation of self rotation can be induced by a moving visual surround (circularvection). The question was whether, in such situations where motion is perceived psychophysically, any influences can be recorded in the central vestibular cells.

Recordings were made in alert chronically prepared rhesus monkeys. 25 vestibular units in 3 monkeys were studied and showed consistent behavior. If the animals were rotated with constant velocity in the dark, unit activity decayed within a few seconds. During the same constant velocity rotation in the light, vestibular units showed hardly any adaptation. With the monkey stationary and only the visual surround moving, all units could be influenced in a consistent way. If a unit increased its frequency when the animal was turned to the right, it would also increase its frequency when, with the animal stationary, the visual surround was turned to the left. When the monkey and the visual surround moved simultaneously, preliminary results favor the hypothesis of a non-linear interaction as measured at the level of the central vestibular nucleus. Together, these findings support the notion that these units relay information concerning real or apparent body motion, based not only on labyrinth signals, but also on other sensory systems.

291 DISUSE SUPERSENSITIVITY OF AUDITORY BEHAVIOR AND PHYSIOLOGY. Kenneth R. Henry and Michael D. McGinn.* Dept. Psychol., University of California, Davis, Ca. 95616

Although C57BL/6J inbred mice are not normally susceptible to audiogenic seizures, auditory disuse during a critical developmental period can induce susceptibility in these subjects. Temporary conductive hearing loss (via earplugs) from 17-21 days postpartum induced susceptibility to audiogenic seizures within 2 days, whereas earplugging from 42-46 days of age was ineffective. Mice in both age groups, however, exhibited an augmentation of the amplitude of the peak-to-peak auditory evoked potential. It was concluded that acoustic deprivation produced both behavioral (audiogenic seizures) and neural (augmented AEP amplitudes) disuse supersensitivity, but that the former required a critical period, whereas the latter did not.

292 PROJECTIONS OF THE NONSPECIFIC THALAMIC NUCLEI IN THE RAT. Miles A. Herkenham* (SPON: H. Mahut). Northeastern Univ., Boston, Mass. 02115.

Projections of the nonspecific thalamic nuclei in the adult rat were re-examined with the Fink-Heimer reduced silver methods. Analysis of the ascending fibers which degenerate after small lesions of the intralaminar and midline systems shows a rather specific projection system onto the caudate nucleus and frontal cortical region. Following lesions of the intralaminar nuclei terminal degeneration was seen in layers three and four of the lateral wall of the frontal cortex. After lesions restricted to rhomboidal as well as ventromedial nuclei degenerating terminals were found in the extreme medial aspect of the dorsal bank of the rhinal sulcus at these rostral levels.

In contrast to these localized termination areas, small lesions of the ventromedial nucleus result in diffuse terminal degeneration in the molecular layer of the entire perimeter of the frontal region. This suggests that in the rat the ventromedial nucleus is the only one to have truly nonspecific efferent cortical connections. Additional extrathalamic projections of the nonspecific nuclei are to the nucleus accumbens, amygdala and, posteriorly, into the dorsal gray of the tegmentum.

293 DEFICIT IN PASSIVE AVOIDANCE BEHAVIOR FOLLOWING BILATERAL MEDIAL FOREBRAIN BUNDLE LESIONS IN RATS. John P. Heybach* and Gary D. Coover* (SPON: C. E. Lints). Dept. Psych., Northern Illinois Univ., DeKalb, Ill., 60115

Bilateral electrolytic lesions of the medial forebrain bundle (MFB) at the pre-mammillary level in male hooded rats resulted in a pronounced deficit on a passive avoidance task that paired footshock (intensity was increased in equal increments with each application) with contact of a water spout following 48 hrs of water deprivation. Compared to sham operated controls, rats with lesions of the MFB took significantly more shocks to reach a criterion of 5 min of water spout avoidance. In addition, rats were tested for sensitivity to footshock using a modified psychophysical method of limits technique. Confirming previous reports (Lints and Harvey, JCPP 67: 23, 1969), rats with MFB lesions were found to be significantly more sensitive to footshock as reflected in jump thresholds. Pre-test water consumption measures revealed a slight but significant decrease in 24 hr ad libitum intake in MFB lesioned rats when measured 14-21 days post-operatively (Exp 1) but no difference when measured 21-28 days post-operatively (Exp 2). Responses to shock during passive avoidance testing indicate a specific deficit in the ability to inhibit approach to the water spout following a punishing footshock in rats with MFB damage. Lesions of the septal forebrain nuclei, with which the MFB has extensive fiber connections, resulted in a minimal deficit that was in part dependent upon task parameters. These data implicate the MFB as an important brainstem - limbic system pathway involved in motor and/or sensory inhibitory processes.

294 EFFECTS OF ESERINE (PHYSOSTIGMINE) ON ALPHA MOTONEURONS. M. C. Hickey and C. D. Barnes. Dept. of Life Sciences, Indiana State University, Terre Haute, Indiana 47809.

Several recent studies have indicated that a cholinergic brainstem system intimately influences spinal cord activity (Barnes, 1970; Barnes and Pompeiano, 1970). Eserine has been shown to produce a pattern of inhibition, augmentation or rebound, and further inhibition of the lumbar monosynaptic reflex (MSR) and Ia-inhibited MSR (Hickey-Barnes, 1971). This depression has been shown to be of supraspinal origin mediated by tracts in the lateral funiculus. The purpose of this investigation was to determine directly the nature of the MSR depression. Cats, anesthesized by ether, were decerebrated at the intercollicular level. Both stimulating and recording electrodes were placed on ventral root L7 and stimulating electrodes were placed on peripheral nerves. 3M KCl glass electrodes were used to record from alpha motoneurons intracellularly. Alpha motoneurons were identified by SD and Antidromic Spike Potentials (AP spikes) following antidromic invasion and by IS, SD and AP spikes following orthodromic activation. Following impaling an alpha motoneuron the MSR was ramped for 2 minutes in order to determine control amplitude; following this, eserine (0.1 mgm/kg) was given intravenously and the MSR continued to be ramped. Single sweep pictures of intracellular events were taken approximately every two minutes especially during MSR depression and rebound. Results showed that eserine does produce a MSR depression; this depression is paralleled intracellularly by a drop in the resting membrane potential by approximately 3mV and a decrease in the size of the EPSP by about 4 mV. The EPSP reduction is great enough so that the cell does not reach threshold and, thus, no action potential is generated. It is concluded that eserine causes IPSPs on motoneurons; this activity is reflected by the drop in membrane potential and EPSP size.

295 INTERDEPENDENCE OF REGIONS OF MOTOR-SENSORY CORTEX IN DEVELOPING LOCOMOTOR PLACING RESPONSES IN RATS. S.P. Hicks and C.J. D'Amato. Dept. Path., Univ. of Mich. Med Cntr., Ann Arbor, MI, 48104

Positioning the feet in locomotion on irregular terrain and narrow pathways is considerably governed by the motor-sensory cortex (MSC) and one of its outflows, the corticospinal tract (CST). Major growth of CST into medulla and cord occurred in the 3rd postnatal week coinciding with maturation of locomotion. After uni- or bilateral ablation of MSC in mature rats, contralateral feet slipped off edges and narrow paths and were not lifted and placed on a ledge to which they were laterally touched. Unilateral MSC ablation at birth did not impair placing until mid-third week (17 days), and bilateral ablation at birth did not impair placing at all; an unmatched developing MSC was thus essential for the impairment. Results of ablating various quadrants of MSC at birth, 3 weeks, or 7 weeks, and studying placing impairments and CST projections (Nauta method) included the following. Growth of CST projections continued after the 3rd week surge, and ablations that impaired placing generally had severest effect if performed at 7 weeks. The posterior-medial quadrant (PM) projected to posterior column nuclei and cord, and its unilateral removal much more than other quadrants impaired placing. Ablation of posterior lateral quadrant (PL), which projected to lateral reticular region of medulla, affected placing relatively little, but bilateral ablation of PL plus PM at 3 and 7 weeks greatly impaired placing and also grasping on narrow paths. These latter ablations at birth caused extremely overactive placing (after 17 days) in response to touching feet to a ledge; on narrow paths grasping was extremely poor, worse than when the whole MSC was bilaterally removed. Thus functional effects of injury to one part of motor-sensory cortex depended on what other contralateral and ipsilateral injuries were present, and at what age the injuries occurred. (USPHS grant NS 10531.)

296 MONOSYNAPTIC RETICULO-OCULOMOTOR PROJECTIONS IN THE CAT. S.M. Highstein, B. Cohen and K. Matsunami*. Dept. of Neurology, Mt. Sinai School of Medicine, CUNY, New York, N.Y. 10029

Projections from the pontine reticular formation (PRF) to the IIIrd and VIth nuclei were studied in cervically transected cats. Stimulating electrodes were placed on both IIIrd or both VIth nerves, on both VIIIth nerves, in the rostral PRF, and in the MLF. Intracellular potentials were recorded from IIIrd and VIth nucleus motoneurons identified by their antidromic responses. In IIIrd motoneurons PRF stimulation produced EPSP's, EP-IPSP's and IPSP's all with latencies within the monosynaptic range (0.5-1 msec). The PSP's evoked by PRF stimulation were presumably not a part of the disynaptic vestibulo-ocular reflex as they did not occlude with PSP's produced by VIIIth nerve stimulation. MLF and PRF stimulation could produce PSP's of the same or of opposite sign. Results of occlusion testing in cells in which both MLF and PRF stimulation produced EPSP's, indicate that at least a part of the excitatory projection from PRF to IIIrd nucleus lies outside the MLF. Field potential analysis is consistent with this. In antidromically identified abducens motoneurons ipsilateral PRF stimulation produced monosynaptic EPSP's while contralateral stimulation produced EP-IPSP's. Pressure injection of procion yellow within the abducens nucleus back-filled cell bodies in the PRF. These data indicate that there are direct projections from the PRF to motoneurons in the IIIrd and VIth nuclei. Supported by NS-00294 and NYC HRC I-781.

297 In vitro release of protein from axons during rapid axonal transport. J.F. Hines, M.M. Garwood* and L.A. Forsyth*. Department of Biology, Texas Woman's University, Denton, Texas 76204.

An in vitro system from the frog was used to study fast axonal transport and determine if transported protein may reach the myelin. This preparation included the dorsal root ganglia, sciatic nerve and gastrocnemius. It was placed in a three part chamber. Each compartment was separated by a silicone grease barrier. The dorsal root ganglia was incubated in C^{14} leucine for 5 hours in compartment A. The protein was transported down the axons in compartment B to the muscle in compartment C. The axons in compartment B were superfused with frog Ringer. This solution was collected in hourly samples, dialyzed to remove unincorporated leucine before counting. Based in the determined transport rate of 125 mm/day at 18° C, the maximum efflux of protein corresponds to the time required for the radiolabelled pulse to reach the superfused compartment. Incubating the ganglia in 100 ug/ml cycloheximide blocked the release of labelled protein from the axon. Superfusing compartment B with 100 ug/ml cycloheximide in frog Ringer inhibited axonal and Schwann cell protein synthesis, but did not block the release of radio-labelled protein. It was concluded that the labelled protein released into the superfusing solution was synthesized in the ganglia and transported down the axon before effluxing. SDS acrylamide gels were used to electrophorese the labelled protein released. Sectioning the gels in 2mm blocks and determining the radioactivity showed that 80-85% of the counts were contained in two fast moving low molecular weight bands. Isolation of myelin is currently being carried out to determine 1) if the myelin protein is labelled and 2) if the labelled protein released from the axon corresponds to labelled protein found in the myelin. (Supported by Institutional Research Fund of Texas Woman's University, #959)

298 Caffeine Effects on Spontaneous Activity of Reticular Formation Neurons. Kenneth Hirsh, Jesse Forde* and Marilyn Pinzone*. General Foods Corporation Technical Center Tarrytown, N.Y. 10591

Caffeine was given either by gastric intubation or intravenously to pentobarbital anesthetized rats. Extracellular recordings of single neuron activity were analyzed using an interspike interval histogram computer. Seventy six cells were studied of which 54 responded significantly (chi-square test) to caffeine administration. Doses tested ranged from 0.1 to 10 mg/kg by gastric intubation and from 0.01 to 5.0 mg/kg i.v. The effects of caffeine were dose dependent. Median interspike intervals were lower than control following all i.v. doses except 0.01 mg/kg which caused no change. After 0.1 and 1.0 mg/kg by gastric intubation an increase in median interspike interval was observed, however, the increase was smaller following the higher dose. Larger doses yielded decreases in median interspike interval. It appears that caffeine's action in the reticular formation is complex, and that the route of administration has an effect on the activity observed. I.V. administration of caffeine caused a consistently stimulatory response. The more gradual rise of caffeine blood levels which occur following gastric intubation evoked a more complicated response which consisted of a mixture of inhibitory and stimulatory effects depending upon the dose given.

299 ROLE OF SCAR FORMATION IN THE DEVELOPMENT OF AN EPILEPTOGENIC FOCUS. Thomas J. Hoeppner* and Frank Morrell. Dept. Neurology, Rush-Presbyterian-St. Luke's Med. Center, Chicago, 60612

Focal epileptogenic lesions were produced in a series of guinea pigs by intracortical injection of aluminum oxide. Half the animals were placed on an ascorbic acid deficient diet (to inhibit scar formation) and the other half were given a normal diet and served as controls. EEGs were recorded three times per week from implanted epidural electrodes. Control animals developed sporadic epileptiform spiking near the injection site and one went on to have a spontaneous clinical seizure. Scorbutic animals showed little or no sharp activity but rather slowing of background rhythms near the injection site. None of the scorbutic animals had a spontaneous seizure.

When challenged with pentylenetetrazol (Metrazol, 30 mg/kg IP), activation was greater in control than in scorbutic animals. Control animals exhibited paroxysmal discharge which began at the primary lesion site and was sometimes confined to that site. When paroxysmal bursts were bilateral they were of higher amplitude on the side of the lesion. In contrast the scorbutic animals had Metrazol-induced paroxysms either confined to the non-lesioned cortex (2^{o} site) or, when bilateral, of higher amplitude at the 2^{o} site.

These findings suggest that scar formation contributes to the development of a primary epileptogenic focus by increasing the excitability of neurons adjacent to a cicatricial lesion.

300 NERVE FIBER ACTIVITY DURING NORMAL MOVEMENTS. J.-A. Hoffer, W.B. Marks, and W.Z. Rymer (SPON: F.T.Hambrecht). Johns Hopkins U. Biophysics, Baltimore 21218 and Laboratory of Neural Control, NIH, Bethesda 20014.

In order to monitor muscle afferent and efferent fibers from normal animals during unrestrained movement, a technique has been developed for capturing nerve fiber bundles in insulating groove electrodes which contain 1 or 2 recording contacts. Multiunit activity with resolvable single units has been observed for up to 8 days from the L7 and S1 dorsal roots of the cat and from the tibial nerve of the rabbit. These sites were chosen because the fascicles can be split into natural filaments of diameter 100-300um, which are then loaded into flexible Silastic grooves 4-13mm long, and sealed with Silastic. The nerve groove is stabilized by attachment to a larger groove which holds the rest of the tibial nerve. The animals are able to walk 1 to 2 days after surgery. Unit potentials may lose their negative phase immediately and reversibly after dissection or within 12 hours of surgery if the blood supply within the filament is inadequate. This positivity indicates conduction failure within the electrode which is usually progressive, causing loss of unitary potentials within a day. Visible blood flow within the filament appears to be a requirement for survival, and in the case of spinal roots, dural reconstruction is necessary, apparently preventing venous collapse. In the tibial nerve preparation, conduction direction was detected from the dual recording contacts, and demonstrated the presence of both motor and sensory unitary potentials which were usually from the footpad and muscles of the foot. The dorsal root activity was largely spontaneous, but increased significantly during arousal, stretch of the ankle extensors, or standing. Supported by NIH grant NS 08385 to WBM, and University funds from the Dept. of Biophysics, JHU.

301 THRESHOLD VS DYNAMIC RESPONSE PROPERTIES OF TYPE I AND TYPE II CUTANEOUS MECHANORECEPTORS. K. W. Horch and P. R. Burgess. Dept. Physiol., Sch. Med., Univ. Utah, Salt Lake City, 84132.

The dynamic responses of Type I and Type II receptors in cat hairy skin, defined as the frequency of discharge during constant velocity (ramp) indentations at different rates, indicate a well developed velocity sensitivity in the former. Type II receptors, on the other hand, show a much less well developed velocity sensitivity. Measures such as the minimum amplitude of single cycle sinusoidal stimuli at different frequencies needed to evoke a single impulse per cycle, or the amplitude of ramp indentations of different slopes at which the first impulse is produced, indicate that the threshold stimulus for both receptor types is a nearly constant amplitude indentation, independent of the velocity component of the stimulus. Thus at threshold these receptors do not show an increased sensitivity to rapid stimuli. Nevertheless, the Type I receptors, especially, clearly respond more vigorously to rapid suprathreshold stimuli. This dichotomy may have important consequences in the central processing of information from these receptors. This work was supported by U.S.P.H.S. Grants NS08769, NS07938 and NS05244.

302 RESPONSE PATTERNS OF PRECENTRAL NEURONS TO RAMP STRETCH OF SOME HINDLIMB MUSCLES IN THE BABOON. J. Hore*, J. B. Preston, R. G. Durkovic* and P. D. Cheney*. Dept. Physiol., SUNY Upstate Med. Ctr., Syracuse, N.Y. 13210

Units which responded to stretch of the gastrocnemius, soleus or peronius tertius muscles were recorded in areas 3a and 4 of the precentral gyrus in baboons anesthetized with chloralose. Units were classified on the basis of the response pattern of their discharge to ramp stretch (10 mm, 45 mm/sec) into one of six categories: initial burst, tonic, dynamic-tonic, inhibited, facilitated-inhibited, and weak. The distribution of units with respect to the cytoarchitectonically determined 3a/4 boundary showed that initial burst and facilitated-inhibited units were mainly found in area 3a, tonic mainly in area 4 and dynamic-tonic, inhibited, and weak in both areas. Threshold and latency measurements of these units to single shock electrical stimulation of muscle nerves together with evoked potential recordings indicate that there is a major group II projection to a region of area 4 adjacent to area 3a, and a group I projection to 3a which overlaps into area 4. Plotting different lengths of ramp stretch against static level of cell discharge revealed that units with length sensitivity were found in both areas 3a and 4. However, units with the best length sensitivity were found primarily in area 4 while many units in area 3a had little or no measurable response to changes in muscle length. Velocity sensitivity was determined by measuring the dynamic index at different rates of ramp stretch. Units with velocity sensitivity were found in both areas 3a and 4, although the best velocity responses tended to be found in 3a. Some units in area 4 had poor or no response to changes in the velocity of muscle stretch.

303 COMPARING THE EFFECTS OF AMYGDALA AND TEMPORAL NEOCORTEX LESIONS ON EMOTIONALITY AND VISUAL PERFORMANCE OF THE MONKEY. James A. Horel, E. Gregory Keating and Louis J. Misantone*. Dept. Anat., Upstate Med. Cntr., Syracuse 13210

The Kluver-Bucy syndrome which results from bilateral temporal lobectomy has been interpreted as a disconnection of visual information from the rhinencephalic or limbic brain. The disrupted pathway mediating this relationship is thought to be a circuit connected in series from striate to prestriate and inferotemporal cortex, and out of the temporal lobe by way of the amygdala and hippocampus. Lesions at points along this pathway should, according to this scheme have similar behavioral effects and should mimic the results of complete temporal lobectomy. In support, previous work has shown that cutting the occipital-temporal axons does reproduce part of the Kluver-Bucy syndrome. The present study compared the effects of amygdala and temporal neocortex lesions. Five of the thirteen rhesus monkeys in the experiment received bilateral amygdalectomies; the lateral temporal neocortex was removed in four other animals, and four animals received skin incisions identical to the experimental groups. We measured postoperative retention of a visual pattern task, ability to distinguish food from junk objects, and changes in emotionality. Neither amygdala nor temporal neocortex lesions produced "psychic blindness" or the inability to distinguish food from junk objects. Both of these lesions caused some change in emotional responsiveness characterized by increased approach toward and oral examining of noxious stimuli. However, this effect seemed less dramatic than the tameness that follows complete temporal lobectomy. Finally, only the lateral temporal cortex lesion severely affected retention of a visual pattern task.

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304 THE STRUCTURAL CORRELATES OF VISUAL INATTENTION FOLLOWING ECTOSYLVIAN LESIONS IN THE CAT. S. Horenstein, R.G. Schwarz*, T. Yamamoto*, and P.A. Young. Saint Louis University, Saint Louis, Missouri 63104.

Subpial resections of portions of the anterior, middle, or posterior ectosylvian gyrus were followed by visual neglect toward the opposite side of space which was proportional to the size of the lesion and was most prominent early after ablation. Never severe, the cat could be attracted to the affected field by stimuli of sufficient intensity. In animals killed by intracardiac saline-formalin perfusion, the lesions were verified and the brains studied for degenerating fibers by the Fink-Heimer method. There was a heavy projection to the ipsilateral suprasylvian visual association cortex. A smaller number of fibers crossed the corpus callosum to the contralateral ectosylvian region ending in areas homologous to those ablated. Some were found in the contralateral suprasylvian visual association cortex. A discrete bundle traversed the internal capsule to the brain stem. Most fibers terminated in the external nucleus of the ipsilateral inferior colliculus, but some ended in the middle layers of the ipsilateral superior colliculus. Very few ended in the contralateral superior and inferior colliculi. It is suggested that the projection to the ipsilateral visual association area subserves visual auditory association and facilitates the function of the visual association cortex. Its loss weakens visual attention to the opposite half field. The transcallosal projection may inhibit function in contralateral areas homologous to those ablated and the loss of their influence may thus result in heightening of visual attention referable to the contralateral hemisphere. Fibers projecting to the superior colliculus may help its activation of the hemisphere and their loss accordingly may diminish a general process of hemisphere arousal. Visual attention in the cat thus appears to depend on specific hemispheric, transcallosal, and mesencephalic influences.

305 EFFECTS OF PENTYLENETETRAZOL AND PICROTOXIN ON HIPPOCAMPAL SLICES IN VITRO. Nobuaki Hori* and Nobuo Katsuda* (SPON: A. R. Dravid). Dept. Pharmacol., Facul. Dent., Kyushu University, Japan.

Electrical activities were recorded from hippocampal slices of the guinea pig in vitro extracellularly and intracellularly. Responses of the pyramidal cells in CA3 to electrical stimulation of the dentate gyrus were studied in the normal medium and the medium containing pentylenetetrazol (5×10^{-3} M) and picrotoxin (1×10^{-5} M).

The pyramidal cell responded only with IPSP's to the stimulation of the dentate gyrus in the normal medium. In the medium containing those drugs, the response was in a depolarizing direction superimposed by the train of impulses. The spontaneously bursting discharges of the pyramidal cell were also recorded in the medium containing those drugs, while similarly patterned discharges were never observed in the normal medium. Pentylenetetrazol and picrotoxin did not change the excitability of the pyramidal cell directly. During the depolarizing response, we could observe no significant change in the effective resistance of the membrane of this cell. Neurons bursting with very high frequencies were found near the pyramidal cell layer in the medium containing these drugs. The onset of the burst of these neurons preceded the depolarization of the pyramidal cell. The time course of the depolarization of the pyramidal cell was linearly related to the duration of the bursts of those neurons.

These results suggest that the pyramidal cell is innervated by at least two kinds of interneurons, e.g., excitatory and inhibitory. The seizure-like discharge of the pyramidal cell appears to be caused by disinhibition of those excitatory interneurons.

306 THE DISTRIBUTION OF ODORANT MOLECULES ACROSS THE OLFACTORY MUCOSA. David E. Hornung* and Maxwell M. Mozell (SPON: R. B. Barlow, Jr.). Physiology Department., Upstate Medical Center, Syracuse, New York 13210.

A radiographic technique was developed to map the distribution of odorant molecules across the mucosa of the intact olfactory sac of the bullfrog. A flow dilution olfactometer provided a stimulus with variable flow rate, volume, and partial pressure of tritium labeled butanol. After the stimulus was puffed into the external naris, the animal was frozen in liquid nitrogen. The dorsal olfactory sac and eminentia were then removed and cut into sections perpendicular to the long axis of the mucosal surface. Each section was dissolved in a tissue solubilizer and counted in a liquid scintillation system. The recorded radioactivity represented the number of butanol molecules absorbed by each section. From the section which contained the external naris to the section which contained the internal naris, there was a decrease in the radioactivity. The steepness of this gradient depended upon the flow rate, volume, and partial pressure of the stimulus. This technique provides a method to quantify the number of odorant molecules available to the olfactory receptors at different locations across the olfactory mucosa. In addition, these results complement previously reported electrophysiological data suggesting differential absorption across the mucosa resulting in a chromatographic-like effect. Sponsored by NIH Grant NS 03904.

307 APPLICATION OF MULTIVARIATE ANALYSES TO EXPERIMENTS MEASURING MULTIPLE BEHAVIORAL AND NEUROCHEMICAL INDICES. J. L. Howard, B. R. Cooper*, L. D. Grant, and G. R. Breese. Department Pharmacology, Wellcome Research Labs, Research Triangle Park, N.C. 27709 (J.L.H.), and Department Psychiatry, University North Carolina, Chapel Hill, N.C. 27514.

In two recent experiments, microinjections of 6-hydroxydopamine (8 µg bilaterally) were made into various catecholamine-containing areas or pathways to produce different patterns of norepinephrine (NE) and dopamine (DA) reduction in brain. Measurements were made of NE and DA levels in four areas of brain: mesolimbic region, hypothalamus, caudate and hippocampus-cortex; and multiple aspects of behavior: acquisition and performance of active avoidance responses, weight gain or loss, sucrose and water consumption in experiment one (126 rats); and acquisition and performance of food-rewarded responses in a double T-maze, food consumption, and effects of alpha-methyltyrosine and behavioral reversal in experiment two (118 rats). Groups of animals in which 6-hydroxydopamine injection produced depletion of brain DA, especially in caudate and mesolimbic areas, showed deficits in the behavioral tasks and reductions in consumatory behavior. To further understand the data, multivariate techniques were used. Homogeneity of treatment effects was assessed using stepwise discriminant analysis. The relationship among all dependent measures was evaluated with factor analysis. The relationship between the neurochemical and behavioral data was evaluated using canonical correlation analysis. Some results of particular interest were that mesolimbic, hippocampal and cortical DA levels were directly related to the rate of acquisition of the double T-maze task, but that final levels of performance were dependent on caudate DA level, consumatory behavior was more related to mesolimbic DA than to the catecholamines in other areas, and NE levels in any area were essentially unrelated to any behavior. (Grants HD-03110, and HD-24585)

308 REGIONAL DISTRIBUTION OF AROMATIC ALKYLAMINE N-METHYLTRANSFERASE IN RAT BRAIN. Louise L. Hsu* and Arnold J. Mandell. Dept. Psychiat., Sch. Med., UCSD, La Jolla, CA 92037

5-N-Methyltetrahydrofolic acid (5-MTHF) can serve as the methyl donor in the N-methylation of indolealkylamines (Hsu and Mandell, Life Sci. 13: 847, 1973; Banerjee and Snyder, Science 183:74, 1973; Leysen and Laduron in 5-Hydroxytryptamine and Other Indolalkylamines in Brain, eds. Costa and Gessa, Raven Press, in press). The activity of aromatic alkylamine N-methyltransferase (AANMT) is markedly stimulated by the addition of FAD (but not $FADH_2$) and methylcobalamin to the original assay, which included simply donor, acceptor, and a phosphate buffer (Hsu and Mandell, Life Sci. 14: in press). Using the optimal assay, with tryptamine as the substrate, we have assayed AANMT activity in 15 regions of rat brain as well as cervical and lumbosacral spinal cord. Supernatant fractions obtained from centrifugation of the homogenates at 100,000 g for 40 minutes were dialyzed overnight against 0.02 M K-phosphate buffer (pH 6.5), and the enzyme activity was assayed in the dialyzed fraction from each region. Activity ranged from 210 to 69 pmoles of product per mg of protein per hr. Corpus striatum manifested the highest activity; corpus callosum the lowest. The regional variations in activity suggest some physiological specificity of function for the enzyme(s). The regional distribution of 5-MTHF (Korevaar et al., Nature New Biol., 45:244, 1973) is consonant with its possible role in the N-methylation of aromatic alkylamines in brain. There is a possibility of multiple products from this methylation reaction, which suggests that some methyl groups might attach elsewhere than at the terminal alkylamine nitrogen.

309 STUDIES OF THE POPULATION OF UNITARY SENSORY RESPONSES IN THE POSTERIOR THALAMIC ASSOCIATION NUCLEI OF THE CATS. Chuong C. Huang. Univ. of Mo. Inst. of Psychiatry, St.Louis, Mo. 63139.

By using stainless steel microelectrodes the unit responses to flash, click stimuli and shock to contralateral forepaw were studied in 9 chloralose anesthetized cats. All locations of recording sites were carefully determined histologically. 115 unit responses were studied. These unit responses were recorded extracellularly from Pulvinar, N.posterior, N.lateralis posterior and N.supragenicularus, especially the Pulvinar nucleus at A:4.0 and 6.0 of Horsley-Clarke stereotaxic coordinates. Very few evoked units were recorded from A:8.0. The percentage of the distribution of unit responses to the different sensory stimuli is as follow: Visual (V):28.7%; Auditory (A): 0.9%; Somatosensory (S):6.1%; V,A,S:40.9%; V,S:18.2%; V,A:4.3 %; S,A:0.9%. 92.1% of the unit responses responded to flash stimulation. These findings are corresponding to the results of author's previous studies in mapping as well as recovery cycle and intermodality interaction tests that Pulvinar is more specific in response to V stimuli. The histograms of the latencies of the unit responses show that there are 2 groups of unit responses to V,A and S stimuli. The latencies of the early responses are from 15 to 150 msec. and those of the late responses are from 340 to 450 msec. The histogram of V unit responses is different from those of the A and S responses with the most of unit responses latencies ranging from 25 to 65 msec. and the peak at 45 msec. The histograms of the A and S unit responses are similar, with the most of unit responses latencies ranging from 25 to 150 msec.

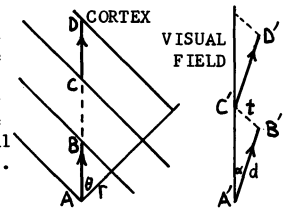
310 MORPHINE NEURON MEMBRANE EFFECTS IN THE CAT PERICRUCIATE CORTEX. Chuong C. Huang* and Amedeo S. Marrazzi, University of Missouri Institute of Psychiatry, St. Louis, Mo. 63139.

Intracellular recording of the cerebral effects of opiates and their antagonists is providing data on the membrane effects at the unit level, and may possibly lead to clinical utilization of an additional site of action — one beyond the receptor — for prophylaxis and therapy of drug abuse. 50 units (mainly spontaneously firing but with some evoked) were studied in the pericruciate gyrus in flaxedilized cats. Morphine sulphate was injected close-arterially via the ipsilateral common carotid artery. The doses used were from 125 μg/Kg to 750 μg/Kg. 350 μg/Kg to 500 μg/Kg were optimal for the actions studied. The basic pattern of the morphine effects on the units is inhibition of firing, hyperpolarization and increased transmembrane resistance, followed by postinhibitory rebound (with increased firing, depolarization and decreased transmembrane resistance) preceding recovery. Preinhibitory excitation was found in one-third of the units which received doses from 250 μg/Kg to 500 μg/Kg. The preinhibitory excitation is suspected to be due to a release of acetylcholine by morphine. It was, therefore, thought that atropine might block this excitation. Careful studies in six units do show that atropine blocks the preinhibitory excitation. When morphine was applied in high doses (over 750 μg/Kg), the units were strongly inhibited without the appearance of preinhibitory excitation, perhaps due to telescoping, and with the occurrence of decreasing spike amplitude, salivation and dilatation of pupils in cats. The atropine sensitive response represents a receptor mediated action, while the inhibition resembling that of serotonin and norepinephrine may be an action on receptors or directly on the membrane taking place distal to receptors. In the latter case an effective antagonist might also be found to operate beyond the receptors and directly on the membrane.

311 VISUAL-FIELD REPRESENTATION IN LAYER IV C OF MONKEY STRIATE CORTEX. David H. Hubel, Torsten N. Wiesel and Simon LeVay*.
Dept. of Neurobiology, Harvard Medical School, Boston, Mass. 02115.

In monkey striate cortex, above and below layer IV the size and scatter of receptive fields obscure the small drift in receptive-field position that is predicted when a tangentially moving electrode traverses an ocular-dominance slab (column). In layer IV C, however, fields are smaller and less scattered and show a clear progression as one slab is crossed. Thus topographic representation is more detailed in this layer. This has surprising consequences. Visual-field representations in left and right eye are interlaced, so that fields just at the boundary between two slabs are separated by about $m^{-1}r/2$, where r=slab width and m=magnification in mm/degree. Within a single slab in IV C, the magnification is anisotropic; parallel to the slabs it is the same as the overall value (m_{90}), whereas normal to the slabs it has half the value. As an electrode moves at an angle θ to the normal, along AC, $m_\theta/m_{90} = (3\cos^2\theta + 1)^{-1/2}$, and fields progress, not along the expected trajectory (A'C') but along a series of oblique parallel lines A'B', C'D', whose starting points lie on A'C'. The angle between actual and expected movement $\alpha = \theta - \tan^{-1}\frac{\tan\theta}{2}$; this is 0 for $\theta=0^\circ$ and $\theta=90^\circ$ and has a maximum of 19°28' for $\theta=54^\circ44'$. If t is the jump from the end of one line to the start of the next, and d the length of each line, $d/t = (4\cot^2\theta + 1)^{1/2}$. Direct measurements were made of the angle between reconstructed electrode tracks and the slabs seen as bands in reduced silver stains of tangential sections. The results were in good agreement with experimental values of θ calculated from m_θ/m_{90} and from t/d.

NIH Grant No. EY00605.



312 PARALLEL ALTERATIONS IN ELECTROCORTICOGRAM PATTERNS AND SPONTANEOUS MULTI-UNIT ACTIVITY OF THE AUDITORY SYSTEM IN PARALYZED CATS. G. Humphrey and S. Orman.* Dept. Physiol., Univ. Ill. Med. Center, Chicago, Ill., 60680.

Multiple unit activity (MUA) was recorded from the cochlear nuclei (CN), superior olive, inferior colliculi, and medial geniculate body (GM) in chronically implanted Flaxedilized cats, and was compared with simultaneously recorded electrocorticographic (ECoG) patterns. A number of brain stem motor and "nonspecific" areas served as controls. Paralysis permitted adequate control of movement-induced noise and of ear muscle effects but precluded reliable extrapolation from ECoG to behavioral state. In general, auditory neurons showed a relationship to ECoG similar to that exhibited by motor and nonspecific units. Rates of unit activity tended to be higher in most sites, including much of the CN, during ECoG desynchronization, and lower during periods of synchronization. Brief alerting stimuli led to substantial long-duration increases in unit activity concomitantly with ECoG desynchronization. MUA from the central CN in the region of auditory nerve fibers showed no consistent relation to ECoG. Magnocellular GM activity showed a significant linear negative correlation with ECoG amplitude through the entire range of the ECoG, suggesting either a close association of this area with those responsible for the genesis of ECoG, or a particularly potent cortical influence on this site. Our data suggest that brain stem regions responsible for ECoG alterations are capable of generating enhanced activity in the auditory path during periods of cortical desynchronization. Such enhancement could facilitate transmission or processing, and could account for dishabituatory phenomena which have been observed in the auditory system of intact cats during acoustic habituation procedures.

313 AN ELECTROGRAPHIC ANALYSIS OF CONVULSIONS DURING ALCOHOL WITHDRAWAL IN THE RAT. Bruce E. Hunter*, Don W. Walker, Joseph N. Riley*, Carl A. Boast*, Steven F. Zornetzer and Gerhard Freund. Dept. Neuroscience. Col. Med. Univ. Fl. and VA Hospital, Gainesville, Fl.

Rats chronically implanted with electrodes in cortical, limbic, diencephalic and mesencephalic brain regions, were maintained for 14-26 days on a liquid diet in which 35-42% of total calories were provided by ethanol. The removal of alcohol resulted in the development of a variety of withdrawal symptoms including tail arching, ataxia, rigidity and tremor. Audiogenic convulsions were elicited 8-12 hours post-withdrawal and consisted of running episodes followed either by a generalized convulsion with tonic, clonic or tonic-clonic components (30-45 sec.), or a series of convulsions of a mixed variety with a total duration of 5-35 min. Brain seizure activity in conjunction with behavioral convulsions initially began in mesencephalic or limbic areas, spreading later to diencephalic and finally cortical regions. The pattern of behavioral convulsions, as well as their duration, appeared to be related to the intensity of seizures in mesencephalic, limbic and diencephalic regions. The results indicate the relative importance of subcortical, as opposed to cortical regions, in the genesis of convulsions during alcohol withdrawal in the rat. Supported by PHS Grant #AA00200 and the Veterans Administration, Project # MRIS 9183.

314 GLIAL-ENDOTHELIAL INTERACTIONS IN VITRO: RELEASE OF CULTURED HUMAN ENDOTHELIA TOPOINHIBITION BY C6 ASTROCYTOMA CONDITIONED MEDIA. H.T. Hutchison*, R.L. Suddith*, P.J. Kelly, K. Werrbach*, T. Colmore* and B. Haber, Dept. of Human Biol. Chem. & Genetics, Div. of Neurosurg. and Marine Biomedical Instit., Univ. Texas Med. Br., Galveston, Texas 77550

Trophic influences of glial cells upon other cell types may be important for the normal development and function of the CNS. Interaction between glial and endothelial cells is suggested by the intimate association of these cell types in the CNS, the specific morphological differences between central and peripheral endothelia, and the neovascularization characteristic of gliomas, as well as other tumors. As a model system in which to study possible glial-endothelial interactions, we have chosen endothelia cultured from human umbilical cord veins and the C6 astrocytoma cell line, a line which possesses many properties characteristic of normal glia. We have shown that media conditioned by C6 astrocytoma cells induces the proliferation of contact inhibited endothelial cells. That this medium specifically stimulates contact inhibited endothelial cells is shown by the observation that the rate of proliferation of endothelial cells in confluent portions of the culture dish increases dramatically whereas the rate of proliferation of endothelia in non-confluent regions of the same dish is actually slightly reduced. This effect is specific to C6 astrocytoma conditioned medium and is not produced by medium conditioned by homologous endothelial cultures. Several other tumor and non-tumor cell lines are currently being tested for trophic influences on endothelial cells. (Supported by PHS grants NS 11255, NS 11354, Welch Grants H-504 and H-536, the Moody and Lanier Foundations, and Neurosurgery MSRDP Research Funds.)

315 INNERVATION OF THE CAT SPINAL CORD VASCULATURE BY THE CATECHOLAMINE CONTAINING FIBERS (CCF). John D. Irvin,* Evangelos T. Angelakos,* and Jewell L. Osterholm.* (SPON. Jo Ann Heltzel) Hahnemann Med. Col., Phila., PA 19102.

Using the Falck-Hillarp formaldehyde condensation reaction, the innervation by CCF to the blood vessels in the spinal cord of the cat was studied. In the control cat, the large arteries and veins (extra medullary vessels [EMV]) in the ventral medial sulcus were extensively innervated by CCF; the lower cervical segments showing a higher percentage of innervated vessels than the remaining cord segments. Parenchymal vessels (PV) were identified by injection with a fluorescent latex. Many of these vessels were innervated by CCF; more in the white matter than gray. Nialamide pretreatment potentiated the catecholamine fluorescence seen in these vessels but did not increase the percentage of vessels innervated or the pattern of distribution of the CCF. Spinal cord injury likewise did not alter the pattern of distribution of the CCF to the EMV or PV. Mid-thoracic cord transection preserved the vascular innervation above the transection. Below the transection the innervation to the PV was depleted; Ecolid pretreatment depleted the fluorescence of the CCF (fiber) innervation to the EMV without affecting that in PV. It is concluded that the innervation by CCF to the spinal cord EMV is of a different origin than is that to the PV. (Supported in part by NIH grants HL 13008 and NS 10163 and a Themis contract from the Office of Naval Research).

316 HIPPOCAMPECTOMY IN RHESUS MONKEYS: EFFECTS ON PLASMA CORTISOL DURING TWO STRESSFUL CONDITIONS. William J. Jackson, Department of Physiology, Medical College of Georgia, Augusta, Ga. 30902, and Quentin R. Regestein*, Department of Psychiatry, Peter Bent Brigham Hospital, Boston, Mass.

Plasma cortisol was monitored at 8:00 AM, 2:00 PM, 8:00 PM, and 2:00 AM during: (1) Continuous 72-hr. confinement in a primate restraint chair and (2) Continuous 48-hr. exposure to a titrated aversive schedule. Monkeys with total removal of the hippocampus showed lower levels of plasma cortisol during chair confinement than normal monkeys. Subtotal lesions of the hippocampus, regardless of anterior or posterior location, did not alter the concentration of plasma cortisol during either stressful situation. The ciracadian periodicity of plasma cortisol concentration remained intact for all surgical groups, including those with total bilateral ablation of the hippocampus. Plasma cortisol did not vary significantly among any of the groups during continuous titrated aversive performance, but only 1 of 4 monkeys with total hippocampectomy had sufficient behavioral endurance to last the entire 48 hr. session. Pain threshold as measured by titrating aversive performance was not altered by hippocampectomy. Supported by USPHS Research Grant MH 16635-01, funds from the 6571st Aeromedical Research Laboratory, Holloman, N.M., and by GRS Grant, NIH 5S01 RR05365-10.

317 DIFFERENTIAL BEHAVIORAL AND NEUROCHEMICAL EFFECTS FOLLOWING LESIONS OF THE DORSAL OR MEDIAN RAPHE NUCLEI IN RATS. Barry L. Jacobs, William D. Wise* and Kenneth M. Taylor*. Dept. Psychol., Princeton Univ. and Squibb Inst. of Medical Res., Princeton, N.J. 08540

Locomotor activity and regional forebrain levels of serotonin (5-HT) were measured following the placement of electrolytic lesions in either the dorsal or median raphe nucleus of adult male rats. In the first two experiments, control lesions were placed in the brachium conjunctivum, and in the third experiment, a sham lesion group served as control. Median lesions significantly increased locomotor activity as measured in tilt cages, by 250-300% on the second day post-lesion, and this elevation stabilized at approximately 100% above control levels on day nine post-lesion. There were no statistically significant differences in the amount of locomotor activity in the dorsal, brachium or sham lesioned groups on any post-lesion day. When the amount of 5-HT depletion was measured five days post-lesion, it was found that the dorsal (D) and median (M) lesions produced similar reductions in cerebral cortex (D-40%; M-31%); hypothalamus (D-54%; M-58%) and striatum (D-50%; M-29%). However, the effects of the two lesions were markedly different in the hippocampus. The dorsal lesion produced a non-significant 10% reduction in hippocampal 5-HT level, while the median lesion caused an 82% reduction. On the basis of these data it is hypothesized that a reduction in hippocampal 5-HT may account for the increased activity in the median lesioned group.

318 DEVELOPMENT OF TOLERANCE TO MORPHINE FOLLOWING INTRACEREBRAL INJECTION IN THE PERIAQUEDUCTAL GRAY OF THE RAT. Yasuko F. Jacquet and Abel Lajtha. NY State Research Institute for Neurochemistry and Drug Addiction, Ward's Island, N.Y. 10035

Morphine injected via fine-gauge cannula in the rostral periaqueductal gray (PAG) of the rat resulted in profound analgesia accompanied simultaneously by an explosive hyper-reactivity to sudden auditory and visual stimuli. Both effects were dose-dependent, and could be blocked temporarily by prior intracerebral (IC) naloxone, or reversed temporarily by subsequent IC naloxone. This PAG site showed rapid tolerance development to a toxic dose of morphine. An initial dose of 20 µg of morphine bilaterally resulted in a 57% mortality rate, whereas if preceded by 1 - 3 injections of moderate doses of morphine, the mortality rate was cut to 0. Tolerance was also shown to the analgesic action of IC etorphine (1 µg bilaterally) given on 2 successive days. Cross tolerance to the analgesic action of morphine occurred between IC morphine and intraperitoneal (IP) administrations of morphine, as well as between IC morphine and subsequent IP levorphanol. These results indicate that 1) the PAG is a major site of morphine action, and 2) tolerance is a central, and not peripheral phenomenon.

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319 EFFECT OF Δ^9-THC AND ALCOHOL ON NUCLEIC ACIDS AND PROTEINS IN THE BRA AND LIVER OF THE CHICK EMBRYO. A. Jakubovic and P. L. McGeer. Kinsm Laboratory of Neurological Research, University of British Columbia, Vancouver, Canada.

Our previous studies have shown inhibition of nucleic acid and protei synthesis by THC in the brain of rats *in vitro* and *in vivo*. The presen study was an attempt to examine the overall effect of THC and/or alcoho in developing chick embryo and specially on protein and nucleic acid synthesis. The drug was injected into the yolk of the egg with the firs treatment on incubation day 2. THC was dissolved in alcohol. After one acute dose of THC 5 mg and/or the alcohol vehicle, the embryos were examined on day 13. With THC 1 mg or 2 mg and/or alcohol 10 µl the embryos were examined after 4 and 5 injections on incubation days 11 and 15, respectively. A mixture of L-leucine-U-^{14}C and uridine-5-^{3}H was injected into the air space one hour before termination of the experiment. The result showed that repeated injections of THC and/or alcohol reduced the body weight of the 11 day embryos. The 15 day embryos were, however, affected only by THC and not by alcohol alone. Moreover, the weight of the forebrain was significantly reduced only by THC. The weight of the liver was significantly increased by THC as well as by alcohol. In the embryo forebrain, optic lobe, cerebellum and liver the repeated application of THC and/or alcohol brought about changes in total as well as specific activities of RNA and protein and DNA. Under the conditions of these experiments no teratogenic effects were observed.

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320 ANATOMICAL AND BEHAVIORAL ANALYSIS OF HIPPOCAMPAL CELL FIELDS Leonard E. Jarrard. Dept. of Psychology, Washington & Lee University, Lexington, Va. 24450

Patterns of degeneration following unilateral aspiration lesions of either the anterodorsal CA1 cell field or fimbria (disrupting the major extrahippocampal afferent and efferent pathways of CA3-CA4 cell fields) with various survival times were studied in the rat using the Fink-Heimer stain. The resulting degeneration was generally similar to that previously described by Raisman et al. (Brain 89:83-108, 1966) with the Nauta stain. Especially important to the present research was the finding that following CA1 damage degeneration was confined to the dorsal fornix and absent in fimbria, while the opposite was found with section of fimbria.

In the behavioral study, 48 rats were divided into two control groups (unoperated and operated) and 4 groups that received bilateral aspiration lesions of either the fimbria, CA1 cell field, alveus, or "complete" hippocampus (consisting of damage to all cell fields and fimbria). Each animal was tested on a series of behavioral tasks chosen to measure different aspects of motivation and response perseveration. Animals with damage to hippocampus and those with fimbria damage were generally more active than controls, while subjects with complete hippocampal damage were impaired on tasks requiring the inhibiting of responses. Especially of interest was the finding that animals with complete hippocampal lesions and those with fimbria damage were similarly affected on some measures of activity and were more active than CA1, alveus, and control subjects. The results are discussed as they relate to the model proposed by Raisman et al. in which there are two distinct neuronal systems, one including the anterior part of field CA1 and the other including fields CA3 and CA4. (Supported by NSF Grant GB-30113.)

321 HIPPOCAMPAL AND PITUITARY-ADRENAL INFLUENCES ON ACTIVITY AND AVOIDANCE LEARNING IN RATS. John J. Jaso. Dept. Psychiatry and Behav. Sci., Univ. Okla. Health Sci. Ctr., Oklahoma City, Oklahoma 73190

Several studies have implicated the hippocampus with the hypothalamic-pituitary-adrenal axis. Knigge and Hays reported increased adrenocortical activity following lesions of the hippocampus (Proc. Soc. Expt. Biol., 1963, 114, 67-69). In the present experiment, the effects of hippocampal lesions were examined under pharmacologically-induced changes in pituitary-adrenal function to determine whether the behavioral changes produced by these lesions are the result of elevated pituitary-adrenal activity. Under saline conditions, lesioned animals were more active during a 15 min period in an activity chamber and exhibited poorer retention in a passive avoidance step-through task (one-trial learning; test 72 hrs later). Dexamethasone, a synthetic corticosteroid which suppresses adrenocorticotropic hormone (ACTH) release, reduced the locomotor activity of the lesioned group to saline-injected unoperated levels. Injections of ACTH elevated the activity of the unoperated animals to the level of the saline-injected lesioned group, but had little or no effect on the activity of lesioned rats. Retention in the passive avoidance task was enhanced by ACTH and impaired by dexamethasone injections in unoperated animals. The passive avoidance performance of lesioned animals was not affected by either raising or lowering adrenal activity. The absence of any drug effect on the lesioned group's passive avoidance performance suggests the impaired retention associated with hippocampectomy is not due to any hormonal action. On the other hand, the increased activity reported for hippocampectomy appears to be a function of the normally elevated pituitary-adrenal function associated with hippocampal lesions. This locomotor activity can be brought within normal ranges by lowering ACTH levels.

322 INTERRELATIONSHIP BETWEEN DOPAMINERGIC AND CHOLINERGIC NEURONS IN THE RAT STRIATUM. France Javoy°, Patrice Guyenet°, Jean-Claude Beaujouan°, Jacques Glowinski° and Yves Agid°. (Spon : F.N.Jones) Groupe NB, Collège de France Paris.

Interrelationship between dopamine (DA)and acetylcholine (ACh) systems was investigated by measuring in the striatum changes in DA or ACh metabolism induced by agonists and antagonists of ACh or DA receptors respectively. Changes in striatal DA metabolism induced by oxotremorine or atropine (i.p.) were estimated after injection of ^{3}H-tyrosine (i.v.) by following ^{3}H-DA accumulation (15 min) or in rats pretreated with a DOPA decarboxylase inhibitor (RO4-4602) ^{3}H-DOPA accumulation (index of DA synthesis) and DA decline (index of DA utilization). The effects of apomorphine or chlorpromazine (i.p.) on ACh metabolism were investigated by studying striatal ACh content : utilization was estimated by following the rate of ACh decline after inhibition of its synthesis by local injection of Hemicholinium (HC-3). Oxotremorine 0.1 mg/kg did not affect DA metabolism but at 0.5 or 1.5 mg/kg increased ^{3}H-DOPA formation and DA decline induced by RO4-4602 . Atropine 1 mg/kg was uneffective on DA metabolism; the injection of 5 or 20 mg/kg increased ^{3}H-DA accumulation, however ^{3}H-DOPA formation was unaffected in RO4-4602 treated rats. Thus at small doses neither the cholinergic stimulating nor the antimuscarinic drug affected striatal DA metabolism. At higher doses oxotremorine stimulated DA turnover while atropine reduced DA utilization. Chlorpromazine (15 mg/kg) and apomorphine (10 mg/kg) decreased or increased respectively the striatal ACh content. CPZ accelerated the rate of ACh decline following HC-3 injection. This effect was abolished by the simultaneous injection of APO. The data indicate that the antagonist of DA receptors increases while the agonist decreases ACh release. The results suggest a mutual regulatory influence (inhibitory influence of DA neurons on ACh neurons; excitatory influence of ACh neurons on DA neurons) between DA and ACh systems in the striatum.

323 IMMUNOCHEMICAL PROPERTIES OF THE SUBUNITS OF LUBROL SOLUBILIZED (Na^++K^+)-ATPase FROM ELECTRIC EEL. Dou Huey Jean*, R. Wayne Albers* and George J. Koval*. (SPON: H. Yellin). Lab. of Neurochemistry, NIH, Bethesda, Md. 20014.

(Na^++K^+)-ATPase consists of two subunits--96,000 daltons (P96) and 58,000 daltons (P58)--as revealed in SDS-polyacrylamide gel electrophoresis. P96 has been shown as the phosphoryl acceptor protein; whereas the function of P58 is still unknown. The consistent presence of P58 in (Na^++K^+)-ATPase preparations from various tissues and species suggests its possible role in this transport ATPase system. The strategy employed was an immunochemical approach. These two subunits were isolated by preparative SDS-polyacrylamide gel electrophoresis. Lubrol solubilized (Na^++K^+)-ATPase (LSE) and the two subunits derived from it were all antigenic. The antiserum against each of these three antigens inhibited (Na^++K^+)-ATPase activity to some degree. The inhibition was maximal four weeks after first injection and was directly proportional to the increasing amounts of antisera. Immunodiffusion in 1% agar gel indicated that only LSE antiserum, but not P96 or P58 antiserum, gave one major precipitating band with LSE. However, specific complex formation between anti-P96 and LSE and between anti-P58 and LSE was shown indirectly: after incubating LSE and increasing amounts of antisera at 37° for 15 min, they were placed on the side wells of an immunodiffusion plate with antisera against LSE in the central well. The intensity of the precipitating band decreased with increasing amounts of antisera. When goat anti-rabbit serum was added to similar reaction mixtures, the non-precipitating enzyme activity decreased with increasing amounts of antisera in the mixture. Thus, we conclude that both P96 and P58 are integral parts of (Na^++K^+)-ATPase.

324 ULTRASTRUCTURE OF NUCLEUS SOLITARIUS AND PARASOLITARIUS IN THE RAT. John E. Johnson, Jr. and William R. Mehler. Neurosciences Branch, Ames Research Center, Moffett Field, California 94035

Nucleus solitarius extends from the level of the obex rostrally to a point just rostral to the level of the dorsal cochlear nucleus. Dorsolateral to the caudal third of the nucleus solitarius, and co-extensive with the area postrema, lies a strip of smaller cells, the nucleus parasolitarius. The predominant neurons of nucleus solitarius are round to oval shaped and 15u-20u in size. The nuclei are somewhat oval in shape and occasionally invaginated. The cytoplasm contains well developed Golgi, numerous mitochondria and extensive granular endoplasmic reticulum. The neuropil contains few myelinated fibers. Cells of nucleus parasolitarius are consistently smaller (10u) and elongated. Both solitarius and parasolitarius contain a complete complement of glial cells. Occasionally, unusual neuronal cytoplasmic organelles such as whorls of apparent endoplasmic reticulum and filamentous bodies are encountered. Synaptic terminals containing spherical (S), flattened (F) and dark cored vesicles are numerous.

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325 BLOCKADE OF OVULATION BY METHADONE IN THE RAT. James H. Johnson, Michael W. Etkin* and John A. Rosecrans. Virginia Commonwealth University/Medical College of Virginia, Richmond, Virginia 23298.

Spontaneous ovulation in the female rat is initiated by a neurogenic activation of pituitary LH release occurring between 14:00 and 16:00 colony time on the afternoon of proestrus. Administration of CNS depressants prior to and during this "critical period" blocks ovulation. Morphine has such an effect (Barraclough & Sawyer, Endocrin 57:329, 1955) and the present studies were undertaken to determine whether methadone can also block ovulation. Since complete blockade of ovulation requires suppression of neural mechanisms for most of the afternoon of proestrus, the total dose was administered in thirds at 13:00, 14:00, and 15:00. Regularly-cycling rats of both the Wistar and Sprague-Dawley strains were used. Oviducts were removed bilaterally the following morning and the number of ova shed was determined. Three doses of methadone were tested, and the results are shown in the table.

Total Dose Methadone	Number		Number Ovulating		% Blocked		Ova Per Ovulating Rat	
	W[a]	SD[b]	W	SD	W	SD	W	SD
6 mg/kg	5	4	5	4	0	0	11	10
9 mg/kg	2	5	1	3	50	40	14	8
15 mg/kg	7	17	1	2	85	88	6	9

a. W=Wistar b. SD=Sprague-Dawley

The methadone blockade of ovulation was overcome by electrochemical stimulation of the medial preoptic area, whereas stimulation of the caudate nucleus had no effect on ovulation. It is concluded, therefore, that methadone, like morphine, can inhibit ovulation in the rat, and that this drug should be added to the growing list of compounds which do so.
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326 GLUTAMATE AND GLUTAMINE PROXIMO-DISTAL FLOW IN THE DORSAL SENSORY NEURON. Jeffery Lee Johnson. Dept. of Physiol., USD School of Medicine, Vermillion, South Dakota 57069

The nature of the proximo-distal (P-D) convection mechanism in the sensory axons in relation to glutamate formation and conversion to glutamine, was noted after injection of various labeled precursors into the lumbosacral dorsal root ganglia of cats. When (U-14C) glutamate was injected into the ganglion, and the P-D distribution of label noted down the peripheral nerve at 1, 3 and 5 hr periods, a rapid flow of about 400 mm/day was evident. This rapid component for glutamate, however, was smaller than that noted for labeled leucine previously. When the label from (U-14C) glutamate was compared proximally (down the dorsal roots) vs distally (down the peripheral nerve) from the injection site at the ganglion, more label was convected proximally than distally, consistent with the fact that glutamate levels are higher in the dorsal root than in the distal fibers. When a combination of 10 μc of (U-14C) glutamate, 5 μc of (U-14C) glucose and 5 μc of (U-14C) aspartate was injected into the L7 & SI ganglia bilaterally, there was a sharp P-D increase in the glutamine/glutamate relative specific radioactivity ratio (RSA) at 60 min but not at 15 min. Also, the P-D decrease in the glutamate specific radioactivity (dpm/μmole) was much less at 60 min than at 15 min. Both of the above observations suggest a P-D convection of glutamate with conversion to glutamine. Analysis of the alanine/glutamate and glycine/glutamate RSA in the combination injection vs values obtained with each precursor alone reveal that each precursor in the combination is feeding into the free glutamate pool flowing down the axons. Thus, there is a rapid P-D convection of free glutamate down the axons of the dorsal root with the perikaryon being an effective source for glutamate at the terminals in the spinal grey but not in the more distant nucleus gracilis.

327 A Regulatory Mechanism Related to Cortical Stability and Epileptiform Activity in the Thalamocortical Motor System of the Cat. R.N. Johnson and G.R. Hanna. Depts. Biomed. Engr. and Neurology, Sch. Med., Univ. of Virginia, Charlottesville, Virginia 22901

Based on physiological data, a simplified model of the ventrolateral thalamic-sensorimotor cortical system (VL-MC) is proposed, containing as principal components an integrator and a regulator. The integrator generates ramp functions, with the slope of the ramp determined by sensory (peripheral) input. The duration of the ramp function is controlled by the regulator. The regulator is assumed to be a higher order control system whose overall goal is to prevent the VL-MC system from shifting to an unstable (e.g. epileptiform) mode of operation. The VL-MC system has been investigated in alert cats and under 3 anesthetic agents; pentobarbital, chloralose and ketamine. The later 2 have been claimed by some authors to have convulsant properties. The experimental results under ketamine, when explained within the constraints of the model, indicated that the ramp generation mechanism was disabled. No cortical epileptiform activity was observed. In experimental tests under chloralose, the ramp truncation or regulatory mechanism appeared to be reduced in capacity with epileptiform activity present on motor cortex when "critical" parameter values were exceeded. The interplay of the cerebellum on this system has been experimentally observed. Stimulation of the cerebellar cortex can force key parameters below "critical" values. It is suggested that a regulatory mechanism exists as a functional part of the thalamocortical motor system of the cat and that this regulatory mechanism plays a key role in preventing the system from shifting to an unstable mode, characterized by epileptiform cortical activity. The model has also been simulated on an analog computer and suggests one possible design for the regulatory mechanism, in terms of the variables measured and the parameters controlled.

328 RECONSTRUCTIVE MEMORY IN HUMAN SUBJECTS OBSERVED AS NEUROMUSCULAR BEHAVIOR PATTERNS: A clinical model. Virginia Johnson. 1516 Westwood Boulevard, Los Angeles, California 90024.

Neuromuscular systems are available for learning and conditioning (organismic modifiability), such programming being reflected in the "final common pathway" which is called behavior. Learning and feedback principles apply to psychopathological syndromes as well as to "normal" (adaptive) patterns; and the clinical observation is well documented that stereotypical or repetitive movements characterize many behavior disorders. The hypothesis is suggested that these latter patterns reflect a reconstructive memory process involving self-reinforcing feedback in the motor (neuromuscular) system; and therefore in the accompanying sensory responses monitored by the cortex which play a crucial role in perceptual adaptation. Such a clinical model of behavior not only assumes a specificity of neurophysiological experience (engram), conditional with respect to neuromuscular symptoms (encoded), but that the experiential prior can be traced (retrieved), and that it is etiologically significant for diagnosis, prognosis, and treatment. Filmed sequences on human subjects will be shown to illustrate the suggested clinical model.

329 THE SOMATOSENSORY CORTEX: WHAT IS A STELLATE CELL? E. G. Jones. Dept. Anat., Washington Univ. Sch. Med., St. Louis, 63110.

Non-pyramidal cells have been studied in SI of the squirrel monkey cortex using the rapid Golgi method, the material being analyzed qualitatively, quantitatively and by computer rotations. Layer IV contains the somata of spiny cells which resemble the spiny stellate cell of the visual cortex except in shape. The cells are not star-shaped but elongated with a prominent dendritic tuft, frequently resembling the apical dendrite of a pyramidal cell, ascending into layer IIIb. Like visual stellate cells, however, the cells have three or more strongly recurrent axon branches which ascend in a tight bundle to layer II, enclosing the apical dendrites of pyramidal cells as they do so. Comparative counts of the distribution of dendritic spines show that the frequency of spines is identical on visual stellates and on the spiny cells of SI; in each case, the concentration per 10μ segment is consistently less than on pyramidal cells with somata of similar diameter. Concurrent autoradiographic studies show that thalamic afferents terminate in layers IV and IIIb and it is thought that the shape of the spiny cells in SI is linked to this extensive spread. The shape also varies with the folding of the cortex, becoming star-like only as layers III-VI become thinned in the floor of the central sulcus and the extent of the thalamic afferent plexus is concomitantly reduced.

330 SEDIMENTATION CHARACTERISTICS OF CATECHOLAMINE SYNAPTOSOMES IN SUCROSE DENSITY GRADIENTS. G. Jonsson* and C. Pycock* (SPON: D. Novin) Dept. Histology, Karolinska Institutet, S-104 01 Stockholm, Sweden.

The sedimentation properties of catecholamine (CA) synaptosomes from various regions of rat brain have been studied after sucrose density gradient centrifugations. The synaptosomes were prepared by homogenization of brain tissue in isotonic sucrose, labelled in vitro with radioactive noradrenaline and centrifuged in continous sucrose density gradients (ranging from 0.3-1.6 M sucrose) at 75,000 g for 120 min. Thereafter the distribution of radioactivity in the gradients was determined. The heaviest synaptosomes were obtained from the neostriatum (equilibrating at 1.25 M sucrose) and the lightest from the cerebellum (equilibrating at 1.1 M sucrose). Treatment of the rats with reserpine or α-methyl-p-tyrosine, known to deplete brain CA, caused the synaptosomes to sediment at a lower sucrose concentration. The reversed effect was observed after producing an increase in the CA concentration of the synaptosomes. The present results indicate that the transmitter content can modify the sedimentation characteristics of CA synaptosomes in sucrose density gradients. It is suggested that this may be related to changes in osmotic properties of the synaptosome.

331 EVIDENCE FOR A CORTICAL ESTROGENIC INVOLVEMENT IN EXPERIMENTAL PETIT MAL EPILEPSY. Robert M. Julien, Steven C. Lange*, and Glen W. Fowler*. Depts. of Pharmacology and Pediatrics, Univ. of California, Irvine, CA 92664.

Studies on male and female cats were conducted using cortical and subcortical application of conjugated estrogens (CE) in order to further delineate the site of estrogen-induced 3Hz spike-wave activity. 2% CE was topically applied to intact and chronically isolated cerebral cortex and also injected into n. centrum medianum (CM) of the thalamus and into ventral and dorsal hippocampi. Injection of CE into subcortical structures produced generalized, intermittent bursts of high voltage polyspike (8-12 Hz) complexes. Subcortical injection of CE failed to elicit 3 Hz spike-wave discharges. Unilateral application of CE to intact frontal cortex produced a generalized 3Hz spike-wave pattern recordable from cortex and CM. Topical application of CE to intact frontal cortex with simultaneous CE injection into CM produced two independent yet simultaneous seizure patterns: i.e., 3Hz spike-wave discharges originating from the cortex and 8-12Hz polyspike patterns recorded from thalamus. Chronically isolated slabs of suprasylvian cortex (Sharpless & Halpern: Electroenceph. clin. Neurophysiol. 14:244, 1962) were prepared in 5 animals. Topical application of CE to these slabs produced a 3Hz spike-wave pattern restricted to the isolated tissue. Results indicate that CE initiates a generalized 3Hz spike-wave pattern, subcortical CE initiates a generalized polyspike discharge, and that while spike-wave discharge may be visualized in subcortical structures, the participation of these structures in 3Hz spike-wave discharges appears to be unnecessary. (Supported by USPHS Grant No. NS-09835 and by the Rebecca Payne Livingston Foundation).

332 POSTNATAL DEVELOPMENT OF VISUAL ACUITY, CYTOARCHITECTURAL AND CHEMICAL ORGANIZATION OF THE STRIATE CORTEX AND GROWTH OF THE BRAIN, PITUITARY AND ADRENALS IN THE SQUIRREL MONKEY. B. Kaack*, J. M. Ordy, and K. R. Brizzee. Delta Regional Primate Research Center, Covington, La. 70433

Postnatal visual acuity was established in the squirrel monkey from birth to adult levels in relation to the cytoarchitectural and chemical organization of the foveal projection area on the lateral and posterior striate cortex of the brain. Rank order comparisons were also made of the relative growth of the brain, pituitary, adrenals and body at birth in relation to their respective asymptotic values at maturity. Visual acuity was 36 minutes at birth. Adult acuity of 1 minute was established by the end of the first year. A mean cortical depth of 1.59 mm was established in the foveal projection area on the lateral surface of the striate cortex in adult monkeys. Shortly after birth, striate cortical depth in this region was 1.30 mm. Adult values of 1.50 mm were established by the end of the first year. During the first 3 months after birth there was rapid isocortical stratification, decreased cell packing density and increased neuropil differentiation in all 6 laminae of the striate cortex. DNA, RNA and protein concentrations in the foveal projection area in 5 mature subjects were respectively 2.06, 9.07 and 114.7 mg/g. DNA remained relatively constant during the 1st year, whereas cellular RNA and protein increased from 4.60 and 67.0 mg/g at birth to adult levels of 9.0 and 120.0 mg/g by the end of the 1st year. Brain weight after birth was 15.00g which constitutes 64% of the mature brain weight of 25 g. Relative to the respective asymptotic values at maturity, the left-right adrenal weights at birth were 61% and 62%, the pituitary was 30%, and the body weight was 16% at birth. There was an increasing sex dimorphism in organ and body weight with age. (Supported by NIH Grant RR00164-12.)

333 MECHANISMS INVOLVED IN THE PROLONGED MOTOR INHIBITION PRODUCED BY IMPULSES FROM TYPE J PULMONARY RECEPTORS. M. Kalia* and H.P. Koepchen* (SPON: A. L. Beckman). Cardiovasc.-Pulm. Div., Univ. of Pa. School of Medicine, Philadelphia and Physiologishes Institut der Freien Universitat Berlin.

Although the activity in most fibers of type J receptors ends about 7 seconds after a right atrial injection of phenyl diguanide (pdg), there are some fibers in which the activity continues beyond this period and so it is possible that the prolonged reflex inhibition (up to 2 minutes) of somatic muscles may be due to continued input from type J receptors. To test this possibility, experiments were done on cats using previously described techniques (Kalia (1973) Pflugers Archiv., p. 297). In the initial experiments the vagus nerves were cooled rapidly down to 2^{o} C immediately after a right atrial injection of pdg, while the knee jerk was being continuously recorded; the vagal block so produced did not reduce the duration of the inhibition of the knee jerk. In 10 subsequent experiments the vagi were sectioned 8 seconds after a right atrial injection of pdg. Again no reduction in the duration of inhibition was found. Subsequent right atrial injection of pdg failed to elicit any response. Thus it is clear that the prolonged inhibition of the knee jerk must be due to the activation of central neural mechanisms produced by the initial discharge from type J receptors and not due to a prolonged input from the periphery. (Supported in part by USPHS grant HL-08805 and Alexander von Humboldt Stiftung).

334 CONNECTIONS OF THE POSTERIOR CINGULATE CORTEX IN THE CAT. K. Kalil* (SPON: W.I. Welker). Dept. Anat., Univ. of Wisconsin, Madison, Wisconsin 53706.

The efferent connections of the two cytoarchitecturally distinct fields of the posterior cingulate cortex: (1)the dorsal cingular area (CG) and (2) the ventral retrosplenial region (RS) were studied with the Fink-Heimer and autoradiographic methods for tracing neuronal pathways. Both methods revealed that the CG and RS fields have clearly different thalamic and cortical projections. The RS cortex projects heavily upon the anteroventral (AV) and laterodorsal (LD) nuclei, some of these projection fibers travelling by way of the fornix. By contrast, the CG cortex projects to a rostral area of the lateralis posterior (LP), a region sometimes termed lateralis intermedius (LI), and does not project to the AV, the LD, or through the fornix. Cortical association fibers from the RS field project upon the parahippocampal cortex; the CG cortex sends ipsilateral efferents to the frontal cortex and the suprasylvian gyrus. These differential projections indicate that the RS cortex is associated with limbic regions such as the AV and LD nuclei, the fornix, and the parahippocampal cortex, but a major dorsal region (CG) of the posterior cingulate cortex does not share these connections and thus lies outside the circuitry of the limbic forebrain. In its thalamic and cortical connections the CG field appears to be more closely related to parietal association rather than limbic cortex.

335 CONTROL OF CENTRALLY PROGRAMMED FEEDING IN HELISOMA TRIVOLVIS. Chris R.S. Kaneko*, Stanley B. Kater*, and Robert L. Fountain*. (SPON: B. Zipser). Dept. Zool., Univ. Iowa, Iowa City, Iowa, 52242.

As an initial step in the analysis of higher order control of feeding behavior, the effects of various modalities of stimulation were recorded intracellularly in the neurons of the buccal ganglia which comprise the basis of the central program. Presentation of aversive stimuli result in the cessation of feeding. Inhibitory postsynaptic potentials (IPSPs) are evoked by aversive stimuli and recorded in the Cyberchrons and the Protractor Motorneurons (PMns). These chemical IPSPs inhibit feeding by increasing the membrane potential, decreasing the shunt resistance of the membrane, and decreasing the electrical coupling within each group of cells. Excitatory postsynaptic potentials (EPSPs) in Retractor motoneurons (RMns) serve to facilitate retraction of the feeding apparatus, the buccal mass, back into the animal. Since the IPSPs are small and since electrical coupling between Cyberchrons is essential for feeding (Kater, Am. Zool, in press), we believe that it is the reduction in coupling which mediates the cessation of feeding. Proprioceptive input from receptors in the buccal mass may be excited mechanically. Such stimulation results in IPSPs in PMns and EPSPs in RMns which serve to modulate stroke intensity in proportion to substrate drag. Proprioceptors also evoke EPSPs in Cyberchrons which modulate the feeding frequency but not the amplitude. Other modalities of stimulation have no reproducible effects on feeding neurons. No large magnitude inputs have been observed. It is concluded that feeding is controlled by a number of low magnitude parallel inputs which act in concert as level setters.

336 MUSCLE PATHOLOGY FOLLOWING BRAIN LESIONS IN RATS. Marilyn I. Kanner and Herbert Y. Meltzer. Univ. Chicago Pritzker Sch. Med., Dept. Psychiatry, Chicago, Ill. 60637.

The role of the nervous system in the maintenance of normal skeletal muscle structure is of great current interest. Atrophy of skeletal muscle in man following various brain diseases has been frequently described. We have found that electrolytic lesions of the substantia nigra, caudate putamen, lateral hypothalamus, nucleus accumbens septi and lateral septum in the rat may lead to scattered pathologic skeletal muscle fibers in the vastus lateralis muscle 8 weeks after lesioning. Lesions of the frontal lobe and locus coeruleus did not produce pathologic changes in muscle. After unilateral substantia nigra lesions, 4/16 rats had a relatively large amount of pathology (e.g. 19 necrotic fibers, slight Type I fiber hypertrophy, and 9 small angular or round fibers/3000 fibers); 4 had lesser pathology of this type, and 8 were without any pathology. The incidence of rats with muscle pathology after the lesion was significantly greater than that of 15 sham-operated controls ($p < 0.025$). Rats with bilateral lateral hypothalamic lesions had more extreme pathology (e.g. 50 atrophic fibers/3000 fibers). Serum creatine phosphokinase activity was not significantly increased in any of the lesioned rats at the time of sacrifice. (Supported by FFRP grant #72-533 and by USPHS MH grants 16,127 and 18,396).

337 TRAINING INCREASES LEUCYL-tRNA ACCEPTOR ACTIVITY IN GOLDFISH BRAIN. B.B. Kaplan and J.L. Sirlin. Dept. Anat., Cornell Univ. Med. Coll., New York, N.Y. 10021.

Changes in brain $tRNA^{leu}$ activity correlate with the acquisition of a new behavioral skill in goldfish (Kaplan et al., Brain Res. 56: 239, 1973), whereas the level of free brain leucine remains invariant. Initial controls indicated that the increased $tRNA^{leu}$ activity induced by training (4 h) was not caused by stress, physical exertion or gross non-specific stimuli attendant to training. To assess further the specificity of this molecular alteration additional controls were conducted. The type, duration and pattern of stimuli undergone during training were duplicated mechanically by rotating animals about their longitudinal axis (20 rpm) at four selected angles. Rotation (1 h) followed by forced swimming in a whirlpool apparatus (3 h) caused increase in $tRNA^{leu}$ activity smaller than but similar to that seen in trained fish. By contrast, 1 h disoriented swimming provoked by KCl administration (10 µl 0.75 M KCl, i.c.) followed by whirlpool swimming (3 h) had little if any effect. Whirlpool swimming (4 h) by itself had no effect. Since fish invariably struggle in the rotation apparatus the effect of rotation on learning behavior was examined. Rotated animals adapted more rapidly to the behavioral challenge than naive controls as judged from both learning curves and mean group times to criterion. Whirlpool-stressed fish behaved no differently than naive controls. These findings indicate that fish undergo behavioral adaptation during rotation. Thus, like training, adaptation but not physical exertion or stress appears to increase $tRNA^{leu}$ activity. The data support the correlation of this activity with some as yet undefined aspect of behavioral training. (Supported by PHS grants MH-45139 and 5 SO1 RR05396)

338 **Behavioral Effects of Hippocampal X-Irradiation.**
Richard Kaplan*, Robert B. Wallace, and Jack Werboff* Dept. Psych., University of Hartford, West Hartford, Conn. 06117

Eleven litters of Long-Evans hooded rats randomly bred from the colony at the University of Hartford were divided into three groups, such that each group contained at least 14 male pups. Half of each litter group (7 males) received 150r of x-irradiation on that portion of the head containing the hippocampus using a 250 KV Kelekett deep therapy unit. The remaining half of each group served as nonirradiated controls. The experimental group received this treatment on postnatal days 5 - 15. All animals were evaluated behaviorally in the open field and in a two-way shuttle box avoidance task. Open field behavior measured at 30 days of age showed rats that had received 150r of x-irradiation for 15 days had higher ambulatory scores. When these same rats were trained in a two-way shuttle box avoidance task as adults they demonstrated facilitated acquisition. Histological examination of the hippocampus revealed approximately a 60% reduction in the number of granular cells, with no apparent damage to other structures. These results demonstrate behavioral deficits parallel to those following classical hippocampal lesions.

339 PASSIVE AVOIDANCE LEARNING DEFICITS PRODUCED BY AMYGDALA LESIONS: RELATIONSHIP WITH PITUITARY-ADRENAL SYSTEM. Bruce S. Kapp, Nicholas J. Russo II* and Richard E. Musty. Dept. of Psychology, University of Vermont, Burlington, Vermont, 05401.

Recent experiments have demonstrated that rats with amygdala lesions are deficient in learning both active (Bush et al., 1973) and passive (Pellegrino, 1968) avoidance tasks. Furthermore, when compared to controls, rats with amygdala lesions demonstrate decreased levels of plasma corticosterone in response to stress (Knigge, 1961). The present experiments were designed to determine whether or not the passive avoidance deficits produced by amygdala lesions are a function of a lesion-induced decrease in the response of the pituitary-adrenal system to footshock-produced stress during conditioning. Male Sprague-Dawley rats with lesions of the amygdala demonstrated significant retention deficits for one-trial passive avoidance conditioning when compared with unoperated and operated control subjects. The deficits were not due to altered footshock sensitivity in the lesioned subjects. In a second experiment, injections of 16 I.U. of adrenocorticotrophic hormone (ACTH) immediately following the conditioning footshock did not significantly attenuate the retention deficits in the amygdala-lesioned subjects and had no effect on the retention scores of control subjects. In a final series of experiments, no significant decrease in plasma corticosterone levels was found in amygdala-lesioned subjects in response to the footshock-induced stress of the conditioning task when compared with control subjects. The results of these experiments suggest that retention deficits for one-trial passive avoidance conditioning in amygdala-lesioned rats are neither correlated with, nor a function of, an altered pituitary-adrenal response to the stress incurred during the avoidance conditioning.

340 DISTRIBUTION AND REGULATION OF PHOSPHORIBOSYLPYROPHOSPHATE SYNTHETASE IN RAT BRAIN. Frederick C. Kauffman and Rita Ghosh*. Department of Cell Biology and Pharmacology, University of Maryland, School of Medicine, Baltimore, Maryland 21201.

Phosphoribosylpyrophosphate (PRPP) synthetase has been measured in seven regions of the adult rat brain including the cerebellum, cerebral cortex, olfactory bulbs, hippocampus, brain stem, septum and hypothalamus. Kinetic studies were carried out with a preparation purified approximately 50-fold from whole rat brain. The enzyme is similar to that obtained from other sources in having an absolute requirement for high levels of inorganic phosphate for both the forward and reverse reactions. In the presence of optimal levels of inorganic phosphate and Mg^{++}, the apparent Km for ATP is 0.14 mM and 0.23 mM for ribose-5-phosphate. The apparent Km's for PRPP and AMP in the reverse reaction are 0.67 mM and 0.08 mM, respectively. The enzyme is highly specific for ribose-5-phosphate, and is inhibited by levels of this substrate above 2 mM. The activity from rat brain appears to be regulated by cellular energy charge. Both ADP and AMP inhibit the enzyme. When adenine nucleotides were adjusted to levels corresponding to that observed in rat brain under resting conditions, i.e., an energy charge of 0.8, the activity of PRPP synthetase was approximately 80% of that observed with ATP alone. In the presence of adenine nucleotide levels corresponding to a high energy charge, 6-phosphogluconate caused a marked enhancement in the activity from brain. These findings support the conclusion that PRPP synthetase represents an important regulatory enzyme in the de novo biosynthetic pathway for ribonucleotides in mammalian neural tissue. (Supported by USPHS Grant NS08157).

341 PHYSICOCHEMICAL, QUANTUM CHEMICAL AND OTHER THEORETICAL STUDIES FOR THE UNDERSTANDING OF THE MECHANISM OF ACTION OF CNS AGENTS: PSYCHOTROPIC DRUGS, NARCOTICS AND NARCOTIC ANTAGONISTS AND ANESTHETICS. Joyce J. Kaufman* and W. S. Koski* (SPON: W. H. Gantt). The Johns Hopkins University School of Medicine, Baltimore, Maryland 21205 and The Johns Hopkins University, Department of Chemistry, Baltimore, Maryland 21218

Pharmacological effectivity of CNS agents is governed by lipophilicity and topographical and electronic structure of pharmacophores. Three different classes of drugs investigated (anesthetics, narcotics and narcotic antagonists and psychotropic drugs) depend differently on these. Isonarcotic pressures of most anesthetics are proportional to $\sqrt{a}$, (Van der Waal's constant). Thermochemical theory verifies this. Narcotic and narcotic antagonist effectivity are governed both by their lipophilicities and by electronic and topographical properties. pK_a's, partition coefficients and drug distribution coefficients have been measured accurately by a microtitrimetric technique as a smooth function of pH. Calculated quantum chemical electron densities have been verified by experimental measurements. Neuroleptics require not only high partition coefficients but very specific topography. Calculations on a hither unknown series indicated these would be effective neuroleptics; this was confirmed by subsequent report of their synthesis and testing. Support in part by NIMH (Psychopharmacology Branch and Narcotic Addiction and Drug Abuse Division), ONR and Ayerst Laboratories.

342 REWARD-ASSOCIATED EXCITATION AND PAIN-ASSOCIATED INHIBITION LASTING SECONDS IN SINGLE MEDIAL GLOBUS PALLIDUS NEURONS. James J. Keene. Dept. Physiol., Sch. Med., Univ. Puerto Rico, San Juan, P. R. 00936.

In unit recording studies seeking forebrain neural substrates for sensations of pain or reward, unit responses may represent arousal effects or non-motivational stimulus properties in addition to the rewarding or aversive features per se of the stimuli. But by examining single cell responses to both rewarding and aversive stimuli, contrasting effects of these emotionally opposite stimuli might reveal their possible media of neural representation separate from other arousal or cognitive properties of the stimuli. Prolonged changes (10 sec poststimulus periods) in unit firing rate following stimuli (0.2 sec, 100 Hz, 0.5 msec cathodal pulses) at reward sites in medial forebrain bundle (MFB) and aversive midbrain reticular sites (RET) were observed in unanesthetized post-collicular cerveau isolé rats. Longlasting MFB-elicited inhibition and RET-elicited excitation converged on single cells only in intralaminar thalamus (Brain Res., 64: 211-224, 1973). Since these effects had a comparatively long duration, the present study postulated that a reciprocally connected brain region might also show opposite MFB and RET effects, but the inverse of those seen in intralaminar thalamus. Thus far, the following mean post-stimulus (10 sec) discharge rates (spikes/sec) suggest that this region may be medial globus pallidus and the ansa lenticularis projection path.

Structure	No. Units	Control	MFB	RET
Medial Globus Pallidus	23	10.15	12.44	8.45
Lateral Globus Pallidus	38	8.14	9.05	9.40
Thalamic Ventral Lateral N.	53	7.71	5.58	5.82

Thus, a medial globus pallidus-intralaminar thalamus system may be central to the neural coding of affective states, integrating these with motor control and sensory information respectively.

343 ELECTROPHYSIOLOGICAL OBSERVATIONS IN THE COCHLEAR NUCLEAR COMPLEX.
Duncan T. Kennedy, Morin Memorial Laboratory, Dept. Anat., Wayne State University, Detroit, Michigan 48201.

This study utilizes the advantages of electrical stimulation in studying the central auditory system. Field and extracellular unit potentials were recorded in the cochlear nuclear complex (CNC) of the cat (chloralose anesthesia) with 2-8 Megohm micropipettes (2M NaCl). Brief (0.01-0.05 msec) electrical stimulation of the cochlea produced a remarkably synchronous activation of cochlear nerve fibers of triphasic waveform, in the ventral CNC with a duration of ca. 0.5 msec and an amplitude of 5 mV or more. This volley had a refractory period of 0.3-0.5 msec and was followed immediately by a double peaked negativity of 0.8 msec duration and some 3 mV amplitude. Antidromic activation of the ventral CNC by stimulation of the superior olive-trapezoid body demonstrated a refractory period of 0.5 msec for these secondary neurons. Orthodromic-antidromic double shock studies revealed that the second peak of the double negative component is postsynaptic. Cochlear double shocks showed a 0.5 msec refractory period for this postsynaptic component, indicating a secure synapse capable of following frequencies up to 2 KHz. Unitary, giant spikes occurred at the time of the postsynaptic component of the orthodromic field and had similar refractory periods and interactions. When antidromically activated these spikes had an inflection on their rising edge which under double shock separated into two components indicating an initial segment, soma-dendritic sequence of antidromic activation.
Supported by Grant NIH RR 05384-12.

344 ROLE OF THE CONTRALATERAL SPINAL ROOTS IN SPINAL HABITUATION.
D. R. Keppner* and P. Roccaforte* (SPON: C. Sherry). Dept. Psych. Ed. Illinois Institute of Technology, Chicago, Ill. 60600.

Transection of the ventral roots contralateral to a hindlimb muscle that has been classically conditioned renders the CR unextinguishable in spinal preparations. The present study was an attempt to determine whether or not the contralateral ventral roots play a role in spinal habituation. Hindleg flexion responses were habituated to a shock stimulus. Following habituation, either the contralateral ventral or dorsal roots were transected. No change in habituation was found following either dorsal or ventral root transection. Unbalancing the spinal preparation by disrupting afferent input through the dorsal and ventral roots on one side does not affect the process of habituation on the other side. Apparently, different mechanisms control extinction and habituation in the acute spinal mammal.

345 NEUROCHEMICAL EFFECTS OF CHRONIC PRETREATMENT WITH α-METHYLTYROSINE OR U-14,624 IN RATS. J. H. Khalsa* and W. M. Davis. (SPON: Harold B. White). Dept. of Pharmacol., Sch. of Pharm. of Mississippi, University, MS 38677.

Recently we have reported (Khalsa and Davis, 1973, 1974) that motor stimulant effects of morphine sulfate (MS) and d-amphetamine sulfate (AS) are blocked by both acute and chronic pretreatment with catecholamine (CA) depleting agents, α-methyl-p-tyrosine (AMT) and 1-phenyl-3-(2-thiazolyl)-2-thiourea (U-14,624; U) indicating a role of central noradrenergic system in the action of MS and AS. However, tolerance developed to antimorphine effects in chronic AMT rats and to antiamphetamine effects in chronic U-treated rats. In the present experiments, 12 groups (48 each) of male Holtzman rats were treated with either saline (S), AMT (50 mg/kgi.p. once daily) or U (25 mg/kg/i.p. once daily). Eight rats from each group were injected i.p. with a single dose of S, MS (5 mg/kg) or AS (1 mg/kg) 4 or 6 hrs. after the a.m. dose of AMT or U on days 1, 6, 12 or 18 of chronic treatment and also 24 and 96 hrs. after the last dose of AMT or U. Rats were decapitated and brains were dissected into discrete areas (corpus striatum, hypothalamus and remaining brain) and analysed for CA levels at each of the above times. The results show that tolerance developed to the CA-depleting effects of AMT or U within 18 days of chronic treatment. No rebound in CA levels was noted upon discontinuation of chronic drug administration.

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346 LUMINOUS FLUX, WAVELENGTH AND STRIPE ORIENTATION DISCRIMINATION IN GROUND SQUIRRELS (Citellus tridecemlineatus) AFTER POSTERIOR NEOCORTICAL LESIONS. Earl Kicliter, Michael S. Loop*, and John A. Jane. Department of Neurological Surgery, University of Virginia School of Medicine, Charlottesville, Virginia 22901.

As part of a study aimed at determining whether different retinal projection systems might subserve different types of visual discriminations, eight ground squirrels were trained in a two-choice visual discrimination apparatus on three problems: 1) light/dark; 2) color (wavelength discrimination); and 3) horizontal/vertical stripes. Large bilateral posterior neocortical lesions were made by subpial aspiration in either one-stage (5 Ss) or two-stage (3 Ss) operations. An attempt was made to vary the size of the lesions and especially the amount of involvement of temporal neocortex. Subjects sustaining two-stage lesions were re-trained during the inter-operative interval. The two-stage subjects mastered all three problems after the first stage of the ablation. After the second stage (or after surgery for the one-stage animals) subjects again mastered the light/dark and wavelength discrimination problems. However, only one subject with a bilateral cortical lesion was able to perform the stripe discrimination and this subject sustained minimal temporal lobe involvement. Histologically confirmed lesions in two of the animals with large lesions demonstrate complete degeneration of LGNd in the sense that no normal neurons were observed. These results support previous findings that rhesus monkeys and tree shrews lacking LGNd cortical projection areas are capable of wavelength discrimination. Supported by NIH Grant EY 00154, the Sloan Foundation, the James Baur Research Fund and NIH Postdoctoral Fellowships EY 54337 and NS 54882.

347 17,OH-STEROID AND CATECHOLAMINES IN HUMAN URINE DURING ACUPUNCTURE AND TREATMENT ON LOW BACK PAIN. K. C. Kim, Robert Heimburger, Chris Ritter* and Susan Baldwin*. Dept. Anes., Sch. Med., Indiana University, Indianapolis, 46202

The 24 hour urine level of 17,OH-Steroid,Adrenalin,Noradrenalin and V.M.A. were measured in 5 cases of intractable low back pain post laminectomy before and during acupuncture treatment. The mean value of 2 days output before the acupuncture treatment was used as the control value. This mean value was similar to the mean value obtained from normal subjects for 5 days. 17,OH-Steroid output increased by 70% on the 2nd and 3rd days. On the 5th day, it reached the peak of 200% then back to 50% on the 6th and 7th days. On the 8th day it increased again 90%, then back to the control level. Contrary to elevation of 17,OH-Steroid,adrenaline output was decreased. On the 1st and 2nd days there was a 30% reduction and on the 4th day it decreased further to 70%, while 17,OH-Steroid output increased to a maximum of 200%. After the 4th day adrenalin increased 30% above control value, while 17,OH-Steroid output was only 40% above the control level. On the 8th day adrenalin decreased to 30% below the control level while 17,OH-Steroid increased 90% above the control. Noradrenaline output fluctuated 35% $\pm$ 18 above or below the control level. All patients were relaxed on the first day, relieved within 3 days and were discharged within 9 days.

348 INHIBITED MYELINATION AND NEURONAL CYTOPLASMIC INCLUSIONS PRODUCED BY CHOLESTEROL SYNTHESIS INHIBITOR AY 9944 IN ORANGOTYPIC CNS CULTURES. Seung U. Kim. Division of Neuropathology, University of Pennsylvania, Philadelphia, Pa., 19174

AY 9944 [trans-1,4-bis (2-chlorobenzylamino-methyl) cyclohexane dihydrochloride] is a potent inhibitor of cholesterol biosynthesis by blocking Δ^7 reductase activity. Administration of this inhibitor in animals has resulted in the retardation of myelination and an accumulation of abnormal cytoplasmic inclusions in neurons of the CNS. In the present study, organotypic cultures of fetal mouse spinal cord were exposed to nutrient fluid containing 10-50 μg/ml AY 9944, and their reactions studied by light and electron microscopy. Our spinal cord cultures began myelinating 7 days after explantation, and myelination reached its peak by 16-18 days in vitro. Cultures were exposed to AY 9944 for 7 days starting on the 4th day in vitro and examined at different times during the exposure and following its removal. Normal sister cultures served as controls. This treatment retarded myelin formation in vitro; thus only 27% of the cultures exposed to 50 μg/ml AY 9944 and 74% of the cultures exposed to 10 μg/ml AY 9944 formed myelin by 11 days in vitro, while all of the normal sister cultures myelinated. Electron microscopic examination of experimental cultures revealed an accumulation of numerous intracytoplasmic inclusions in neurons, astrocytes and oligodenrocytes, a feature resembling a neuronal storage disease. These inclusions were composed of concentrical lamellar structures or of reticular structures. Although slight improvement of myelination and diminution of cytoplasmic inclusions were noted following the removal of the inhibitor, a complete recovery of cultures were not observed even after a 2 week recovery period in vitro.

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349 INSOMNIA INDUCED BY META-CHLOROTYROSINE IN CATS. Carl D. King* (SPON: R.P. White). Dept. Pharmacol., Univ. Tenn. Medical Units, Memphis, 38163.

There is much evidence that brain serotonin (5-HT) is important for the genesis of sleep. Insomnia induced in cats by p-chlorophenylalanine (PCPA) is a critical part of this evidence. As several have reported, however, there is a discrepancy: after PCPA, brain 5-HT levels fall well in advance of the onset of insomnia. Stark and Fuller (Neuropharmacol. 11:261, 1972) have suggested that some effects of PCPA may be due to a metabolite of PCPA, meta-chlorotyrosine (MCT). MCT does not alter brain 5-HT levels, and may act by being transformed to false transmitters such as meta-chloro-octopamine. To investigate the possibility that MCT may play a part in PCPA-insomnia, MCT was given to cats chroncially implanted with electrodes for the measurement of arousal, spindle sleep, slow wave sleep (SWS) and rapid eye movement (REM) sleep. The cats were recorded continuously for periods of 8-24 hrs. MCT (75 mg/kg, i.p.) produced insomnia. The insomnia's onset was rapid (30 min.), and the effect lasted about 6 hrs. The cats were not agitated, but sat or reclined quietly. When sleep returned, it consisted chiefly of spindle sleep and REM sleep; SWS reappeared about 8 hrs. after the drug. In further studies, iproniazid (I) was used. I (100 mg/kg, i.p.) alone induced a long period of SWS. The combination of I and MCT, however, led to an extended period of insomnia (12-16 hrs.). As the insomnia finally faded, the I syndrome reasserted itself. These data lend support to the idea that false transmitters are formed from MCT, and that these compounds produce behavioral effects. The data also suggest that PCPA-insomnia may not be entirely related to depletion of brain 5-HT: it is possible that the gradual onset of insomnia in cats after PCPA is related to a gradual metabolism of PCPA to MCT, with subsequent formation of insomnia-producing false transmitters. (Supported by USPHS Grant RR-05423.)

350 ORGANIZATION OF SYNAPTIC INTERACTIONS BETWEEN IDENTIFIED MOTOR NEURONS IN LOBSTER STOMATOGASTRIC GANGLION. David G. King. Dept. of Neurosciences, UCSD, La Jolla, CA 92037

Several motor neurons, including the gastric mill (GM) neurons, from the stomatogastric ganglion of the spiny lobster (*Panulirus interruptus*) were reconstructed from serial sections of ganglia fixed for electron microscopy and embedded in Epon. Each GM cell consists of a heavily-sheathed 80-100μ soma, a single heavily-sheathed gently tapering neurite leading to an expanded integrative segment from which several large, lightly-sheathed branches diverge, and a very heavily-sheathed axon. Although the physiological investigations of Selverston and Mulloney (J. Comp. Physiol., in press) have demonstrated several synapses onto the GM neurons, and although a general anatomical survey of the ganglion reveals an abundance (thousands per neuron) of presumed synaptic structures, an examination of thin sections with the electron microscope at several hundred loci on these neurons failed to locate any of these synapses on the heavily-sheathed neurite or integrative segment of the neurons or on the large primary branches. Most of the synaptic contacts onto these neurons occur on more distal processes, at points near the terminals of the finer branches. This pattern - a well insulated central portion of a neuron connected to many small distant processes where synaptic contacts are made - appears to hold for each of the several motor neuron types examined.

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351 LOCALIZATION OF LH-RH IN THE HYPOTHALAMUS OF RATS USING RIA. J.C.King*,A.Arimura*, andT.H.Williams. (SPON: A.K.Afifi) Dept.Anat.,Sch. Med., U. of Iowa, Iowa City,52240, VA Hospital, New Orleans, 70114

This study was an attempt to define the nuclei and/or regions of the hypothalamus containing LH-RH as measured by the technique of radioimmunoassay developed by A.Arimura et al (1973). Frozen 150 micron sections were cut in coronal, sagittal and horizontal planes. In the first study pooled sections from corresponding levels in 8 diestrous females were assayed: 3 animals for coronal sections; 2 for sagittal and 3 for horizontal. In the second study 15 diestrous females were used; 5 for each plane of sectioning. Tissue coronally sectioned from the rostral tip of the anterior arcuate nucleus to the caudal extent of the arcuate nucleus yielded high LH-RH values. A small strip in the region of the medial preoptic area (MPOA) displayed some LH-RH content in the pooled samples (first study); but this finding was not replicated in the individually analyzed samples (second study). Sagittal sections showed high values in a narrow zone either side of the midline; horizontal sections yielded maximum values in the arcuate-median eminence (ME) region. Integrating the information across planes, only the arcuate-ME region was consistently rich in LH-RH. A similar finding was obtained in studies using pooled coronal sections from 6 adult males. Tissue from the arcuate-ME region displayed high LH-RH levels in both diestrous female and normal male rats.

352 PHOTOMICROTOMY OF WHOLE HUMAN BRAIN. Joel B. Kirkpatrick,and Roy Mills*. Dept. Path., Southwestern Med. Sch,UTHSCD,Dallas, Texas 75235.

Cinematographers have long recognized the potential application of motion picture technique for the study of serial sections of a tissue or organ. A limiting problem thus far has been the inability to achieve exact register of the photographic images. We have developed an instrument, the photomicrotome, which approaches this problem by photographing the cut surface of the block on a frame of 16mm film after each section is cut away. To obviate the prolonged sequence of dehydration for paraffin sections this instrument operates at 5°F. The specimen is embedded in a solution of cornstarch and frozen to the chuck of the microtome. The cornstarch helps to prevent crystallization of the frozen embedment. When the film is viewed with the motion picture projector sequential images remain in register and the illusion of rapidly passing through serial planes of the brain is obtained. This technique has immediate applications for the production of neuroanatomical teaching films. Besides permitting exposure of structures in a variety of planes, the use of actual specimens conveys the concept of biological variation which is lost in conventional idealized diagrams. The technique is useful for recording neuropathological changes and could be used to confirm and record the locallization of lesions in experimental animals. A film will be shown to illustrate the technique. (Supported by USPHS grant No. NS11239).

353 MONOAMINES IN AVERSIVE MIDBRAIN STIMULATION. R. Sanford Kiser, Jr. and Robert M. Lebovitz. Dept. Psych. and Dept. Phys., Univ. of Tex. Health Sci. Center at Dallas, Dallas, Tex., 75235

This study examined the role of brain monoamines in aversive electrical stimulation of the midbrain in rats. Chronic bipolar stimulating electrodes were implanted at two different sites -- (1) the dorsal longitudinal fasciculus or (2) the interstitial nucleus of Cajal. Stimulation of the former site elicited fearlike, escape-seeking responses. Electrodes at the latter site elicited stereotyped motor responses such as circling. Despite these obvious behavioral differences, electrical stimulation at either site could be classified as aversive, in that the animals would learn to bar press for escape. To determine if the two behavioral patterns were pharmacologically distinguishable, a sensitive behavioral format was established such that each animal could adjust the stimulation current to a behaviorally neutral level. In this paradigm, each bar press decremented the stimulation current by 5% of the initial stimulation current level. The roles of brain monoamines in the above two types of aversive behavior were then examined by administering the catecholamine-depleting drug alpha-methyl-para-tyrosine (αMPT), the serotonin-depleting drug para-chlorophenylalanine (pCPA), or the serotonin metabolic precursor 5-hydroxytryptophan (5-HTP). αMPT was found to have no effect upon either type of aversive behavior. pCPA, however, markedly increased decremental bar-pressing in fearlike rats for up to 18 days after its administration, but had no effect in non-fearlike rats. 5-HTP selectively inhibited decremental bar-pressing in fearlike animals in a dose-dependent manner. No 5-HTP effect was seen in non-fearlike animals. These results suggest that fearlike responses to dorsal midbrain stimulation in rats were inversely related to brain serotonin levels, and that the similarly aversive motoric responses were not strongly related to serotonin in the brain.

354 ANTIDROMIC AND ORTHODROMIC ACTIVATION OF THE CAUDATE NEURONS. S.T. KITAI, W. PRECHT*, T. OHNO* and A WAGNER*. Morin Memorial Laboratory, Dept. Anat., Sch. Med., Wayne State Univ., Detroit, Mich., Max-Plank Institute for Brain Research, Frankfurt/M, Germany.

Intra and extracellular recordings were made from caudate (Cd) neurons in cats anaesthetized with sodium pentobarbital. During recording animals were paralyzed with flaxedil. Electrical stimulation was applied through either monopolar or bipolar electrodes. Stimulation sites were at the thalamic and midbrain levels of nigro-striatal (N-S) pathway and the striato-nigro (S-N) pathway. The ipsilateral sensorimotor cortex was also stimulated. S-N stimulation evoked action potentials with latencies ranging from 7 to 30 msec. They were considered to be antidromically activated since they had stable latencies regardless of stimulus strength, followed double shocks with inter-stimulus time intervals of less than 1.5 msec and had typical IS-SD sequence of firing when recorded intracellularly. Average conduction velocity of the S-N fibers was around 1 M/sec. EPSPs were recorded from Cd neurons following stimulation of N-S pathway. Extrapolation from latencies of EPSPs evoked by two loci in the N-S pathway showed both monosynaptic and polysynaptic inputs are present. The monosynaptic pathway had a conduction velocity of around 0.8 M/sec. EPSPs were usually followed by hyperpolarizing potentials which could be reversed by injection of either chloride ions or hyperpolarizing current. Pure IPSPs were rarely observed. Cortical stimulation also evoked mono- and polysynaptic EPSPs. However, no monosynaptic EPSPs produced by N-S stimulation were recorded from those Cd neurons activated antidromically following S-N stimulation. Findings indicate that there is no direct neuronal loop between the caudate and substantia nigra. (Supported by NIH Grant NS00405 and NSF Grant 35532.)

355 ELECTROPHYSIOLOGICAL EFFECTS OF TETRAETHYLAMMONIUM CHLORIDE ON LEECH RETZIUS CELLS. Anna L. Kleinhaus and James W. Prichard. Dept. Neurol., Yale Med. Sch., New Haven, 06510

Tetraethylammonium chloride (TEA) prolonged the duration of Retzius cell action potentials elicited by injected current or synaptic stimulation. A large portion of the lengthened action potential was Ca-dependent; in the absence of TEA, no Ca-dependent action potential component could be demonstrated. TEA was effective when applied extracellularly by chamber perfusion. The characteristic changes appeared within minutes at 25 mM but developed slowly over half an hour at 10 mM; at both concentrations the changes were immediately reversible even after long soaks in TEA. Intrasomatic iontophoresis of TEA caused irreversible steady depolarization and development of a complex, prolonged action potential consisting of several or one early depolarizations and a later, larger one. The amplitude of the late depolarization, but not the early one, responded to changes in external Ca with the slope expected for a Ca-dependent event. Manipulations of external Na affected the early event more than the late one. The characteristic delayed development of the late depolarization suggested that its appearance depended upon diffusion of TEA to some extrasomatic portion of the cell. Both extracellular and intracellular TEA were capable of inducing Ca-dependent 50-60 mV; 300-500 msec action potentials in cells previously rendered inexcitable by removal of external sodium. Ca-dependent events do not appear in squid axon (Armstrong and Binstock, J. gen. Physiol. 48: 859, 1965) or frog node of Ranvier (Armstrong and Hille, J. gen. Physiol. 59: 388, 1972) exposed to TEA, but the response of frog dorsal root ganglion cells to the drug in part resembles our findings (Koketsu et al., J. Neurophysiol. 22: 177,1959)

356 A NEW, CHRONIC EXPERIMENTAL PROCEDURE FOR ELECTROGRAPHIC STUDY OF NEUROPHARMACOLOGICAL MECHANISMS. W. R. Klemm. Dept. of Biology, Texas A&M University, College Station, Texas 77843

A stable baseline of electrographic activity for studying drug mechanisms and actions is difficult, if not impossible, to achieve in the common methods that use animals which are either freely behaving, immobilized with muscle relaxant or surgically deafferented. A new experimental procedure for drug studies has been developed in which the EEG, multiple-unit activity, and averaged evoked responses seem to be unusually stable and free of artifacts. This procedure involves inducing a state of Immobility Reflex (IR) (also known as "animal hypnosis"). The IR is a reversible, involuntary, and an unconditioned reflex response in certain species to sudden change in afferent stimulation that results from the common method of simultaneous inversion and manual restraint. Because intact, chronically prepared animals are used, the same brain areas can be tested repeatedly with vehicle or different drug doses, administered either systemically or topically. The IR offers the unique combination of simplicity, of being non-surgical and non-traumatic, of reproducibility, and of relative freedom from behavioral variables.

357 EFFECT OF BETA-ADRENERGIC BLOCKING AGENTS ON CENTRAL REGULATION OF BLOOD PRESSURE. L. R. Klevans, J. L. Kovacs* and R. Kelly*. Research Division, Hoffmann-La Roche Inc., Nutley, N.J. 07110.

The cardiovascular and neural effects produced by intravenous infusion (0.1 ml/min.) of d-, dl-propranolol (d-p, dl-p), sotalol (sot) hydrochlorides and pindolol (pi) were compared with effects produced by perfusion of these drugs from lateral ventricle (LV) to lumbar spinal cord in chloralose anesthetized vagotomized cats. Blood pressure (BP) and sympathetic discharges evoked in preganglionic (splanchnic) or postganglionic (renal) nerves by sciatic nerve stimulation were recorded during infusion of three concentrations (1,3,5 mM/ml) of each drug for 20 min. per concentration. Infusions in LV of pi, d-p, dl-p but not sot produced dose-dependent decreases in BP and evoked potentials (EPs). These decreases were often preceded by an increase in the EP and sometimes BP within 2 min. after infusion of 1 mM/ml of drug. Although the time course for decreases in BP and potentials evoked in the postganglionic renal nerve were different, parallel decreases in these parameters, as well as spontaneous discharges, were observed when recording from splanchnic nerve. When each agent was infused intravenously at the doses used for LV infusion, small decreases in BP associated with increases in EPs recorded from renal nerves were observed. These data suggest that certain beta-antagonists directly influence the central regulation of BP. Additional experimentation revealed that the hypotensive response produced by pi infused in LV could be antagonized by pi administered intraventricularly in doses which did not decrease BP. This observation shows that an agent known to possess properties of a beta-receptor agonist and antagonist produces different effects at low (<1 mM/ml) and high concentrations (≥1 mM/ml).

358 CHEMICAL ALTERATION OF SUBCORTICAL EVOKED RESISTANCE SHIFTS Kenneth A. Klivington. Dept. Neurosciences, U. of Calif., San Diego, 92037

Microliter quantities of tetrodotoxin (TTX), tetraethylammonium chloride (TEA), and picrotoxin were injected into the inferior colliculi and superior olives of cats to help identify events involved in production of the evoked resistance shift (ERS) which accompanies the click evoked potential (EP). The ERS is known to be affected differently than the EP by variation of parameters such as anesthetic level or brain temperature, but present evidence does not permit definite conclusions about which of five possible contributions to the ERS are involved. The five possibilities include alterations in: (1) extracellular conductivity; (2) intracellular conductivity; (3) membrane conductivity; (4) blood flow, and (5) temperature. Implanted insulated cannulas were used both for injection and as electrodes. Tissue-electrode impedance constituted one arm of a Wheatstone bridge configuration with a lock-in amplifier as detector. TTX simultaneously reduced the negative phase of the EP and eliminated the ERS. TEA enhanced the negative EP component, presumably of postsynaptic origin, without significantly altering ERS amplitude. Picrotoxin also enhanced the negative EP wave but increased ERS amplitude. These findings implicate postsynaptic membrane permeability changes in the production of the ERS.

359 SIGNAL PROCESSING BY TYPE III (ON/OFF) GANGLION CELLS IN THE FROG'S VISUAL SYSTEM. F. S. Knox III, Dept. of Physiology, LSU School of Medicine in Shreveport, Shreveport, Louisiana 71130.

The frog's retina performs a great deal of preprocessing before transmitting visual information to the brain. The task was to decipher the anatomical network associated with Type III ganglion cells and to specify how that net performs feature extraction. The approach taken in this study was to specify the computations performed by the net by monitoring Type III ganglion cell output while presenting temporally (sine or square wave) modulated stimuli (glow modulator) focused either directly on the retina or on a screen located in the frog's field of view. Both multiunit responses and evoked, Tectal Slow Waves (TSW) were simultaneously recorded using tungsten microelectrodes from the frog's (Rana pipiens) optic tectum. The TSW was closely correlated with the firing pattern in the multiunit response. Using TSW amplitude as a response measure it was found that ON and OFF responses behaved differently with respect to changes in modulation index, DC light level and area of the test spot. This suggests that the mechanisms mediating the ON and OFF responses are spatially heterogeneous through the receptive field. Evidence supports a two channel model of the Type III ganglion cell system in which one channel handles ON information while the other handles OFF. The two channels may have distinctive sets of receptors and bipolars which synapse with a common set of amacrines which in turn synapse with a single ganglion cell. The bandpass characteristics of the system may be explained on the basis of mutual inhibitory interaction between channels. This interaction causes the Type III system to switch from ON/OFF to OFF type responses when presented square wave modulated light ≥ 4 Hz. This is ideal for damping out responses to the slowly moving bright horizon resulting from eye movements while at the same time emphasizing dark objects moving at $45°-60°sec^{-1}$.

360 EFFECTS OF STRESS ON CATECHOLAMINES AND TYROSINE HYDROXYLASE ACTIVITY IN SPECIFIC HYPOTHALAMIC NUCLEI. Ronald M. Kobayashi*, Miklos Palkovits*, J. Steven Kizer*, David M. Jacobowitz and Irwin J. Kopin. Lab. of Clin. Sci., NIMH, Bethesda, Md. 20014.

The effects of acute stress on catecholamine content and repeated stress on tyrosine hydroxylase (TH) activity were measured in individual hypothalamic nuclei of the rat. Animals were killed 30 min after 10% formalin (1 ml/kg)injection, after 3 hr of forced immobilization in special restraint frames and after 3 hr of exposure to 4°C. Five different hypothalamic nuclei were dissected from frozen brain slices by the method of Palkovits (Brain Res 59:449, 1973). Norepinephrine (NE) and dopamine (DA) and TH were measured by sensitive radiosotopic methods. Both NE and DA were markedly reduced in the arcuate nucleus, but were unchanged in the median eminence, ventromedial nucleus, supraoptic nucleus and medial forebrain bundle. Immobilization for 3 hrs repeated for 5 consecutive days increased TH activity only in the arcuate nucleus but not in the other nuclei. No change in TH activity in any nucleus resulted from repeated formalin or cold exposure. The decreased NE content of the arcuate nucleus following acute stress must reflect a decrease in NE content of noradrenergic terminals since NE cell bodies are not found in this region. The decreased DA concentration in the arcuate nucleus (predominantly DA cell bodies) was not accompanied by a change in DA content in the median eminence (predominantly DA terminals), or in the nigrostriatal dopaminergic system (no change in DA content of the substantia nigra or caudate nucleus after formalin injection). The mechanism for the decreased amine content in the arcuate nucleus presumably is increased amine release, which leads to induction of TH activity only in this nucleus after 5 daily immobilization sessions.

361 DIRECT AND PROSTAGLANDIN-MEDIATED COMPONENTS OF THE HYPERTHERMIA EVOKED BY INTRAHYPOTHALAMIC INJECTION OF 5-HYDROXYTRYPTAMINE (5-HT) IN THE CAT. H. L. Komiskey* and T. A. Rudy. School of Pharmacy, Univ. of Wisconsin, Madison, 53706.

5-HT injected in or near the anterior hypothalamus (AH) of the cat evokes a rise in body temperature. Although this may represent a direct action of 5-HT at synapses in the hypothalamic thermoregulatory pathways, the reported ability of acetaminophen to abolish the response (Milton and Wendlandt, Br. J. Pharmac. 34: 215P, 1968) suggested that locally released prostaglandins may be involved and led to the present investigation. Cats with microinjection guide cannulae implanted in the AH were maintained at an ambient temperature of 20°C while colonic and ear pinna temperatures were monitored continuously. One µl of 0.03 M 5-HT injected into the AH evoked immediate shivering, vasoconstriction and a short-lasting rise in colonic temperature (Phase 1). This was sometimes followed by a long-lasting secondary hyperthermia (Phase 2). Pretreatment with indomethacin (10 mg/kg i.p.) or acetaminophen (50 mg/kg i.p.), centrally active inhibitors of prostaglandin synthesis, had no effect on Phase 1 but reduced or abolished Phase 2. Pretreatment with the 5-HT receptor antagonist, methysergide (2 mg/kg i.p.) reduced or abolished Phase 1 but had little effect on Phase 2. These preliminary results suggest that Phase 1 is dependent upon activation of methysergide-sensitive 5-HT receptors and is not mediated by prostaglandin release, whereas Phase 2 is entirely dependent upon a continuous local release of prostaglandins. The characteristics of Phase 1 are the most compatible with a proposed direct synaptic action of 5-HT and support the possibility that 5-HT may be a neurotransmitter within the hypothalamic thermoregulatory pathways.

362 CONCURRENT SELF-STIMULATION IN THE MFB, VENTRAL TEGMENTUM, AND LOCUS COERULEUS: THE EFFECTS OF D-AMPHETAMINE. George F. Koob, Gail D. Winger*, James L. Meyerhoff and Zoltan Annau. Dept. Env. Med., Johns Hopkins Univ., Baltimore, Md. 21205 and Walter Reed Army Institute of Research, Washington, D.C. 20012.

Rats with chronic stainless steel monopolar electrodes in the medial forebrain bundle, ventral tegmental area and the locus coeruleus were placed in an experimental chamber equipped with three levers. Depression of each lever activated separate brain stimulation circuits from a constant current source. The animals were allowed continuous access to all levers, 24 hours per day on a crf schedule. Currents were adjusted to produce stable and equal daily rates on all 3 electrodes. The rats were subjected to a series of injections of 0.5, 1.0, 2.0 and 4.0 mg/kg of d-amphetamine sulfate, administered in a random order. At 0.5 and 1.0 mg/kg, self-stimulation was most enhanced in the medial forebrain bundle, with less effect in the ventral tegmental area, followed by the locus coeruleus. At 2.0 and 4.0 mg/kg, self-stimulation in the ventral tegmental electrode predominated during the first two hours following the injection with a delayed enhancement of medial forebrain bundle self-stimulation occuring at approximately four hours following the injection. As with the lower doses of amphetamine, self-stimulation at the locus coeruleus was the least enhanced. Results suggest differential sensitivity to amphetamine at different anatomical loci supporting self-stimulation.

363 OXIDATIVE METABOLISM OF SKELETAL MUSCLE IN STEROID ATROPHY. Carol L. Koski*, David H. Rifenberick and Stephen R. Max. Depts. Neurol. and Pediat., Univ. of Maryland, Sch. Med., Baltimore, Md. 21201

Glucocorticoids cause muscular atrophy following prolonged administration. To determine whether mitochondrial changes represent the primary lesion in steroid atrophy, we have assessed the oxidative capacity of muscle homogenates from steroid-treated rats. We recently reported that $^{14}CO_2$ production from labeled substrates was reversibly impaired in homogenates of rat plantaris but not of soleus muscles (Neurology, 1974). Further studies have revealed that loss of muscle weight, protein content, and oxidative ability was accompanied by a decrease in the content of mitochondria of plantaris muscles from rats treated with Dexamethasone (Dex; 5 mg/kg/day; i.p.). In addition, Dex was selective with regard to impairment of oxidative metabolism. The utilization of glucose-U-^{14}C was diminished to a greater extent than oxidation of palmitate-1-^{14}C, as shown in the table:

	$^{14}CO_2$ Production (% of Control)	
Substrate	Dex-7 days	Dex-14 days
Glucose	60	40
Palmitate	100	60

Dex had no effect on the utilization of either glucose or palmitate in hypophysectomized rats, although marked muscular atrophy was present. This finding rules out the likelihood that mitochondrial changes represent the primary lesion in steroid atrophy. Additional, as yet unidentified, hormonal factors appear to be involved in this phenomenon. The precise cause of the diminution of oxidative metabolism is under investigation. (Supported in part by NIH Grants NS-05077 and HD-06291-02, and NIH Fellowship 1 FO2 NS 54205-02).

364 EPINEPHRINE CONCENTRATIONS IN DISCRETE BRAIN NUCLEI OF THE RAT MEASURED BY MASS FRAGMENTOGRAPHY. Stephen H. Koslow and Margaret Schlumpf*. Lab. Preclinical Pharmacol and Lab. Neuropharmacol., NIMH, Saint Elizabeths Hosp., Washington, D. C. 20032

Fifteen brain nuclei and areas were dissected and measured for their content of norepinephrine (NE), epinephrine (E) and dopamine (DA). Microdissection of brain nuclei was accomplished by sectioning frozen rat brains in a microtome cryostat at -5°C. Four hundred micron thick sections were prepared and the nuclei were located by computing the distance between the desired individual nucleus and visible surface or intrinsic landmarks such as the decussation of the anterior commissure (DAC). With the aid of a dissecting microscope each area was dissected out with a punch of appropriate diameter and prepared for analysis by gas chromatography-mass spectrometry. Of the fifteen areas studied, 5 contained E.

Brain Area	Microns caudal to DAC (x 10^3)	E pmoles/mg protein	E/NE x 100
N. Reticularis Lat. (A_1)	12.4	1.3 ± .33	1.7
Cerebellum (Vent. Lat)	9.0	1.1 ± .03	6.6
Locus Coeruleus	8.2	1.4 ± .16	1.0
Habenula	2.5	1.2 ± .16	2.9
Periventricular Area of the hypothalamus	2.5	5.7 ± 1.1	3.4

These data support the proposal (Hokfelt et al., Brain Research 66: 1235, 1974) that a neuronal network containing E is present in rat brain.

365 EFFECTS OF MEDIAL HYPOTHALAMIC LESIONS ON THE LORDOSIS RESPONSE IN FEMALE HAMSTERS. L.-M. Kow, C.W. Malsbury and D.W. Pfaff. Rockefeller Univ., New York, N.Y. 10021.

Adult, ovariectomized hamsters were treated weekly with 10μg estradiol benzoate and followed by 0.5mg progesterone (P) two days later to induce receptivity. Behavior tests were done 5 hrs after P to see: (1) if lordosis could be elicited; and, if so, (2) how long could it be maintained with manual somatosensory stimulation. Each female was tested 3 times before and 3 times after bilateral hypothalamic lesions were made with anodal current. Post-lesion performance (PLP) was scored as: (mean post-lesion lordosis duration/mean pre-lesion lordosis duration) X 100%. (I.) Lesions (n=5) which included large portions of medial anterior hypothalamus and sometimes also invaded medial preoptic area, led to PLP's of 44, 81, 100, 100 and 123%, ($\bar{x}$=90%). The female with the lowest PLP appeared to have the largest lesions. None of the lesions at this level eliminated lordosis. (II.) Lesions (n=8) at the level of the ventromedial nucleus (VM) were quite dorsal, their ventral borders ranging from dorsomedial (DM) down to ventromedial nuclei. In this group PLP's (ranging from 4 to 104%, $\bar{x}$=45%) were inversely correlated (r_S = -.79; $p < .05$) with the extent of damage in an area bordered by DM, VM and fornix. In the two females with most damage here, lesions eliminated lordosis in at least one test.

Thus, in female hamsters lordosis can be reduced in duration or even eliminated by lesions in medial hypothalamus. Structures at the VM level seem to be important for the control of lordosis, although estrogen implantation there (Ciaccio & Lisk, Neuroendocrinology, 1973/74) does not facilitate lordosis in female hamsters.

366 RELATIVE EFFECTS OF VISUAL DEPRIVATION AND BINOCULAR COMPETITION ON RESPONSES OF STRIATE CORTEX CELLS IN THE CAT. Kenneth E. Kratz* and Peter D. Spear. (SPON: Vincent St. Omer). K. St. Univ., Manhattan, Kansas 66502

The present experiments examined the relative effects of visual deprivation and alterations in competitive binocular interaction on receptive fields of cat striate cortex cells. Three groups of kittens, representing varying degrees of competitive interaction between inputs from the two eyes, were raised with one eye lid-sutured from birth. In one group the other eye remained open as normal (monoc. dep., MD). In the second group the other eye was also lid-sutured (binoc. dep., BD). In the third group the other eye was enucleated at 3-7 days of age (monoc. dep.-enuc. MD-E). Thus, in the third group the deprived eye has been placed at a competitive advantage over the other eye. Futher, since competing projections from the other eye have been eliminated in the MD-E group, the effects of visual deprivation on the cortical cells could be studied independently of effects of binocular competition. When the kittens were 4-7 months of age, single-cell recordings were conducted in striate cortex. In agreement with previous studies, all of the cells were unresponsive when tested through the deprived eye in MD cats. In BD cats, approximately 75% of the cells were either unresponsive or had abnormal receptive field properties when tested through a single deprived eye. In MD-E cats, approximately 50% of the cells tested through the deprived eye were abnormal or unresponsive. Thus, there may be a slightly smaller effect of visual deprivation when the lid-sutured eye has a competitive advantage over the other eye. However, the results indicate that cells in cat striate cortex are adversely affected by visual deprivation per se, even when competitive input from the other eye has been eliminated during development. This is in contrast to the LGd where previous studies indicate little or no effect of deprivation independent of binocular interaction (NIH Traineeship #MH-08359 and NIH Grant #EY01170)

367 PATTERNED SPIKE TRAINS IN LIMULUS OPTIC NERVE. Howard I. Krausz* and G. David Lange. Dept. of Neurosciences, UCSD, La Jolla, Ca. 92037

When the temperature of an excised Limulus eye is raised about 10°C. above normal, the spike train response of an eccentric cell to steady illumination becomes very irregular or bursty. Steady, diffuse illumination usually results in a steady pattern of paired spikes. Extracellular recordings of single units optically isolated from an active bundle also demonstrated pairing. Therefore patterned firing must not require spatial interactions in the eye. Later experiments, where a steady current injected into an eccentric cell also produced patterning, confirmed this hypothesis. Lateral inhibition can, however, be a factor in patterning when several ommatidia are illuminated. Intracellular recordings showed that patterning is unlikely to be caused by dropping spikes from a steady train as no subthreshold oscillations of the generator potential were seen between spikes. Since current, as well as light also leads to patterning, the phenomenon is most likely related to spike generation or to self-inhibition. Varying the excitatory drive on a cell changed the degree of patterning. An increase converted pairs to triplets or quadruplets, while a decrease led to a slower, steadier train. (Research supported by Sloan and Grass Foundation grants and by NIH grant NS 09342).

368 BRADYKININ ELICITED RESPONSES OF VENTROBASAL THALAMIC NEURONS. G. Krauthamer and L. Gottesman*. Department of Anatomy, C.M.D.N.J. Rutgers Medical School, Piscataway, New Jersey 08854

Bradykinin, a physiologically active pain producing agent, was administered by intra-arterial injection into the radial artery, splenic artery and branches of the mesenteric arterial plexus in doses of 20 ug/0.2cc. K^+ citrate filled microelectrodes were used to explore the ventrobasal complex and adjacent regions of the thalamus in Flaxedil immobilized cats under Nembutal anesthesia. Units recorded extracellularly were either classified as typically somatotopic with restricted, contralateral receptive fields or as spontaneously active and unresponsive to electric shocks and other somatic stimuli. The majority of neurons with lemniscal properties remained unresponsive to bradykinin. Following the injection of bradykinin, pronounced alterations in firing pattern occurred in those cells which did not respond to somatosensory stimuli. Two populations could be distinguished; one responding to visceral artery injections and another responding to radial artery injections. Only some neurons responded to intra-arterial bradykinin irrespective of site of administration. The results indicate that place and modality specificity are also displayed by neurons selectively responsive to presumably noxious stimulation of arterial advential receptors. (Supported by USPHS Grant NS 10922-01).

369 ULTRASTRUCTURAL AND POLYAMINE STUDIES OF DYSTROPHIC MUSCLE OF MICE. Leon T. Kremzner*, Virginia M. Tennyson, and Armand Miranda. Dept. Neurology and Pathology, Division of Neuropathology, Columbia Univ., College of Physicians & Surgeons, New York, N.Y., 10032.

Biceps femoris muscles from one-month old Bar Harbor mice (129 Je dy/dy), which were markedly dystrophic, were assayed for polyamine concentrations by the method of Kremzner (1970) and compared with clinically normal littermates. In dystrophic muscle, putrescine levels were increased 3 to 7 fold and spermidine levels were increased 2 fold. There was little or no difference in spermine levels between dystrophic muscle and controls. Muscle from a mouse showing only slight symptoms of dystrophy had values intermediate between normal and markedly dystrophic muscle. Phase and electron microscopic examination of the dystrophic muscle revealed a wide variation in muscle fiber size, muscle with central nuclei, some necrotic muscle, myoblasts, and numerous fibroblast-like cells which show a random end product of acetylcholinesterase (AChE) activity with the copper thiocholine technique. End product bound to the reticulum is present in myoblasts and normal appearing muscle, particularly in muscle close to the end plate region. A random end product was present in degenerating muscle. Normal appearing motor end plates exhibited AChE activity. Normal muscle had end product in the reticulum close to the motor end plate, in the end plate, and randomly in a sparse number of fibroblast-like cells. Assay using acetyl-1-C^{14}-β-methylcholine showed both a bound and a soluble AChE activity. We have seen similar AChE-containing fibroblast-like cells in the myotube (Tennyson et al., 1973). These are myogenic stem cells, which fuse with myotubes and later form muscle satellite cells.

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370 CONNECTIONS OF THE AMYGDALA WITH THE BED NUCLEUS OF THE STRIA TERMINALIS AND THE HYPOTHALAMUS IN THE RAT AND CAT. J. E. Krettek* and J. L. Price. Dept. Anat., Washington University Sch. Med., St. Louis, 63110.

Autoradiographic experiments with stereotaxic injections of labeled amino acids into individual amygdaloid nuclei show differential patterns of grain distribution within the bed nucleus of the stria terminalis (BNST). A lateral portion of the BNST is labeled following injections of the central, lateral, basolateral and basomedial amygdaloid nuclei, while a dorsal and medial part is labeled with injections into the caudal portions of the cortical and medial nuclei. The intervening portion of the BNST contains autoradiographic grains following injections of the rostral medial and the basomedial nuclei. Two distinct projections to the ventromedial nucleus of the hypothalamus (VM) have been recognized which terminate predominantly either in the "core" or in the cell-sparse "shell" of VM. The projection of the core is labeled in experiments with injections into the basomedial nucleus or the rostral part of the medial nucleus; the pathway taken by these fibers is uncertain. Conversely, injections involving the caudal part of the medial nucleus label a projection through the stria terminalis to the shell of VM. Furthermore, a previously unrecognized projection to the shell, via the medial cortico-hypothalamic tract, has been found to originate in the subiculum and/or presubiculum. There are also projections from the amygdala to the lateral tuberal area and the premammillary region. Finally, the central amygdaloid nucleus appears to project to a region in the lateral hypothalamus via a portion of the ventral pathway. (Supported by N.I.H. grant No. NS 09518-04.)

371 CHANGES IN THE ELECTRICAL ACTIVITY OF THE MEDIAL PREOPTIC AREA IN RESPONSE TO INTRAVENTRICULAR NOREPINEPHRINE. Richard J. Krieg* and Charles H. Sawyer. (SPON: J. A. Colombo). Dept. of Anatomy, Sch. Med., UCLA, Los Angeles, 90024.

Intraventricularly administered norepinephrine is known to stimulate changes in electrical activity of the arcuate nucleus-median eminence complex (Weiner et al. Science 171: 411, 1971). In the present study we have examined changes in medial preoptic (MPO) activity upon infusion of this catecholamine. The third ventricle of proestrous or ovariectomized estrogen-progesterone primed rats was cannulated with stainless steel tubing and 5 ug of norepinephrine (10 ug bitartrate salt) in 2 ul of neutralized physiological saline was infused. Animals served as their own controls by prior infusion of 2 ul saline. Multi-unit spike activity of the MPO was recorded from stainless steel electrodes under urethane (1 g/kg) anesthesia. In every case the initial response to norepinephrine was an increase in spike frequency which was independent of EEG stages. The majority of animals (80%) then showed tonic high amplitude slow wave EEG activity associated with a marked decrease in MPO spike frequency. The other animals (20%) showed a continuous increase in activity followed much later by a return to control levels. Saline infusion induced no change. These data suggest that a biphasic response in MPO activity is induced by norepinephrine, the rising phase of which appears to be specific and may be related to neuroendocrine phenomena. (Supported by NS 01162 and the Ford Foundation.)

372 LIGHT AUTORADIOGRAPHIC LOCALIZATION OF CHOLINERGIC MUSCARINIC SITES IN RAT BRAIN. Michael J. Kuhar and Henry I. Yamamura. Dept. Pharmacol., Johns Hopkins Univ. Sch. Med., Baltimore, Md. 21205

[^{3}H]Quinuclidinyl benzilate ([^{3}H]QNB) binds to apparent cholinergic muscarinic receptor sites in rat brain synaptic membrane fractions in vitro. We have recently found conditions for apparent selective accumulation in vivo. The regional distribution of accumulated [^{3}H]QNB was similar to that observed in vitro, and also the accumulation of [^{3}H]QNB was selectively blocked by pretreatment with cholinergic muscarinic antagonists. In in vivo studies, we have examined the light autoradiographic (AR) localization of [^{3}H]QNB in fresh, frozen unfixed tissue sections (4-6 μ). We observed regional differences in the density of AR grains in agreement with the in vitro biochemical studies. There was a high grain density in the caudate-putamen and hippocampus that was markedly reduced in tissue from animals pretreated with atropine. There were very few grains over white matter areas such as the corpus callosum, alveus and anterior commissure. In addition, we localized AR grains in various regions more extensively than with the in vitro assay. For example, in the cerebral cortex, the AR grain density varied across coronal sections. There were very few grains over blood vessels, the choroid plexus and ependymal cells. We quantitatively examined the grain density over and between cell bodies in the caudate-putamen and the cerebral cortex. In a random selection of micrographs, 5-6% of the grains were over cell bodies, but the cell bodies accounted for 11-15% of the area in the micrographs, indicating a tendency for the grains to be found outside of cells and presumably over dendritic and synaptic areas. In preliminary experiments, using fixed, embedded tissue, we observed a similar distribution of AR grains indicating the feasibility of an electron microscopic study.

373 SIGNAL DETECTION ANALYSIS OF PAIN RESPONSIVITY IN RHESUS MONKEYS. Albert T. Kulics* and Charles G. Lineberry (SPON: K. Carlson) Dept. of Pharm., School of Med., Univ. of Pittsburgh, Pgh., Pa. 15261.

Reaction time data were obtained from rhesus monkeys taught to terminate repetitive bursts of noxious electrocutaneous stimuli. One hundred trials at each of two intensities were randomly presented daily. Differences in reaction time were greater or smaller on training days as a function of stimulus intensity differences. Reaction time data were treated as ratings of stimulus intensity according to assumptions of signal detection theory permitting daily construction of relative operating characteristic (ROC) functions for each monkey. This permitted estimates of stimulus sensitivity (d') and response bias (β) to be derived from the reaction time response distributions. The ROC functions met assumptions of the signal detection model. For a particular pair of stimulus intensities, daily estimates of d' were stable and reliable; unaffected by demonstrably large between-day differences in β. Estimates of d' covaried predictably when stimulus intensity differences were made larger or smaller for a particular monkey. Further, d' values were virtually identical between monkeys for the same stimulus intensity differences. These data suggest that responses to noxious electrocutaneous stimuli may be used to study underlying perceptual determinants of behavior by means of signal detection theory in much the same fashion as current research in vision and audition with animals and humans. Finally, this has permitted the development of a model for the study of pain perception in monkeys which is analogous to the signal detection model used for recent studies of pain perception in humans.

374 **DOES THE MULLER-LYER ILLUSION HAVE LATERALIZING SIGNIFICANCE?** **Santosh Kumar*, Joseph E. Bogen. Ross-Loos Medical Group. Los Angeles 90017**

There is emerging evidence that field-reliance and field-independence are associated with right and left cerebral hemispheres respectively. The Muller-Lyer Illusion, which is caused by the oblique lines making arrowhead or feather-end on the horizontal lines of comparison, is probably attributable to a tendency to perceive the Muller-Lyer figure as a whole. Thus, the greater the illusion effect, the greater the field-reliance, and inferentially, the greater the right hemisphere participation in perceiving the length of the comparison line. A patient with left hemisphere damage and right hemisphere intact should have greater illusion than a patient with right hemisphere damage and left hemisphere intact. A normal person without damage in either hemisphere should have an illusion effect in between.

Results to date, with our current apparatus using a 50 mm standard, show an illusion effect of 20 mm for left hemisphere damaged patients, 5 mm for right damaged, and 10 mm for the normal population.

375 FUNCTIONAL STUDIES ON THE METACEREBRAL CELLS OF APLYSIA. I. Kupfermann and K.R. Weiss* (SPON: J. Koester). Dept. Psychiat., Columbia Univ., and N.Y. State Psychiat. Inst.; and PHRI, 455 1st Ave., N.Y., N.Y.

The cerebral ganglion of Aplysia contains a pair of cells homologous to the metacerebral cells (MCCs) of pulmonate molluscs. The MCCs of Aplysia have an extensive axonal arborization, sending ipsilateral branches to the post. lip n., oes. n. and buccal nerves 1 and 3; and sending both ipsi- and contralateral branches to the radula n. and buccal n. 2. Direct firing of the MCC cell produces an organized pattern of synaptic input to neurons in the buccal ganglion. Interneurons B4 and 5 are inhibited. The excitatory followers of B4 and 5 are also inhibited; their inhibitory followers are excited. With rare exceptions, discrete synaptic potentials are not observed, but rather a train of spikes in the MCC produces a smooth summated synaptic potential. Rise and decay time of depolarizing and hyperpolarizing summated synaptic potentials are very slow (decay time up to 15 secs). In some cases when the MCC is fired continuously, buccal ganglion cells exhibit a tonic depolarization interrupted by rhythmic bursts of discrete IPSPs that presumably are produced by an interneuron that is set into rhythmic activity by the MCC. Experiments with a semi-intact preparation indicate that many cells affected by firing the MCC produce movement of buccal muscles, and are probably motor neurons involved in biting and swallowing. Spontaneous biting or swallowing activity is associated with phasic excitatory synaptic input to the MCCs. However, we have not found that direct firing of the MCC produces biting or swallowing movements. The overall data suggest the hypothesis that the MCCs may serve a non-specific command role in the feeding reflex, perhaps affecting the general excitability level of buccal muscle and neurons. Supported by Training Grant MH 10315-09 and NIH Grant NS 10757.

376 EFFECTIVENESS OF BIOCHEMICAL TRANSFER AS A FUNCTION OF DOSAGE AND INJECTION-TESTING INTERVAL. P. V. Laird and W. G. Braud Univ of Houston, Houston Texas 77004

The activity of a synthetic polypeptide(scotophobin) considered to play an important role in dark-avoidance behavior in several species, was tested in goldfish. Naive recipient fish were injected intercranially with either 1.0, 1.25, 1.5, 1.75 or 2.0 ug of Scotophobin. Light vs dark preference of these fish was measured 24, 48, 72, 96, 120 and 336 hours after injection. Nonreinforced testing of recipients was done in a blind manner in both between S and within S designs. Three statements may summarize results obtained: (a) scotophobin significantly enhanced light preference in experimental fish, (b) the time of maximal effect increased with increasing dosage of injected scotophobin, and (c) following the maximal effect, performance declined rather rapidly to a control (chance, inactive) level. The great sensitivity of the scotophobin induced effect to time and dosage factors may account for whether or not behavioral effects are obtained by various investigators of such "behavioral bioassay" phenomena.

377 FLUORESCENCE AND ELECTRON MICROSCOPIC ANALYSIS OF CATECHOLAMINE-CONTAINING FIBERS IN MUTANT MOUSE CEREBELLUM. S. C. Landis* and F. E. Bloom (SPON: D. M. D. Landis). Lab of Neuropharmacology, NIMH, Washington, D.C. 20032.

The recently described norepinephrine-containing afferent pathway from nucleus locus coeruleus to cerebellar cortex has been examined in normal and cerebellar mutant mice. The Falck-Hillarp histofluorescence technique revealed green fluorescent fibers in normal mice similar to those in the rat. Weanling C57BL and adult outbred staggerer, reeler and weaver mice manifested greatly increased catecholamine (CA) fluorescence per unit area in their hypoplastic cerebella. Abundant varicosities were present in each of the three but the patterns of fluorescent fibers were distinctive. Fluorescent fibers also appeared more abundant than normal in the cerebellar cortex of adult nervous mice in which 90% of the Purkinje cells had degenerated. Cerebella from the three hypoplastic mutants were fixed with permanganate ($KMnO_4$) and examined with the electron microscope. Axonal boutons containing small granular vesicles (SGV) characteristic of CA-containing terminals were present (approximately 1 per 7000 μ^2) and morphologically similar in all three mutants. In general, the boutons were small or medium in size, had lucent axoplasm and relatively few synaptic vesicles. Incubation of tissue slices in 5-hydroxydopamine (5OHDA) followed by $KMnO_4$ fixation caused a four-fold increase in the number of boutons containing SGV and an increase in the number of vesicles containing granules in each bouton. Pretreatment with reserpine eliminated SGV boutons after $KNnO_4$ fixation both with and without 5OHDA incubation. After intracisternal injections of 6-hydroxydopamine, fluorescent fibers disappeared and degenerating boutons were observed in the mutant cerebellar cortices. Using these techniques to identify CA terminals synapses have been observed on Purkinje dendrites and spines and stellate somata.

378 A STATISTICAL ANALYSIS OF THE SPONTANEOUS ACTIVITY FROM SINGLE UNITS IN THE ANTERIOR SEMICIRCULAR CANAL OF THE PIGEON. Jack P. Landolt and Manning J. Correia. DCIEM, Downsview (Toronto), Canada, and Dept. Otolaryng., UTMB, Galveston, Texas.

Spike trains from 120 units were recorded by microelectrode and tested for stationarity by means of the Wald-Wolfowitz runs test. Of the 69 units showing a non-stationarity, the majority (72.5%) displayed an undulation with no apparent distinct frequency of oscillation. For the stationary units, the overall mean firing rate was 94.20 impulses per second and the coefficient of variation was always less than one. Twenty-two of the stationary units were then studied in great detail using a point process theoretic approach (Cox and Lewis, 1966). The Kolmogorov-Smirnov and the Anderson-Darling statistics were used as goodness-of-fit tests of the data to the prediction that the spike train is a Poisson process. When Durbin's transformation was applied to the raw data (to increase the power for rejection of a false null hypothesis), the Poisson hypothesis was rejected in all instances. Further tests for a renewal process, i.e., a process in which the interevent times are independent and identically distributed with common density function, revealed that 14 units were of the renewal type and 8 were non-renewal. Combined with a knowledge of the morphology of the complex hair cell innervation pattern, the results from formulations such as the serial correlation coefficients, exponential scores, survivor function, expectation density, variance-time curve, and the spectral density functions of the intervals and events provide additional information so that a realistic model of the neural generating mechanism can be attained.

379 CONCURRENT MEASUREMENT OF PICOMOLE QUANTITIES OF TRYPTOPHAN, 5-HYDROXYTRYPTOPHAN, SEROTONIN, 5-HYDROXYINDOLEACETIC ACID, TYROSINE, DOPAMINE AND NOREPINEPHRINE IN THE SAME SAMPLE FROM BRAIN AREAS OF RAT AND PIGEON. J.D. Lane*, J.E. Smith* and M.H. Aprison, Sect. of Neurobiology, Depts. of Biochemistry and Psychiatry, Inst. Psych. Res., Indiana Univ. Med. Ctr. Indianapolis, Ind. 46202.

Three ion exchange columns arranged in tandem (Bio-Rex 70, AG 3 X 4A, and AG 1 X 4-top to bottom) were utilized to separate tryptophan (Try), 5-hydroxytryptophan (5-HTP), serotonin (5-HT), 5-hydroxyindoleacetic acid (5-HIAA), tyrosine (Tyr), dopamine (DA) and norepinephrine (NE) in the same sample from individual brain parts of rat and pigeon. Pigeons were decapitated; rats were near-frozen (J. Neurochem. 11: 882, 1964). Brains were dissected, then pulverized in liquid N_2. Tissue powders were extracted with formic acid-acetone, washed with heptane-chloroform, and evaporated to dryness at 37°C under N_2. The extracts were dissolved in water (pH 4), buffered, layered on the Bio-Rex 70 column, and allowed to flow into the other two columns. The columns were washed with a series of solutions (buffer, water, acids, and methanol-acids) to separate and elute the compounds into four fractions. The Bio-Rex 70 (DA, NE, 5-HT) and AG 1 X 4 (5-HTP, Try) fractions were evaporated to dryness at 37° under N_2, and dissolved in small volumes of water (pH 4). The AG 3 X 4A (5-HIAA) and unbound (Tyr) fractions were assayed directly. Aliquots were assayed by modified micro-adaptations of published compound-specific assays: DA (Int. J. Neuropharmac. 3, 643, 1964); NE (J. Pharmac. exp. Ther. 127: 175, 1959); 5-HT, 5-HIAA, 5-HTP (Anal. Chem. 38: 1937, 1966); Try (J. Pharmac. exp. Ther. 127: 175, 1959); and Tyr (J. Lab. Clin. Med. 50: 733, 1957). The method is rapid and amenable to analysis of multiple tissue samples. Recoveries are consistently high, and data obtained for rat and pigeon brain parts are consistent with existing literature values. (Supported by NIMH grant MH-03225-15).

380 ANALYSIS OF SPIKE TRAIN DATA. G. David Lange and Peter H. Hartline. Dept. Neurosciences, Sch. Med., UCSD, San Diego, 92037.

The information in spike trains is carried exclusively in the timing of the nerve action potentials. There is a need for a mathematical representation which has this essential property. This is especially true if mathematical analyses (such as Fourier techniques) are to be applied. A sum of delta function has the requisite properties for such a representation. The resulting Fourier spectrum is dominated, however, by the broad spectra of the spikes themselves. We have devised a representation which when Fourier analyzed emphasizes the information carrying properties of the train. The resultant spectrum is characteristic of the modulation of the spike train frequency. In this method the spike train is represented by the well-known instantaneous frequency function. The instantaneous frequency function is first expressed as a sum of rectangular function. These rectangular functions have Fourier transforms of the form sinc s. The entire transform of the modulated spike train requires the calculation of only one number per Fourier term per spike. The most straightforward application of the technique is in sinusoidal input output analysis. A more intriguing application is in the construction of smooth functions representing the modulation of spike trains.
Supported by grants from PHS (NS 09342), NSF (GJ-41809) and the Sloan Foundation.

381 RESPIRATORY REACTION TIMES IN MAN: ESTIMATION OF CENTRAL DELAYS IN THE INITIATION OF VOLUNTARY BREATHING MOVEMENTS. Robert W. Lansing and John E. Thomas* Dept. of Psychol., Univ. of Arizona, Tucson, 85721

Normal subjects were trained to make simple respiratory movements as quickly as possible in response to light flashes. At a ready signal the subject breath-held at a pre-instructed volume (end of a normal inspiration or normal expiration); 2 to 4 secs later the flash occurred and the reaction time (RT) was measured to the start of air flow. The length and variability of these breath RTs were similar to those typically reported for limb responses under comparable conditions: 198 msec (S.D. 21) for expiratory and 184 msec (S.D. 22) for inspiratory reactions. Neither expiratory nor inspiratory RTs were affected by differences in pre-stimulus holding volume so we conclude that they were determined more by central and neuromuscular factors than by the mechanics of the response itself. To estimate the central delays involved in this type of response a second group of subjects was trained and motivated to produce the shortest possible expiratory RTs while EMGs were recorded from the abdominal muscles and visual evoked potentials were recorded from the occipital scalp. The earliest evoked potential component (first positive) began 30 msec after the flash, the average latency for EMG onset was 108 msec, and the latency to the start of air flow was 165 msec. This gives an estimate of 78 msec for central processing and efferent discharge, a value slightly below that estimated for manual reactions under optimal conditions. These results suggest that the central control of respiratory muscles is similar to that of limb muscles during the initiation of rapid voluntary movements. The simple reaction time procedure appears to offer a useful behavioral technique for the study of neural processes associated with the control of voluntary breathing.

382 INTRAAXONAL TRANSPORT OF HORSERADISH PEROXIDASE FOLLOWING INTRAVITREAL INJECTIONS IN CHICKS. Jennifer LaVail and Matthew LaVail. Depts. of Neuropathology, Harvard Medical School and of Neuroscience, The Children's Hospital Medical Center, Boston, Ma. 02115.

Injections of horseradish peroxidase (HRP) into the vitreous of chicks result in the intraaxonal retrograde transport of the protein from axons in the retina to the cell bodies of neurons of the isthmo-optic nucleus (ION) in the midbrain at a rate of at least 84 mm/day. By 7 hrs after injection HRP had diffused out of the eye and into the extracellular spaces of the proximal optic nerve. By this time HRP-filled vesicles (0.3-0.6 μm in diameter) were abundant in the neuronal somas of the contralateral ION, but no HRP was found extracellularly or within any glial or vascular cell of that nucleus.

The HRP moves in an anterograde direction from retinal ganglion cell bodies in tubules, multivesicular bodies and vesicles (70-75nm) within the axons to axon terminals in the contralateral optic tectum. The marker is detectable in significant quantities 23.5 hrs after injection. Both the rate and quantity of the enzyme transported in the retrograde direction appear to be greater than the rate and quantity transported in the anterograde direction.

The left retina of several chicks was deliberately damaged at the time of introduction of the HRP into both eyes. Axons filled diffusely with HRP could be traced from the damaged retina into the optic nerve and contralateral optic tract 24 hrs after injection. Electron microscopic examination of the nerves indicated that both myelinated and unmyelinated axons contained HRP dispersed within the axoplasm.

383 ORGANELLES INVOLVED IN RETROGRADE AXONAL TRANSPORT IN CHICK RETINAL GANGLION CELLS. Matthew LaVail and Jennifer LaVail. The Depts. of Neuropathology, Harvard Medical School and of Neuroscience, The Children's Hospital Medical Center, Boston, Ma. 02115

Retrograde transport of the exogenous protein, horseradish peroxidase (HRP) from the region of nerve terminals in the chick optic tectum back to cell bodies of the retinal ganglion cells has been studied by electron microscopy. After injection into the optic tectum the marker was observed in pinocytotic vesicles, 43-50 nm in diameter, in axon terminals and in larger, 100-125 nm vesicles in axons and axon terminals. HRP-filled organelles, i.e., 45-220 nm vesicles, small tubules of the axonal agranular reticulum, multivesicular bodies and cup-shaped organelles, could be identified within axons of the stratum opticum as early as 0.5 hr after injection. By 2 hrs no HRP was identified in the optic nerve, but by 7 hrs HRP-filled organelles were found throughout the extent of the ganglion cell axons. The marker accumulated in the cell body in vesicles 65-650 nm in diameter, many of which were concentrated near the Golgi region. By 7 hrs after injection no extracellular HRP could be found in the optic nerves, and none was found within the retina at any time. Pinocytosis along the axon shaft was rare. No HRP was found in the ipsilateral retina. These findings support the concept of the intraaxonal movement of the marker.

In the axons the vesicles containing HRP frequently were partially or completely surrounded by a regular array of microtubules. Doses of colchicine greater than 5 µg/eye administered intravitreally 4 days before tectal injection of HRP interfered with the uptake and/or retrograde transport of HRP. These observations indicate that microtubules may be involved in the mechanism of retrograde intraaxonal transport.

384 MEMBRANE ELECTRICAL CONSTANTS OF INNERVATED AND DENERVATED, NORMAL AND DYSTROPHIC CHICKEN MUSCLES. F.J. Lebeda* and E.X. Albuquerque. Dept. Cell Biol. & Pharmacol., Univ. Maryland, Sch. of Med., Baltimore, Md. 21201

Membrane cable properties of innervated and 3-21 day chronically denervated *fast* posterior latissimus dorsi (PLD) muscles of normal (line 200) and dystrophic (line 304) chickens were examined using conventional microelectrode techniques. Innervated dystrophic fibers had a smaller mean input resistance (R_{in}) than innervated normal fibers, 0.26 and 0.35 MΩ, respectively. Other constants, however, were significantly larger in dystrophic than in normal fibers: space constant (λ) 1.02 *vs.* 0.66 mm, specific membrane resistance (R_m) 1058 *vs.* 634 Ωcm^2, time constant (τ_m) 6.8 *vs.* 3.4 msec, membrane capacitance (C_m) 7.1 *vs.* 5.4 $\mu F/cm^2$ and fiber radius 33.1 *vs.* 22.2 µ. At 21 days after denervation of normal PLD muscles, R_{in}, R_m and τ_m increased ∿ 5 fold; in addition, λ increased to 1.0 mm, while the fiber radius decreased by 40%. The C_m of normal fibers was unchanged 21 days after denervation. In the dystrophic muscles, however, these postdenervation changes were generally less extensive than in normal muscles; by day 21, R_{in} increased ∿ 4 fold as in denervated normal muscle, but R_m and τ_m increased by only a factor of 2.5 and were similar to values from 21 day denervated normal muscles. In 21 day denervated dystrophic fibers, the mean values for λ and C_m were not altered; the fiber radius also declined by ∿ 40%. To study the mechanism underlying the increase in R_m after denervation, the resting membrane conductance was selectively altered. In low pH solutions (5.0) where chloride conductance was presumably reduced, λ, τ_m and R_m of innervated normal and dystrophic muscles were increased and were near to those in 21 day denervated muscles. In contrast, low pH had no marked effects on 21 day denervated normal and dystrophic muscles. It is suggested that the augmented R_m values of denervated and innervated dystrophic PLD muscles may be partially due to reduced potassium and chloride conductances. (Supported by USPHS Grants NS-08233 and GM-00107.)

385 ON THE MECHANISM OF REGULARITY OF PERIODIC INTERICTAL DISCHARGE IN EXPERIMENTAL PENICILLIN EPILEPSY. Robert M. Lebovitz, Dept. of Physiology, Univ. of Texas, Southwestern Medical School, Dallas, Texas, 75235

Penicillin applied topically to cortex induces a form of experimental epilepsy characterized by brief, but spontaneous and periodic paroxysmal discharge, the interictal spike (IS). The characteristics of the processes accounting for the long (15-30 sec) IS interval were here examined using the acutely exposed and topically perfused hippocampus of cat. Histograms of inter-IS intervals from naive penicillin foci showed a narrow, Gaussian distribution, suggesting a pacemaker-like regularity to these epileptiform field potentials. A rapid reactivity to localized hippocampal temperature changes and to differential ion perfusion verified that this regularity was not dependent upon extrahippocampal pathways. Determination of the IS threshold in response to fornix-fimbrial stimulation showed a marked depression of focal excitability immediately after each spontaneous IS, and exponential recovery thereafter; the time constant of this recovery was closely related to the mean spontaneous IS interval. Hippocampal evoked field potentials, in contrast, though likewise depressed immediately after each spontaneous IS, recovered with a time constant on the order of one second. Spontaneous, non-paroxysmal single unit activity in the hippocampal pyramidal cell body layer was similarly found to be only briefly depressed by each IS. This disparate recovery of field and unit activity, on the one hand, and paroxysmal discharge, on the other, suggests that the spontaneous IS interval is regulated by a slow inhibitory process different from the well known recurrent inhibitory collateral pathway. The high Q_{10} of interictal discharge, as well as the accelerating effects of Na-K ATPase inhibitors on the IS rate, suggest that coupled ionic transport may be involved in this inhibitory phasing of interictal discharge. If so, this suggests a general role for Na-K ATPase in phasic modulation of neural population excitability and stability. (Supported by NINDS Grant NS-09975.)

386 NOREPINEPHRINE-ELICITED EATING: INVOLVEMENT OF NEUROENDOCRINE SYSTEM OF THE PARAVENTRICULAR NUCLEUS. Sarah Fryer Leibowitz. The Rockefeller University, New York NY 10021.

On the basis of our studies on noradrenergic control of feeding behavior in the rat, it is proposed that the eating response elicited by central norepinephrine (NE) injection is: a) mediated by the paraventricular nucleus (PVN), and b) critically dependent upon the PVN's neuroendocrine function. Our evidence in support of this hypothesis includes the following. 1) The PVN, as compared to 35 other brain sites tested in 375 rats, was found to be by far the most responsive to NE injection. At a dose of 5 μg, NE injected directly into the PVN consistently produced a relatively large eating response of 4 g. 2) NE stimulation of the PVN produced eating with the shortest mean latency (2.7 min) observed to date. 3) Very low doses, probably near physiological levels, of NE (16 ng) and epinephrine (4 ng) were found to produce reliable eating after administration into the PVN. 4) Under normal conditions, rats are known to precede a meal with a brief, vigorous drinking response. Under conditions of central NE stimulation, this food-associated drinking was observed, however, only when the PVN was the site of injection. Within 0.7 min after administration into the PVN, NE elicited a drinking response (2-3 ml) which lasted less than 3 min and then stopped approximately 1 min before eating began. 5) The eating response elicited by NE injection into the PVN was found to be a pituitary-dependent behavior. Hypophysectomy totally abolished NE-induced eating of lab chow pellets. Ingestion of sweet milk or a sweet milk plus wet mash mixture was reduced by approximately 90%. In contrast to NE-induced eating, the food-associated drinking of water elicited by NE injection was unaffected by hypophysectomy. Carbachol-elicited drinking was reduced by 20%. (Supported by USPHS grant MH 13189 and by a grant from the Grant Foundation.)

387 A NEW "EXTRARHINAL" SOURCE OF AFFERENTS TO THE HIPPOCAMPUS IN THE SQUIRREL MONKEY. George R. Leichnetz and Juan Astruc, Department of Anatomy, Medical College of Virginia, Health Sciences Division, Virginia Commonwealth University, Richmond, Virginia 23298.

The primary source of direct input to the hippocampus reportedly comes from the entorhinal (Cajal,'11; Lorente De No,'34) and septal (Daitz and Powell,'54) areas. However, lesions made by subpial suction in the medial prefrontal granular cortex, and stained by the Nauta and Fink-Heimer methods, in six adult squirrel monkeys (Saimiri sciureus) were shown to produce fiber degeneration which not only reached the entorhinal and subicular areas, as has been reported by Adey and Meyer (1952), but entered the hippocampus proper. Fiber degeneration was followed through both the cingulum and the uncinate fascicle/inferior frontooccipital fasciculus into the entorhinal area, and then appeared to enter the hippocampus by both the alvear and perforant paths. Preterminal degeneration, which followed the perforant path, traversed the stratum radiatum of the CA1, CA2, and CA3 hippocampal subfields, but did not enter the CA4 subfield of the dentate gyrus. CA4 reportedly receives its afferents from only the entorhinal and septal areas. Behavioral studies based upon the deafferentation of the hippocampus should take into account this extrarhinal source of afferent input, as superficial entorhinal lesions would generally fail to interrupt this connection. (Partially supported by USPHS Research Grant NB 08418)

388 DEVELOPMENTAL ANALYSIS OF THE SUPRACHIASMATIC NUCLEUS OF THE HYPOTHALAMUS Nicholas J. Lenn, Bruce Beebe* and Robert Y. Moore, The University of Chicago, Departments of Pediatrics and Medicine (Neurology), Chicago 60637.

The suprachiasmatic nucleus of the hypothalamus receives retinal afferents in all mammals studied, and appears to be involved in the entrainment of endocrine circadian rhythms. The last mitotic division of the neurons forming this nucleus is late in gestation. Light microscopic examination reveals that the nucleus is well formed on the day of birth. It subsequently increases in size, due primarily to an increase in neuropil. In electron microscopic preparations, the neuronal perikarya show no significant change during development. They have characteristic eccentric large nuclei at all stages. On the other hand, at birth, the neuropil is sparse, with very few immature synapses, and rare dendritic growth cones. At four days postnatal dendritic growth cones are common, but the immature synapses are unchanged. By eight days the number of dendritic growth cones decreases. At fourteen days postnatal, there are large numbers of well formed synapses exhibiting both symmetrical and asymmetrical synaptic membrane contacts. Flattened synaptic vesicles are seen within some axonal endings. The synapses, as in the adult, are entirely axodendritic, primarily on distal portions of dendrites. No further change occurs in the older age groups in this material. Bilateral enucleation on the day of birth results in no recognizable fine structural difference from the normal animals when studied on day four and subsequently. This is in keeping with our previous results in adults which showed that the retinal projection to this nucleus was quantitatively quite limited.

389 CONTROL OF SWIMMING IN THE TURTLE BY ELECTRICAL STIMULATION OF THE SPINAL CORD. Paul R. Lennard* and Paul S. G. Stein. Dept. of Biology, Washington Univ., St. Louis, Mo. 63130

Electrical stimulation of the CNS can be utilized to produce coordinated limb movements which resemble natural locomotion (Evarts et al., 1971, Neurosci. Res. Prog. Bull. 9: 1). We have developed a method for electrically eliciting swimming in the turtle, Chrysemys picta. A midline portion of the dorsal carapace was removed exposing a region of the thoracic spinal cord. EMG electrodes were implanted in a knee flexor, a knee extensor, an elbow flexor and an elbow extensor. All surgery was performed under hypothermal conditions. Experimentation was carried out at room temperature. A movement detector was utilized to monitor limb position; in some experiments videotaping was also employed. The shell of the turtle was rigidly held in order to fix the position of the thoracic spinal cord in space. The turtle was partially immersed in water and all four legs were free to move. Discrete areas of the spinal cord were stimulated with electrical pulses delivered at a constant frequency via a suction electrode. Stimulation of specific regions of the lateral columns produced muscle activity and leg movements similar to those observed during spontaneous swimming. Low frequency stimulation (10 Hz-30 Hz) usually caused repetitive swimming movements in only one leg. High frequency stimulation (50 Hz-100 Hz) usually caused swimming movements in several legs. Interlimb phase characteristic of normal swimming was observed with the high frequency stimulation. (Supported by NSF grant GB-35534 to P. S. G. Stein).

390 REGIONAL DISTRIBUTION OF CYCLIC NUCLEOTIDES IN RAT BRAIN AS DETERMINED AFTER MICROWAVE FIXATION TECHNIQUE. R.H. Lenox*, J.L. Meyerhoff and H.L. Wray*, Div Neuropsychiatry, Dept Microwave Res, Walter Reed Army Inst. of Res, Washington, D.C. 20012

Reported in-vivo concentrations of cyclic adenosine 3',5'-monophosphate (cAMP) in the central nervous system have varied widely from region to region as well as from one laboratory to another. This variability appears to reflect changes secondary to inadequate tissue fixation by both freezing and microwave techniques. Male albino rats ranging in weight from 300-500gm were sacrificed by exposure of the head to microwave irradiation of 3.0 kW for 5-6 seconds in a waveguide chamber. This was sufficient to allow stability of the preparation for complex dissection. Thirteen regions of the brain were dissected and assayed for both cAMP and cyclic guanosine 3'5'-monophosphate (cGMP) in a double isotope radioimminoassay system.

cAMP picomoles/mg wet weight (mean ± S.E.M.)

Cerebellum	0.70 ± .03	*Amygdala-Pyriform	0.55 ± .03
Brainstem	0.66 ± .03	Septal Nuclei	0.88 ± .08
Midbrain	0.89 ± .06	*N. Accumbens	0.81 ± .08
*Substantia Nigra	0.70 ± .07	Olfactory Tubercle	0.85 ± .13
Thalamus	0.69 ± .03	Striatum	0.65 ± .02
Hypothalamus	0.84 ± .06	Cortex	0.96 ± .05
Hippocampus	0.76 ± .03		

*cAMP levels in these regions have not previously been reported.

These cAMP concentrations were not only lower than reported values in several regions, but also were remarkably uniform throughout the brain. We found the distribution of cGMP, however, in the rat brain to be consistent with the relative regional variation reported in mice. The level of cGMP in the rat cerebellum (0.99 ± .09 pm/mg) was 3 to 25 fold higher than other regions of the brain.

391 COMPARTMENTALIZATION OF MOTOR UNIT INNERVATION TERRITORIES: IMPLICATIONS FOR MOTOR NUCLEUS ORGANIZATION. William D. Letbetter. Neurophysiology Lab, Regional Rehabilitation Research and Training Center, and Department of Anatomy, Emory University, Atlanta, Georgia 30306.

A recent interest of this laboratory is the segregation into subsets of afferent and efferent axons which occurs when a motor nerve divides into its various intramuscular nerve branches as it enters the neurovascular hilus. Since each of the intramuscular nerve branches should contain a unique subset of the homonymous alpha motor axons (however, see Eccles and Sherrington--*Proc. Roy. Soc. B.* 106, 326), it should be possible to ascertain the muscle innervation territory of a given subset of alpha motoneurons projecting their axons through one of the intramuscular branches. A peripheral hindlimb nerve dissection was carried out in Numbutalized cats wherein the entire medial gastrocnemius muscle was acutely denervated with the exception of a single intramuscular nerve branch. The remaining intact motor axons were subjected to one hour of supramaximal stimuli in the form of a 330 msec train of 0.2 msec pulses (40/sec) delivered once each second (Burke, *et al.--Science* 174, 709). The active muscle fibers were thereby depleted of glycogen and their distribution within the muscle was determined from histologic sections stained by the PAS method. Our freeze processing and histologic techniques allowed accurate whole muscle reconstruction of the innervation territories. Each territory so determined was found to be discretely confined to a given volume of the muscle while practically all of the muscle fibers within that volume were innervated by the intact motor axons. Furthermore, a topographical organization of the innervation territories was revealed which, when viewed in the light of Swett, Eldred and Buchwald's work (*Am. J. Physiol.* 219, 762) suggests the interesting possibility that alpha motoneurons are grouped into functional subsets within the homonymous motor nucleus in the ventral horn.

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392 TOPOGRAPHY OF OCULAR DOMINANCE COLUMNS IN MONKEY STRIATE CORTEX. Simon LeVay*, David H. Hubel and Torsten N. Wiesel (SPON: A.E. Stuart). Dept. of Neurobiology, Harvard Medical School, Boston, Ma. 02115.

Tangential sections of the rhesus monkey's striate cortex, stained with a Cajal silver method for normal fibres, revealed a pattern of parallel dark bands in layer 4C. The bands were 200-500μm wide, and were separated by pale lines about 50μm wide. Reconstructions from serial sections showed that the bands formed two branching but non-communicating systems. This pattern suggested that the bands might represent left and right ocular dominance columns, the pale (fibre-poor) lines being the boundaries between columns. To test this, four electrode penetrations were made tangential to the cortex. As the electrode was advanced horizontally through layer 4, the eye preference of successive single units was recorded, and small electrolytic lesions were placed at the points where eye preference changed. In subsequent histological reconstructions all the lesions (a total of 12) coincided with the thin pale lines. The dark bands did therefore indeed correspond to single ocular dominance columns, as defined physiologically. Serial sections stained with the silver method were used to map the ocular dominance system for most of the striate cortex. The overall pattern was similar in several individual animals. The columns met the 17-18 border at right angles at all points and ended there abruptly. On the smooth outer surface, they converged from the 17-18 border and streamed medially over the lip of the calcarine fissure, where they met a second system of columns running perpendicular to the first in an anteroposterior direction. Transposed on to the visual field, the columns would therefore run horizontally for roughly the central 10° of field, and circumferentially from 10° out to at least 20°.

393 EFFECT OF INTRACEREBRAL NGF INJECTIONS IN NEWBORN RODENTS. R. Levi-Montalcini, M. G. M. Chen* and J. S. Chen*. Dept. Biol., Washington Univ., St. Louis, Mo., 63130, and Lab. Cell Biol. (CNR), Rome, Italy.

Mice and rats were injected twice daily intracerebrally from the day of birth to the 10th postnatal day with 1 lambda of purified NGF per injection. Littermates were injected with saline. 300 experimental and control animals were sacrificed at the end of this period; brain and spinal cord were lyophilized and processed according to the Falck-Hillarp technique and examined in serially cut transverse sections throughout the length of spinal cord, brain stem, up to the mesencephalon. The survival rate was of the order of 90%; the treated animals compared to controls in size and vitality. In all experimental animals large, compact green fluorescent fiber bundles were found in dorsal and lateral funiculi of the spinal cord and in the lateroventral aspect of the brain stem up to the floor of the 4th ventricle. Neither controls nor littermates injected systemically with NGF show these fluorescent fiber systems which were traced in the experimental animals to sympathetic paravertebral chain ganglia. The results suggest that the high NGF concentration in the central nervous system is responsible for this abnormal invasion of the spinal cord and brain stem by sympathetic adrenergic nerve fibers. The end distribution of these aberrant nerve fiber tracts, as well as their relationship to the central adrenergic systems, is under investigation. (Supported in part by grants MH24604 and NS03777)

394 DEVELOPMENT OF MOTORIC ACTIVITY IN KITTENS. M.S. Levine, C.D. Hull and N.A. Buchwald. Depts. of Psychiatry & Anatomy, Ment. Retard. Res. Ctr., UCLA, NPI, Los Angeles, Calif. 90024.

In the process of studying the effects of neuroanatomical and neurochemical manipulation of immature brains, we have attempted to develop a series of tests sensitive to developmental changes in the behavior of kittens. One of these tests consists of measurement of the development of motoric activity patterns. Between birth and 21 days of age quantification of motor patterns was effected by recording displacement of a sensitive force transducer. As locomotion develops, this test becomes too sensitive to gross body movements. Subsequent locomotor activity (days 21-62) was determined by interruption of photocell beams in an open field. During days 1-12 motor activity was stable. From days 12-21, motor activity increased markedly and remained stable at this elevated value. Observation of the kitten's behavior during activity assessment allowed quantification of discrete types of motor activity associated with transducer displacement. In general, vocalization, head, forepaw and gross body movements all increased in frequency from days 1-21. In contrast, frequency of quiescent periods (intervals during which movements were minimal) decreased during this time. During days 1-12, kittens were most active during the first few minutes of the test. By the end of the test period, activity was minimal. After day 12, the activity was distributed consistently throughout the duration of the test period. Locomotor activity in the open field increased gradually from days 21-29. There was a sudden increase during days 30-32 which persisted for the remainder of the tests (until day 62, at which time, the kittens were weaned).

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395 EFFECTS OF ORGANIC ANIONS ON NEURONAL MEMBRANE PERMEABILITY. H. Levitan and J. L. Barker. Dept. of Zool., Univ. of Md., College Park, 20742, and Behav. Biol. Branch, NICHD, Bethesda, Md. 20014.

We have examined the effects of a variety of organic anions on the membrane potential and permeability of identified neurons in the isolated buccal ganglion of the marine mollusc, Navanax. We found that the anions of aliphatic monocarboxylic acids (e.g., octanoate), aliphatic sulfonic acids (e.g., isethionate and SDS), aromatic sulfonic acids (e.g., ANS), and aromatic monocarboxylic acids (e.g., 2,4 di-chlorophenoxyacetate (2,4-D)) all initiated a reversible dose-dependent increase in the membrane potential of these neurons. This was due primarily to an increase in potassium conductance and decrease in chloride conductance, and was accompanied by a reversible, dose-dependent decrease in the permeability of alkali-cations relative to potassium. The ability of all compounds to alter membrane potential was highly correlated with their octanol-water partition coefficient, increasing with increasing hydrophobicity. Since all of the substances were almost completely ionized at the experimental pH of about 8.0, the results indicate that activity is related to the ability of a molecule to hydrophobically interact with the membrane, rather than to any particular steric requirement. A similar relationship between activity and partition coefficient has been described for more than 30 analogs of benzoate and salicylate (Science 176:1423 (1972)). These results lead us to suggest that in other systems where one of these or similar agents have been found active, all other organic anions should be similarly active, with their relative activity determined principally by the octanol-water partition coefficient of the anion. Deviations from the general pattern observed in more complex systems could be attributed to the specific pharmacokinetics of that system.

396 POSTCENTRAL SOMATIC MECHANORECEPTION: I. DORSAL COLUMN AND ANTEROLATERAL LESIONS. Janice Levitt* and M. Levitt. Dept. Physiology, Bowman Gray Sch. Med., Winston-Salem, North Carolina 27103.

Chronic spinal cord lesions were made in macaques. Single neurons in the p.c.g. were extracellularly studied, under Pentothal and Flaxedil. Unilateral midthoracic DC lesions were made in two animals. Usual lemniscal (L) representation of the HL in the core region (areas 3 and anterior 1) of the p.c.g. was virtually absent, but 82% of these neurons exhibited "aberrant lemniscal" (AbL) properties. Of neurons sampled in the posterior region (areas 2 and posterior 1) of the p.c.g., 55% had L properties and were related to distal or proximal peripheral receptive fields. Neurons with AbL properties comprised 31% of this posterior region. Those responding with slow adaptation to movement of joints comprised 29% of the driven neurons in the posterior region. Neurons with AbL properties had local ipsilateral or bilateral peripheral fields; and were classified as phasic hair, or tap, or joint movement, or tonic joint movement. Two animals had lesions of the contralateral ALC as well as the DC. These were midthoracic in one (HL area) and high cervical in the other (FL area). Among 90 neurons studied, none had AbL properties, but 96% in the core region and 61% in the posterior region had L properties. Phasic hair or tap with distal fields predominated. Inadequate sampling of cortical locus for proximal representation probably accounts for dearth of joint movement detectors. Somatotopy and the superficial-deep gradient were preserved. Crossed spinal pathways apparently block transmission in uncrossed spinal L pathways. The mechanism for AbL representation is equivocal. USPHS NB 05234.

397 POSTCENTRAL SOMATIC MECHANORECEPTION: II. DORSAL QUADRANT, HEMISECTION, AND ANTEROLATERAL LESIONS. M. Levitt and Janice Levitt*. Dept. Physiology, Bowman Gray School of Medicine, Winston-Salem, N.C. 27103.

Midthoracic cord lesions were made in macaques. Single neurons were extracellularly studied under Pentothal and Flaxedil. The core region (3 and anterior 1) of the p.c.g. revealed no neurons with lemniscal (L) properties, with DQ lesion; but 90% had extralemniscal (EL) properties. The posterior region (2 and posterior 1) contained neurons with L properties and neurons with EL properties. Percentage of L neurons (35%) for proximal representation did not differ from experiments with only DC lesion; (EL= 46%). Percentage for distal representation did. Only 5% of these neurons had L properties (83% had EL properties). Distal representation in posterior region, when the cord was hemisected, exhibited a reduced percentage of EL neurons (48%), but no apparent further loss of L neurons (7%). When the contralateral ALC was also cut, neurons in posterior region exhibited only EL properties, at a reduced percentage (23%). With sparing only the VQ on right side and VC on the left side, the posterior region of left p.c.g. was unresponsive. Neurons with EL properties had mainly large contralateral receptive fields and tonic discharges. They were classified in rank order: (1) low sensitivity cutaneous mechanoreceptors, (2) superficial, or (3) deep nociceptors, (4) "slowly adapting" hair (probable D-type), (5) deep light pressure, and (6) superficial touch. Latencies for some of (1) and (4) ranged 15-20 msec. Somatotopy and the superficial-deep gradient were preserved. We caution against confusing some EL activity with L activity. USPHS NB 05234.

398 AUDITORY SENSORY EPITHELIAL DEVELOPMENT IN THE BULLFROG. Cheuk W. Li* and Edwin R. Lewis. Dept. of Electrical Engineering and Computer Sciences and the Electronics Research Laboratory, University of California, Berkeley, California 94720.

The inner ear of the frog contains two sensory organs (the Amphibian Papilla and the Basilar Papilla) that have been identified as auditory (Frishkopf and Geisler, 1966). After observing interesting morphogenetic relationship in the bullfrog sacculus (Lewis and Li, 1973), we investigated the morphogenesis of the two auditory papillae in both tadpoles and adult bullfrogs. In the sacculus, we had identified two distinct classes of hair cells, based on surface morphology. One type, the peripheral type, apparently becomes modified during macular growth to become the central type. Our SEM observations show three distinct types in the basilar and amphibian papillae; two of these types are very similar to those types found in the sacculus. As we had found in the sacculus, the peripheral type of hair cell occurs only at the growing edges of these papillae (the edges identified by Geisler et al. as "undifferentiated"). Also, peripheral type hair cells apparently derive through an interesting morphogenic sequence from the cuboidal epithelial cells surrounding the macula. Our SEM observations indicate that each of the undifferentiated epithelial cells surrounding the papillae already possesses an orientation, as indicated by the position of a very short, cilium-like projection. The basilar papilla, innervated by a single branch of the eighth nerve, begins its development as a single sensory epithelium. The amphibian papilla, on the other hand, is innervated by three branches of the eighth nerve. In early larval stages, the most rostral of the branches innervates a separate papilla, which later fuses with the papilla innervated by the other two branches. The orientations of hair cells in the larval amphibian papillae are opposed and are preserved during papillar fusion. (Supported by NIH, grant GM-17523-03.)

399 HORMONES FROM THE EYE OF APLYSIA? EFFECT OF CUTTING THE OPTIC NERVE ON THE CIRCADIAN RHYTHM OF BEHAVIORAL ACTIVITY. M.E. Lickey, G.K. Augter*, G.D. Block & J.A. Wozniak* Dept. of Psych., U. of Ore., Eugene, Ore.97403

In addition to neural machinery for photoreception, the Aplysia retina contains a functional circadian oscillator and cells whose ultrastructure suggests neurosecretion. With plausibility, therefore, it has been speculated that the eye might influence circadian rhythms in other organs by the timed release of ocular hormones. Indeed, the behavioral activity rhythm is modified, though not abolished, by eye removal. The present studies were carried out to see if ocular photoreceptors or oscillators influence the locomotor rhythm by causing the secretion of hormones from the eye. Aplysia were maintained in LD and the activity rhythm was recorded before and after (1) severing the optic nerves bilaterally near their union with the cerebral ganglion, and (2) removing the eyes bilaterally. As an aid to surgery, isotonic $MgCl_2$ was injected to relax the musculature of the body wall. Sham operations ruled out the effects of surgical or pharmacologic trauma. After removing the eyes or cutting the optic nerves the temporal pattern of the locomotor rhythm was nearly always modified. The modifications took one or more of several forms, including (1) disappearance of a prominent feature in the rhythm, (2) increased nocturnal activity, and (3) phase delay of diurnal activity onsets. Effect (3) was especially marked in animals maintained on short photofractions as in LD 8:16. If the optic nerve had already been cut, there was no further change in the locomotor rhythm when the eyes were removed. Thus, cutting the optic nerve mimicked the effect of eye removal and the effect of eye removal was absent after cutting the optic nerve. In influencing the locomotor rhythm, therefore, ocular photoreceptors or oscillators do not cause release of hormones from the eye. Impulse traffic in the optic nerve is required. Whether this traffic is afferent or efferent remains to be determined. (PHS 07458, NSF P3B0837)

400 PALLIDAL AND ENTOPEDUNCULAR SINGLE UNIT ACTIVITY IN CATS DURING DRINKING. T.I. Lidsky*, N.A. Buchwald and C.D. Hull. Depts. of Psychiatry & Anatomy Ment. Retard. Res. Cntr., UCLA, NPI, Los Angeles, Calif. 90024.

Previous work from this and other laboratories has indicated that pallidal units in monkeys display changes in firing rate during food seeking and consummatory responses. The purpose of the present research was to extend observations made in the monkey to the cat and to delineate which properties of the ingested material or ingestive behavior are most potent in altering unit activity. To accomplish this, an effort was made to dissociate the effects of proprioceptive, motoric, gustatory and somatosensory aspects of ingestion upon pallidal unit firing patterns. Unit responses were recorded in awake restrained cats during the introduction of fluids into the mouth. A very high (>80%) proportion of pallidal and entopeduncular neurons showed changes in firing rate during drinking. Responsive units were distributed throught both structures. Two patterns of response were observed. Most typically, responses were phasic in configuration and time-locked to the occurrence of fluid presentation. The other response pattern was a generalized change in firing which persisted throughout drinking. In both cases, excitation was more frequently observed than was inhibition. Changes in firing rate during drinking seemed to be related to the sensory rather than to the motor aspects of ingestion. The introduction of fluids into the mouth, in the absence of licking or swallowing, evoked pronounced changes in unit firing rate. In addition, a majority of pallidal and entopeduncular units also responded vigorously to tactile stimulation of the vibrissae and lip areas.

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401 DIFFERENTIAL EFFECTS OF I.V. DIAZEPAM ON THE SPONTANEOUS EEG RECORDED FROM THE LIMBIC SYSTEM AND CORTEX OF THE MORE EPILEPTOGENIC HEMISPHERE IN TEMPORAL LOBE EPILEPTICS. Jeffrey P. Lieb and Paul H. Crandall*
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The effects of intravenous (I.V.) diazepam on the spontaneous EEG of cortical and limbic system sites have been spectrally analyzed in 11 patients with intractable temporal lobe epilepsy in whom electrodes had been implanted stereotactically and left in place for 3-4 weeks. The clinical purpose of these electrodes is to record spontaneously occurring seizures as a means to identify, if possible, the more epileptogenic hemisphere for future anterior temporal lobectomy. In 8 out of 11 patients, seizures were found to originate unilaterally in the limbic system. Spectral arrays, based on 2-4 second EEG epochs, were computed for 5 minute time periods preceding and following injection. Averaged spectra were computed for 3 minute time periods preceding and following injection. In 4 out of the 8 unilateral patients, I.V. diazepam was found to selectively induce spectral activity in frequency bands greater than alpha in several of the recording sites of the less epileptogenic hemisphere while such activity was only minimally induced in the more epileptogenic hemisphere. This differential effect of diazepam was found to be localized to limbic system recording sites. Spectral enhancement was found bilaterally in the cortex for seizures originating unilaterally and thus yielded no lateralizing information. The spectral effects described were found to result primarily from drug produced changes in background activity in the EEG rather than changes produced in abnormal interictal activity.

402 EFFECT OF DIFFERENT ENDOGENOUS INTRACELLULAR SODIUM AND POTASSIUM ON LITHIUM DISTRIBUTION BETWEEN PLASMA AND RED BLOOD CELLS Kenneth W. Lieberman*, Peter E. Stokes, and George van der Noot*. Psychobiology Study Unit, Dept. of Psychiatry, Payne Whitney Clinic, New York Hospital-Cornell University Medical Center, New York 10021 & Dept. of Animal Science, Cook College, Rutgers University, New Brunswick, New Jersey.

High potassium (HK) sheep, low potassium (LK) sheep and pigs were given lithium chloride in their feed (0.6 meq/kg/day) for a period of 10 days and bloods were obtained daily. The lithium, sodium and potassium levels were analyzed in the separated plasma and red blood cells (RBC). Various ratios were constructed to determine the distribution of the lithium between the plasma and RBC in the animal groups to observe what influence the different endogenous RBC sodium and potassium concentrations exerted upon the lithium distribution. The plasma sodium and potassium levels are the same for the HK and LK sheep and the pigs. In decreasing order, the RBC Li/plasma Li ratios were 0.69 for the LK sheep, 0.16 for the HK sheep and 0.13 for the pigs. In spite of changing plasma lithium levels, the RBC Li/plasma Li ratio remained reasonably constant during the period of lithium administration for each of the three groups. The different intracellular cation compositions of the H K and LK sheep and the pigs influenced the distribution of lithium between the RBC and plasma. Ratios of RBC Li/plasma Li may prove to be of value in acting as a predictive indicator in differentiating between responders and non-responders to lithium treatment among sub-types of various affective disorders. (Supported in part by the George F. Baker Trust)

403 EFFECT OF UNCONDITIONED STIMULUS INTENSITY ON SPINAL CONDITIONING. A. R. Light* and R. G. Durkovic* (SPON: D. L. Blank) Dept. Physiol., Upstate Med. Ctr., Syracuse, N.Y. 13210.

Acute, decapitate cats were rendered spinal by cord transection at T-10. Conditioned and unconditioned responses were flexion reflexes measured by a force transducer attached to the tendon of the tibialis anterior muscle of a rigidly fixed hind limb. The CS was electrical stimulation of the saphenous nerve of this leg which activated Aα and Aδ cutaneous fibers maximally (10 impulses/sec for 1.5 secs). Intertrial interval was one minute. The US was electrical stimulation of the cutaneous superficial peroneal nerve of the same leg (40 impulses/sec for 0.5 sec) overlapping the last 0.5 seconds of the CS. Cats were randomly allocated to one of three groups: Group I - US intensity subthreshold for Aδ fibers but above threshold for 70-95% of Aα fibers; Group II - US intensity for maximal excitation of Aα and Aδ fibers but subthreshold for C fibers; Group III - US intensity for maximal excitation of Aα, Aδ and C fibers. Over a 30-minute conditioning period the change in flexion reflex during the first second of the CS was correlated with the magnitude of the US. The reflex declined in magnitude in Group I animals over conditioning but increased in Group II and increased even more in Group III. Statistical analysis showed that for Groups II and III the overall change in flexion reflex magnitude was significantly greater than that of Group I. Comparisons between Groups II and III were not significant. These results support the hypothesis that unconditioned stimuli must excite at least Aδ cutaneous fibers to produce the reflex facilitation characteristic of spinal conditioning. Supported by S.U.N.Y. Research Foundation Grant NR 67226.

404 SOME CORTICAL PROJECTIONS OF THE DORSOMEDIAL VISUAL AREA (DM) IN THE OWL MONKEY (AOTUS TRIVIRGATUS). C.S.Lin*, E.Wagor* and J.H.Kaas. Depts. of Anatomy and Psychology, Vanderbilt U., Nashville, TN 37203.

A small 8 x 4 mm representation of the contralateral visual hemifield (DM) adjoins the Second Visual area (VII) on the dorsal surface and medial wall of the occipital lobe of the owl monkey (Allman, Kaas, & Miezin, 1971). Efferent connections of DM were determined by studying degenerating fibers and terminals with the Fink-Heimer and Wiitanen silver stain methods 3-5 days after small lesions within this area in six owl monkeys. Ipsilaterally, the most massive degenerating fiber pathways were to the adjoining portion of the parietal lobe just rostral to DM and the adjacent cortex on the upper bank of the superior end of the Sylvian sulcus. Another degenerating fiber pathway coursed laterally from the lesion site to terminate in the region of the Middle Temporal Visual Area (MT) (See Allman & Kaas, 1971). Less dense terminal fields were found in the inferotemporal cortex and in the superior portion of the temporal lobe. Callosal connections were to the contralateral DM and the adjacent upper bank of the Sylvian sulcus. These results add to the evidence that visual association cortex in primates consists of a number of interconnected subdivisions of functional significance. (Supported by NSF grant GB-36779 and NIH fellowship 1-F02-EY-54344).

405 METHYLTETRAHYDROFOLIC ACID- AND S-ADENOSYLMETHIONINE-DEPENDENT INDOLETHYLAMINE N-METHYLTRANSFERASES: TWO DISTINCT ENZYMES. R.-L. Lin* and N. Narasimhachari (SPON: H. E. Himwich). Galesburg State Research Hospital, Galesburg, Illinois 61401.

The two indole N-methyltransferases from rabbit lung requiring either methyltetrahydrofolic acid (MTHF) or S-adenosylmethionine (SAM) as the methyl donor have been completely separated by column chromatography on Sepharose 4B or Sephadex G-200. The molecular weights for MTHF- and SAM-dependent enzymes are approximately 60,000 and 14,000, respectively. The strongest evidence that these are two distinct enzymes is that the products of the N-methylation of indolethylamines (tryptamines) by N-methyltransferase with MTHF as the methyl donor are different from those obtained with SAM. We have recently shown that with MTHF the products are not N_{ω}-methylated compounds, while with SAM the enzyme yields N_{ω}-methylated tryptamines. Contrary to a previous report (Science 182: 74, 1973) no O-methylation of serotonin, N-methylserotonin or bufotenin was observed with MTHF-dependent enzyme. The two enzymes also differ in other properties: optimal pH, stability, kinetic parameters, sensitivity to thiol reagents, and to chelating agents. S-Adenosylhomocysteine, N,N-dimethyltryptamine and bufotenin exert product inhibition on SAM-dependent N-methyltransferase but have no effect on MTHF-dependent enzyme. However, tetrahydrofolic acid inhibits the MTHF-dependent but not the SAM-dependent enzyme. Purified specific endogenous inhibitor for SAM-dependent N-methyltransferase does not inhibit the MTHF-dependent enzyme.

406 SIGNAL DETECTION ANALYSIS OF MORPHINE ANALGESIA IN THE RHESUS MONKEY. Charles G. Lineberry and Albert T. Kulics*. Dept. Pharm., School of Med., Univ. of Pittsburgh, Pgh., Pa. 15261.

Signal detection theory was used to determine the effects of the administration of morphine on pain responsivity in rhesus monkeys. Monkeys received 100 trials at each of two stimulus intensities in daily sessions. On each trial, monkeys were required to press a manipulandum within 500 msec after the presentation of a 20 msec train of noxious, electrocutaneous, constant current pulses in order to prevent the occurrence of a second train of identical stimuli. The response latencies for each stimulus intensity were used as intensity ratings of the stimuli and analyzed according to the rating procedure methodology of signal detection theory. In other experiments, we have shown that this approach results in relative operating characteristic (ROC) functions which satisfy the assumptions of signal detection theory and provide estimates of pain sensitivity (d') and response bias (β) which are independent. The administration of 0.25 to 1.0 mg/kg of morphine sulphate (I.M.), in contrast to saline injections, reduced pain sensitivity and also resulted in a change in response bias which indicated a reduction in overall reactivity. The magnitude of the effects on pain sensitivity and response bias were dose dependent. Signal detection theory analysis thus reveals that the effects of morphine on pain responsivity consist of two components: 1) a reduction in pain sensitivity and 2) a general reduction in reactivity. In contrast to the morphine effects, experimental manipulations analagous to human placebo administration failed to affect pain sensitivity but did reduce reactivity. These findings demonstrate the capability of this technique for distinguishing between manipulations which reduce pain sensation and those which affect response bias.

407 MYOGENIC ORIGIN OF INHERITED MUSCULAR DYSTROPHY OF THE CHICKEN. Thomas A. Linkhart*, G. Wendel Yee* and Barry W. Wilson. Dept. Avian Sciences, Univ. Calif. Davis, Davis, Calif., 95616.

Inherited muscular dystrophy of the chicken (and similar disorders of man and other animals) is thought to involve a defect in trophic regulation of muscle maturation. Transplantation of entire wing limb buds between normal and dystrophic 3-1/2 day chick embryos was performed to determine whether the lesion in trophic function lies in the affected muscle or its innervating nerve. The time of transplantation was prior to muscle differentiation, axon outgrowth and innervation in the limb. Muscles of transplanted limbs became innervated by nerves of the host. Transplant and contralateral unoperated limb biceps muscles were analyzed 5-12 weeks post-hatch for several properties which are significantly altered in muscular dystrophy of the chicken: acetylcholinesterase activity, localization, and isozyme number; cytochemical activity of succinic dehydrogenase; lactic dehydrogenase activity; fiber diameter; ultrastructure; and EMG evidence of myotonia. The results showed genetically normal muscle innervated by genetically normal or dystrophic nerves was normal, while dystrophic muscle innervated by normal or dystrophic nerves remained dystrophic. This work supports the hypothesis that inherited muscular dystrophy of the chicken arises from an inability of the muscle to respond to a trophic influence of the nerve, and not from a lesion in the nerve itself. Supported by NIH Grant NS-10957.

408 EYE MOVEMENT AND VESTIBULAR FIBERS IN MONKEY FLOCCULUS. Stephen G. Lisberger* and Albert F. Fuchs (SPON: H. D. Patton). Dept. of Physiology and Biophysics and Regional Primate Research Center, University of Washington, Seattle, Washington, 98195

Flocculus Purkinje cells are modulated by vestibular stimulation only when the monkey uses a visual fixation point to suppress the vestibulo-ocular reflex (Brain Res. 69(1974),347-353). The present study shows that presumed mossy fiber afferents recorded in the flocculus provide eye movement and vestibular information that may play a role in determining the depth of Purkinje cell modulation. Eye movements and extracellular single fiber responses were recorded from alert monkeys trained to make eye movements while undergoing sinusoidal horizontal vestibular stimulation. Based on their discharge patterns, three populations of fibers were distinguished in the flocculus. (1) Vestibular fibers have a sinusoidal modulation of firing frequency that lags head acceleration by 71° at 0.9 Hz. The population is evenly distributed between fibers that are excited by ipsilateral or contralateral head accelerations. In the absence of vestibular stimulation, all fibers are spontaneously active (range 18-105/sec). Many pause during all saccades and few have an eye position sensitivity. (2) Burst fibers respond only with a high frequency burst of spikes that precedes saccades in a preferred direction. The duration of the burst is correlated with the duration of the saccade. (3) Burst-tonic fibers respond prior to saccades with a burst that is similar to the burst fibers. In addition, these fibers have a regular discharge rate that is linearly related to eye positions above a threshold position. Preferred directions for burst and burst-tonic fibers may be horizontal or vertical. All 3 fiber populations have firing patterns that are quantitatively similar to known cell populations in the brainstem. Despite the presence of burst and burst-tonic fibers, flocculus Purkinje cells do not explicitly reflect this afferent eye movement activity.

409 A SODIUM PUMP INDUCED CHLORIDE CONDUCTANCE DECREASE IN FROG MUSCLE. David R. Livengood and Donald Geduldig. Neurobiology Dept., Armed Forces Radiobiology Research Institute, Bethesda, Md. 20014; Dept. of Biophysics, Univ. of Maryland Sch. Med., Baltimore, Md.

A large conductance decrease (50%) has been observed in Na^+-loaded frog muscle fibers during strong electrogenic pumping. Such an apparent conductance change can be due to either a true ionic conductance change or to a potential-dependent pump which would be indistinguishable on a purely electrical basis. This measured conductance change did not seem to be due to a change in membrane potential since the current voltage relationship measured before and during pump activation was linear. However, when the membrane was hyperpolarized, a time- and potential-dependent conductance decrease was observed which was indistinguishable from the pump-activated conductance change. After the removal of chloride ions from the bathing solution the membrane no longer showed a conductance decrease with hyperpolarization. It appears that the pump-produced conductance decrease is due to a time- and potential-dependent chloride ion shift out of the muscle fiber. A correlary conclusion is that, since the apparent conductance decrease is due to a chloride ion shift, the sodium pump is not potential-dependent.

410 REVERSAL PROPERTIES OF CLIMBING FIBER POTENTIAL IN PURKINJE CELLS OF CAT CEREBELLUM. R. Llinás and C. Nicholson. Div. of Neurobiology, Dept. of Physiology & Biophysics, University of Iowa, Iowa City 52242.

Cats were anesthetized with pentobarbital and white matter evoked climbing fiber EPSPs recorded intracellularly from Purkinje cells. Current was injected through the recording micropipette using an active bridge circuit. A steady depolarizing current was injected to inactivate action potentials and current pulses applied to reverse the climbing fiber EPSP. It was found that the EPSP reversal was not simultaneous over the whole waveform; the early part reversed before the late part. Measurements at EPSP peak and half decay time show that a) the slope to peak EPSP is more sensitive and has a steeper slope with respect to membrane potential than that of the half decay potential and b) the reversal current level is smaller for the peak than for the half decay level. We conclude that the reversal phenomena reflect the spatially distributed nature of the climbing fiber contact with the Purkinje cell. Thus the EPSP produced by proximal synapses reverses at a lower level of soma-injected current than does a distal EPSP. Differences in the Na:K conductance ratio may also exist for synapses at different spatial locations. These results contrast with the reversal of monosynaptic EPSP generated by Ia afferents to cat motoneurons, where the reversal commences on the falling phase of the potential. The latter results may be due to disynaptic inhibitory contamination of the postsynaptic potential. (Supported by USPHS research grant NS-09916 from NINDS)

411 PHARMACOLOGIC PROPHYLAXIS OF POST-TRAUMATIC EPILEPSY IN MONKEY MODEL. Joan S. Lockard, William C. Congdon*, Larry L. DuCharme*, and Betty J. Huntsman*. Dept. of Neurol. Surg., Sch. of Med., Univ. of Washington, Seattle, 98195.

Impetus to the pharmacologic treatment of post-traumatic epilepsy, based largely on Servit's experimental work (1958-1962), has been provided recently by the clinical studies of his colleagues, Popek and Musil (1969), in Czechoslovakia. A current review by Rapport and Penry (1972), of the supporting evidence in the literature for such treatment, suggests that post-traumatic epilepsy may be attenuated or prevented by prophylactic administration of anticonvulsant drugs. Utilizing our alumina-gel epileptic monkey model, with instrumentation for continuous monitoring of all overt, spontaneous motor seizures, the efficacy of pharmacologic prophylactic treatment of post-traumatic epilepsy was explored. The alumina-gel model provides a relatively standardized brain trauma from monkey to monkey, resulting in virtually complete assurance that all animals will manifest, in time, electrical and clinical seizures if not treated. Twelve rhesus monkeys were divided into two groups of 8 drug treatment and 4 placebo animals respectively. Administration of diphenylhydantoin (DPH) and phenobarbital in a combined regimen commenced within 48 hours of the alumina-gel injections. After one year the monkeys were withdrawn from either their drugs or placebo and followed for a subsequent four-month period. Seizure frequency, EEG inter-ictal spikes, plasma drug levels, and behavioral and laboratory tests were obtained weekly for each monkey. The data indicate that anticonvulsant treatment of potentially epileptic monkeys (a) decreases both the frequency and severity of seizures they would have had without treatment and (b) early drug treatment is more effective than later drug treatment. (NIH #NO1-NS-1-2282 and NS04053)

412 CONNECTIVITY OF BODY REPRESENTATION IN THE VENTROPOSTERIOR NUCLEUS OF THE MACAQUE THALAMUS. P. R. Loe, B. L. Whitsel, and D. A. Dreyer. Dept. Physiol., UNC, Chapel Hill, N. C., 27514

Extracellular recordings were obtained from 686 single units located in the ventroposterior nucleus (VP) of the thalamus of Macaca mulatta. Natural stimuli were employed in order to classify each unit according to submodality type and to map its receptive field. All recordings were obtained in the absence of general anesthesia. The positions of all units within VP were verified histologically, and a composite reconstruction of the single unit data was prepared. The location of each unit within VP was plotted on the closest of a series of frontal sections taken at 1 and at 0.5 mm intervals. The results have enabled us to construct a detailed approximation of the body representation in this region of the somatosensory thalamus. In general, the mediolateral sequence of representation of body regions within any given frontal plane through VP resembles that in the postcentral gyrus of the same species. The detailed connectivity and submodality composition, however, differ systematically from one frontal plane to another. It is suggested that these data have implications for the organization of the thalamocortical projections which link VP and somatic sensory area I.

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413 HEAT SENSITIVITY IN COLD FIBERS INNERVATING MONKEY GLABROUS SKIN. Randall R. Long* (SPON: V. B. Mountcastle). Department of Physiology, The Johns Hopkins University School of Medicine, Baltimore, Md. 21205

"Paradoxical" discharge at noxious skin temperatures has been examined in 398 single cold fibers in median and ulnar nerves of *M. mulatta*. The investigation has had two aims: the elucidation of mechanisms linking heat sensitivity to body temperature, and characterization of stimulus-response relations. Elevation of body temperature increases the proportion of cold fibers responsive to a 53°C stimulus from 19% at 37°C to 89% at 39°C. This effect can be reproduced by acute section of the nerve proximal to the recording site and by alpha-adrenergic blockade (phenoxybenzamine). These observations indicate an inverse relation between cold fiber heat sensitivity and activity in a population of adrenergic efferents suppressed by hyperthermia. The only recognized peripheral fibers with this behavior are cutaneous vasoconstrictors. At 39°C body temperature the mean heat threshold for cold fibers is 47°C (range, 43-51°C). The response to a supra-threshold temperature pulse increases with increasing stimulus intensity and duration. Moreover, repetition of a constant stimulus sensitizes cold fibers. Successive responses increase to a maximum which depends on stimulus intensity and repetition rate. The rate of sensitization also depends on intensity and repetition rate.

414 LEVELS OF POTASSIUM, NADH AND EXTRACELLULAR POTENTIAL IN THE CEREBRAL CORTEX DURING ELECTRICAL STIMULATION, SEIZURES AND SPREADING DEPRESSION. E. Lothman*, J. LaManna*, G. Cordingley*, M. Rosenthal, and G. Somjen, Dept. of Physiol. and Pharmacol. Duke Univ., Durham, N.C. 27710

Previous studies have shown a correlation between sustained potentials (SP) and extracellular potassium activity (K_o^+) in the spinal cord and a correlation between oxidative metabolism and SP in the forebrain. In this study, oxidative metabolism, K_o^+ and SP were monitored simultaneously *in situ* in cat neocortex. The fluoresence level of intramitochondrial NADH provided a measure of oxidative metabolism. K_o^+ and SP were measured with a potassium-sensitive microelectrode assembly. There was a precise correlation between the oxidation of NADH, the negative SP and elevations of K_o^+ following direct cortical stimulation. Changes up to 5.5 mM K_o^+, 3 mV SP and 3% oxidation of NADH were evoked by 3 second trains at 10 Hz. These three parameters varied in the same direction but to a larger extent during seizures and spreading depression. The K_o^+-SP relationship may result from extracellular current from depolarized glial cells. Because the rate of oxidation of NADH has been shown to be related to the breakdown of ATP by oubain-sensitive ATPase, we suggest that oxidative metabolism is stimulated in proportion to the elevation of extracellular K^+ levels as active transport processes are engaged in reestablishing the normal transmembrane ionic gradients.

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415 AMYGDALOID LESIONS, BEHAVIORAL AROUSAL AND HABITUATION. Irwin Lourie* and Michael M. Krieger* (SPON: Max L. Fogel). Res. Dept., Norristown State Hospital, Norristown, Pa. 19401

Bilateral amygdaloid lesions including both corticomedial and basolateral structures were prepared in 150-day male rats (A, n=10) and sham operated controls (C, n=10). Two weeks post-operatively Ss were observed, using a videotape method, for exploratory and social interactive behavior daily for a period of 8 days. Each observation session consisted of 1-min samples taken during 30 min of exploratory behavior followed by pairing and 2-min samples during 30 min of interaction. Quantitative, qualitative, temporal and discrete components could be reliably measured. From these inter- and intratrial patterns of motor activity, motivational state and habituation rates could be described. A showed high initial exploratory activity characterized by increased motor function on the first day. This decreased over days in contrast to C whose daily initial motor activity remained constant. All other exploratory habituation rates for A appeared more rapid than in C, the rates increasing over days. The result after 7 days was a hypoactive animal whose response to stimuli simulated more rapid habituation than C. These findings are consistent with the view that initial registration of sensory input in establishing the neural trace is unaffected but corticofugal processes necessary to maintain arousal and subsequent 'matching' to the established trace are impaired. The arousal level of A to a social stimulus, measured as total activity, is similar to C with its attending apparent rapid habituation rate. However, the response is reflected in increased exploratory activity and a marked deficit in social interaction characterized by an absence of sustained patterns of grooming and following. The inappropriate responding to a social stimulus is discussed in terms of an inability to integrate temporally ordered species specific behavior and a deficit in responsiveness to positively reinforcing stimuli.

416 A SIMPLIFIED SPECTRAL ANALYSIS OF THE EEG ACTIVITY DURING THE HUMAN SLEEP. Lozoya, X., González-Villalpando, C. and García-Peña, J.- Sci. Res. Dept., Natl. Med. Ctr., México, D. F. (73-032)

A description of a method capable of reducing the information from a complete night, allowing a clear visualization of the fundamental frequency bands, is the purpose of this communication. EEG tracings from six volunteers were obtained during all-night spontaneous sleep. The signal from the C4-A1 combination was channeled to a frequency analyzer-integrator with 4 band-pass filters (beta, alpha, theta and delta). The integration interval was one minute and a plot of the values of the area covered for each band during the night, was obtained from a printer. This information was filtered with a digital filter and processed to obtain the mean voltages and the proportion that they represented from the total mean voltage for each band in each stage through all the night. The method described allowed a sharper picture of the periodic transitions from slow wave high amplitude to fast wave-low amplitude activity. Delta reflected the best these transitions. During a cross-comparation of the sleep stages visually scored with the traces obtained with our method, we found that the point where the curves for delta and theta crossed alpha corresponded to the end of the stage I and the point where delta suddenly decreased corresponded to the end of the stage IV and the beginning of a REM period. The mean of the mean voltages of the different frequency bands seems to be useful to discriminate the various sleep stages. The possibility of a cross correlation of the sleep phenomena viewed under this approach with endocrine events is proposed.

417 SLEEP DEPRIVATION BY RETICULAR STIMULATION: A COMPARISON OF TWO METHODS. E. Lucas, Dept. of Anat., Univ. of Ark. Med Center, Little Rock, Ark. 72201

In this study cats were sleep-deprived for 5 to 7 days by either continuous electrical stimulation of the mesencephalic reticular formation (MRF) or by an automated system in which 1 to 5 sec. trains of electrical pulses 70-100cps were delivered to the MRF within 1 sec. of the appearance of slow wave activity (9-13 Hz for 1 sec.) in the EEG tracing of the alert animal. Four cats were prepared for chronic stimulation with tripolar electrodes at P-1, H-1, L 1.5, 2.5, 3.5 and with other leads for evaluation of sleep-wake patterns. A baseline recording (24 hours) was followed by 5 to 7 days of sleep deprivation and then 48 hrs of observation in which animals were allowed to sleep ad lib. Continuous polygraphic recordings were scored for alert, drowsy, slow wave sleep and active sleep. All animals had elevated amounts of active sleep and slow wave sleep throughout the first 24 hours and also during at least part of the second day of recovery on both experimental schedules. Animals on both schedules tended to habituate to the stimulus and required frequent upward adjustments of stimulus duration, frequency, and/or voltage to maintain wakefulness. Animals on the automated feedback schedule tended to enter quiet sleep almost immediately and proceeded to have long active sleep episodes during the first four hours with very brief interludes of quiet sleep. Total sleep rebound usually ended early on day two. Cats on the continuous stimulation schedule remained awake for up to 30 minutes and then had elevated amounts of quiet sleep followed by a total sleep rebound which lasted through day two. From a comparison of these data to the results of other sleep deprivation studies it is concluded that continuous reticular stimulation results in total sleep deprivation whereas the automated schedule results in total deprivation of active sleep and only partial deprivation of sleep.

418 EFFECT OF GONADAL STEROIDS ON ACTIVITIES OF ENZYMES IN MALE AND FEMALE RAT BRAINS. V. N. Luine*, R. I. Khylchevskaya*, and B. S. McEwen. The Rockefeller University, New York NY 10021.

The ability of 17β-estradiol benzoate (EB) and testosterone propionate (TP) to alter activities of enzymes involved in neurotransmitter and intermediary metabolism was assessed in brain sub-regions and pituitary from gonadectomized male and female rats. As reported previously, EB administration to ovariectomized females resulted in 30% increases in malate dehydrogenase (MDH), isocitrate dehydrogenase (ICDH), and glucose-6-phosphate dehydrogenase (G6PDH), and a 30% decrease in monoamine oxidase activity (MAO) in the basomedial-hypothalamus; 20-30% increases in ICDH and MDH, and a 50% decrease in MAO in the corticomedial-amygdala; 30-200% increases in pituitary G6PDH, 6-phosphogluconate dehydrogenase and lactate dehydrogenase (Luine et al., J. Neurochem., in press). We now report that levels of choline acetylase are elevated in females in the pre-optic area and amygdala after EB treatment. Administration of the estrogen antagonist, MER-25, with EB antagonizes estrogen-dependent changes in enzyme activity in female brain and pituitary. In addition, sex differences in the response to EB and TP were observed for many of these enzymes. Administration of TP, in amounts equimolar with EB, did not result in enzyme changes in any brain region or in pituitary of females. In contrast, TP administration to males results in changes in many of these enzymes in brain and pituitary. Enzyme levels in males were less responsive to EB than in females. Enzyme changes by EB are consistent with the presence of stereospecific, limited-capacity nuclear receptors for EB in female brain and pituitary. (Supported by USPHS grant NS 07080 and by an institutional grant, RF 70095, from the Rockefeller Foundation.)

419 DEVELOPMENT OF CENTRAL REGULATION OF HABITUATION OF THE GILL WITHDRAWAL REFLEX IN APLYSIA. K.Lukowiak* and B.Peretz. Dept. of Physiol., U Kentucky Med. Ctr., Lexington 40506

We have examined habituation of the gill withdrawal reflex in mature and immature Aplysia. The reflex is mediated by a neural plexus in the gill and the CNS regulates the reflex via the plexus; inhibition is the proposed mechanism of the regulation (Peretz and Howieson, 1973). Experiments were carried out before and after removal of the CNS (parieto-visceral ganglion PVG), thus PVG regulation in both groups of animals was assessed using analysis of variance. Tactile stimuli were applied to the gill at 1/30 sec. A) In mature Aplysia ($\bar{x}$=239±7gms, n=10), with the PVG intact, the reflex amplitude was depressed ($p<.01$) and rate of habituation was faster ($p<.01$) than after PVG removal. With the PVG intact, mature Aplysia discriminated among three levels of stimulus intensity (140, 280, and 1740 mg of force). Discrimination was measured as the difference in reflex amplitudes ($p<.05$) and in rates of habituation ($p<.05$). B) In immature Aplysia ($\bar{x}$=16±7gm, n=10), with the PVG intact, the rate of habituation was not significantly different ($p<.3$) but the levels were ($p<.01$) after PVG removal. Also, immature Aplysia could not discriminate among the three stimulus intensities ($p>.2$). Intracellular recordings showed that PVG neurons in immature Aplysia, as in mature animals did receive PSP's resulting from tactile stimulation (140 mg of force) of the gill. C) Comparing immature and mature animals with the PVG intact, it was found that the rate of habituation was slower ($p<.05$) and the reflex amplitude was greater ($p<.05$) in the immature Aplysia. These differences between mature and immature Aplysia are attributable to the level of maturation in the PVG. In Aplysia,as in vertebrates, rate of habituation is slower in immature animals and the responsiveness is greater, suggesting less behavioral inhibition in immature Aplysia. (Fnd.Fund.Res.Psych.T64-205;NIMH).

420 SHORT-LATENCY RESPONSES TO LOAD CHANGES IN HUMAN MASSETER MUSCLES. J.P. Lund and Y. Lamarre. Centre de Recherches en Sciences Neurologiques, Université de Montréal, Montréal, P.Q. H3C 3T8, CANADA.

Human subjects bit on a lever fixed to the spindle of a torque motor with their lower jaw, while the upper teeth engaged a fixed bar. The output of a potentiometer, which recorded the angular displacement of the spindle, was displayed and the subjects were asked to close their jaw at the same constant velocity as a slowly moving spot. During closure, force pulses of 20-30 msec were applied during randomly selected trials to oppose or aid the movement. The integrated masseteric EMG and the displacement were averaged over multiple trials. EMG activity began to rise rapidly 5-7 msec after the initiation of loading and remained elevated for up to 30 msec even when the muscle continued to shorten, but at reduced velocity. No later increase in activity was seen with these small load pulses. During unloading, EMG activity began to fall 7 to 10 msec after the decrease in load began and remained depressed for 20-30 msec. Tapping the chin evoked a monosynaptic jaw jerk myotatic reflex at a latency of 5-7 msec. Thus, the EMG responses to load changes are of monosynaptic latency. They were not abolished when the teeth were anesthetized and were not seen when similar tasks were performed by the spindle-poor jaw opening muscles. They are therefore probably of muscle spindle origin. We suggest that the αmotoneurons of these muscles receive a large part of their input via the γloop. This would allow rapid compensation for changes in the resistance of different food particles during chewing. Sudden shortening which follows the breakage of brittle food would reduce the Ia input, producing rapid disfacilitation of the αmotoneurons and thus prevent damage to teeth and supporting structures.

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421 CELLS IN AREA 17 OF MONKEY (MACACA MULATTA) WHICH GIVE RISE TO CORTICOTECTAL AND CORTICOGENICULATE PATHWAYS. R.D. Lund, J.S. Lund*, A.H. Bunt, A.E. Hendrickson, A.F. Fuchs. School of Medicine, University of Washington, Seattle, Wa. 98195

Horseradish peroxidase was injected into either the lateral geniculate nucleus (LGN) or superior colliculus (SC) of 5 monkeys, and after 16 to 30 hours survival, the animals were perfused with buffered paraformaldehyde. The brains were subsequently reacted to demonstrate peroxidase in area 17, reflecting retrograde transport of the enzyme by cells projecting to the injected region. After LGN injections, two populations of medium-sized pyramidal cell somata in layer VI were labeled, one in the upper 1/3 of the layer and the other lying at the lower border and in the adjacent white matter. After SC injection, the major cell type labeled was a medium-sized pyramidal cell with its soma in the lower 2/3 of layer V (VB), but in one part of area 17, the largest pyramidal cells of layer VB, also contained peroxidase. No label was ever found in the Meynert cells of layer VI after injection of either site. The topographic location of labeled cells within area 17 corresponded closely with the position of the injection needle track rather than the whole extent of peroxidase reaction within the SC or LGN. These results indicate that corticofugal influences from area 17 to LGN and SC arise from neuronal somata which are situated in different cortical laminae. As shown by Golgi studies (J.S. Lund and R. Boothe), these neurons have different dendritic configurations and are likely to receive rather different synaptic inputs as well. (Supported by USPHS Grants EY0-0491, 0596, 1086, 1311, 1208, 0745.)

422 THE DISCHARGE OF SPINDLE AFFERENTS FROM JAW CLOSING MUSCLES DURING CHEWING IN ALERT MONKEYS. E.S. Luschei* and G.M. Goodwin* (SPON:T.C. Ruch). Primate Center, U. of Washington Med. Sch., Seattle, Wa. 98195.

Muscle spindle afferent units were recorded with tungsten microelectrodes from the mesencephalic nucleus of the fifth nerve in alert monkeys. Spindle afferents were distinguished from tooth afferents (the only other receptor type in the nucleus) by their response to opening, i.e. stretch of jaw closers, and by palpation of the surface of the temporalis and masseter muscles. Jaw position and EMGs from the jaw closing muscles were also recorded. Typically, discharge rates during closing were 3-4 times lower than during opening. Discharge during closing was usually attributable to fusimotor co-activation, although in some cases the passive properties of the spindles seen after anaesthetising the monkey showed excitation when the jaw was closing with an additional lateral component of the sort normally seen in chewing. All spindles showed some degree of sensitivity to passive lateral movement; temporalis spindles were excited by horizontal movement to the contralateral side, masseter and medial pterygoid spindles by movement in the opposite direction. This is consonant with the effective lines of pull of these muscles. The discharge patterns seen here lend little support to the idea of a powerful contribution from the muscle afferents in servocontrol of movement. These afferents do, however, send precise information about the stretch of the jaw closing muscles which could usefully contribute to the perception of jaw movement and position.

423 INFLUENCE OF DYNAMIC STIMULI ON THE MULTIVALUED RELATION BETWEEN MAINTAINED HEAD POSITION AND RATE OF GUITAR-FISH UTRICULAR AFFERENTS. O. Macadar*, G. E. Wolfe and J. P. Segundo. Dept. Anat., Sch. Med., UCLA, Los Angeles, Calif., 90024.

The reliability with which single utricular afferents code for maintained spatial orientation of the head is limited by a frequent multivaluedness in the relation between position and discharge; i.e., for each cell, the discharge corresponding to different stations at the same position may differ. The isolated head was held many times at a central position reached from two extreme positions; a small perturbation (jitter) was added to some transitions. The firing rate at the center position was influenced by the side from which it was reached. The "phasic" response was an acceleration (slowing) when coming from a slower (faster) rate position; this influence extended even into the practically stable or "tonic" portion of the response. Rare purely tonic units showed less multivaluedness. The jitter also affected multivaluedness. These data suggest that histeresis and dynamic response play an important role in multivaluedness. A multivalued stimulus-response relation may well be an important issue in some sensory systems and, when present, raises the question of how the message is "read" by central analyzers.

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424 EXPLORATORY SNIFFING AND THE HIPPOCAMPAL THETA RHYTHM IN THE SYRIAN GOLDEN HAMSTER. F. Macrides. Worcester Foundation for Experimental Biology, Shrewsbury, Mass. 01545 (Supported by NSF grant GB-36070).

Komisaruk (JCPP 70: 482, 1970) has observed in the rat that exploratory sniffing and theta rhythm are repetitive at about the same rate, and that neural populations in the limbic system and hypothalamus tend to fire in phase with theta waves. He has speculated that temporal correlations between sniffing and theta may be important for neural processing of sensory input to the limbic-hypothalamic system. We studied rate and phase relationships among inhalation, vibrissae twitching, and the hippocampal theta rhythm during exploratory sniffing in male hamsters. Hamsters exhibited stereotyped sniffing bouts during which inhalation and vibrissae twitching were strictly correlated. In contrast, sniff and theta rates were similar but rarely identical for the full duration of a sniffing bout. However, inhalation and theta exhibited average phase relationships which were characteristic for each subject. During the course of a sniffing bout, as the phase difference drifted to more than a quarter cycle from the "preferred" relationship, discontinuities in the sniffing rate typically resulted in a resumption of the preferred relationship. Block analyses of 3,000-11,000 sniff cycles and 6,000-12,000 theta waves per subject revealed that the preferred average phase relationships were consistently maintained. Since olfactory bulb units have been found to fire with odor-dependent phase relationships to the inhalation cycle (MACRIDES & CHOROVER, Sci. 175: 84, 1972), the present findings strengthen the speculation that regulation of motor activity during exploration, and consequent temporal characteristics of sensory input, are important parameters for sensory processing.

425 CONTRACTILE, HISTOCHEMICAL, BIOCHEMICAL AND MORPHOLOGICAL PROPERTIES OF GUINEA PIG HINDLIMB MUSCLES RESTRAINED FROM CONTRACTING ISOTONICALLY. A. Maier*, J.L. Crockett*, D.R. Simpson* and V.R. Edgerton. Neuromus. Res. Lab., Dept. of Kines. and BRI, UCLA, Los Angeles, Cal. 90024.

Guinea pig calf muscles were unilaterally immobilized at rest length by pinning the knee and ankle joints. The contralateral legs served as controls. Wet weight decreased 38 percent in the gastrocnemius (G) and Soleus (S). After 4 or 12 weeks of immobilization the mean cross-sectional area of fibers in the S was reduced nearly twice as much as in the G. The amount of atrophy among histochemical fiber types in the G was not significantly different. At 4 weeks the mean contraction times in the S shortened significantly from 54 to 37 msec while in the G they lengthened significantly from 19 to 22 msec. One half relaxation times were not significantly affected in either type of muscle after 4 or 12 weeks. The rate of tetanic tension development increased in the immobilized S while in the G there was no change. Twitch and tetanic tensions per gram of muscle were greater in the atrophied G and less in the S relative to control muscles. Experimental S and G muscles fatigued more rapidly than control muscles in response to a train of single supramaximal stimuli. After 4 weeks in the immobilized G the biochemically assayed actomyosin adenosine triphosphatase (ATPase) activity was not significantly different. There was also no significant difference in non-collageneous protein (mg/gram wet weight) between control and experimental sides in either type of muscle. Histochemical "myofibrillar" ATPase and nicotinamide adenine dinucleotide diaphorase profiles showed no marked alterations in the immobilized muscles. The results show that the G and S respond differently to immobilization in terms of contraction times and maximum tension produced. Changes in contraction time in a fast and a slow muscle appear to be unrelated to histochemical characteristics, amount of non-collageneous protein or degree of atrophy.

426 STIMULUS SPECIFIC EFFECT OF SCOTOPHOBIN ON MOUSE PLASMA CORTICOIDS. D. H. Malin, G. J. Radcliffe, Jr., D. M. Osterman*, and B. S. Keenan*. Dept. Anesthesiology and Pediatrics, Baylor Coll. Med., Houston, TX 77025

Scotophobin is a peptide occurring in the brains of rodents trained to avoid the dark. Injection into naive recipients causes these animals to spend less time in a dark compartment and more in a light compartment. Ungar suggests that scotophobin induces a specific fear of the dark. Others have proposed that scotophobin's behavioral effects reflect a general, nonselective stress, anxiety, or arousal. The object of this experiment was to determine whether scotophobin caused no stress, a general stress, or a stimulus-specific stress reaction, as measured by plasma corticoid levels. Fifty-six mice were habituated to the test apparatus for 10 days. Half were then injected i.p. with saline and half with 4 µg of a synthetic derivative of scotophobin (prepared by D. M. Desiderio). Twenty-four hr after injection half of each group were locked into the dark compartment for 3 min and half were locked into a similar white compartment. Fifteen min later the mice were bled and plasma samples from each mouse were assayed (on a "blind" basis) for total corticoid levels by the radioassay method of B. Murphy.

Results:

	Plasma corticoid (ng/ml) ± S.D.	
	Light	Dark
Scotophobin	116.7 ± 40.1	208.6 ± 91.6†
Control	133.0 ± 69.5	92.4 ± 52.5

†Significantly different from scotophobin/light ($P < .005$) and from control/dark ($P < .001$). Overall analysis of variance disclosed a highly significant ($P < .001$) interaction effect between test environment and scotophobin, indicating that the stress inducing effects of scotophobin are strongly dependent on test environment. (Supported by USPH grant HL-05435-14)

427 EFFECT OF MERCURY ON THE ELECTROPHYSIOLOGY OF NEUROMUSCULAR TRANSMISSION IN THE FROG. R. S. Manalis and G. P. Cooper. Departments of Physiology and Environmental Health, University of Cincinnati, Cincinnati, Ohio 45219.

Sciatic nerve-sartorius muscle preparations of the frog (Rana pipiens) were used to investigate the effect of mercury ions on neuromuscular transmission. Experiments were performed in vitro using a suitable chamber; the temperature was maintained at 15° C. Micromolar amounts of $HgCl_2$ were added to the control Ringer with the following composition (in mM): 111 NaCl, 2.5 KCl, 0.4 $CaCl_2$, 0.9 $MgCl_2$, 4.0 tris maleate (pH = 6.9). In seven out of eight experiments, the endplate potential (EPP) amplitude increased in the presence of low doses of Hg^{2+}; higher doses depressed the EPP. In one experiment, the mean EPP increased 26% in the presence of 0.10 μM Hg^{2+}; finally, 10.0 μM Hg^{2+} completely blocked the EPP even though the frequency of the miniature endplate potentials (MEPP's) was elevated at that time. There was no obvious reduction in the MEPP amplitude. In another experiment, the EPP amplitude increased by 33% in the presence of .010 μM Hg^{2+} whereas the mean input resistance (measured in separate fibers) did not change significantly. All of these effects occurred within 3-5 minutes from the start of the mercury exposure, and they were irreversible. These preliminary data are consistent with the hypothesis that disulfide bonds reside in the motor nerve terminal and that facilitation of the phasic release of transmitter in the presence of low doses of mercury is due to the splitting of these bonds.

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428 ACETYLCHOLINE: AN EXCITATORY NEUROMUSCULAR TRANSMITTER IN THE LOBSTER STOMATOGASTRIC SYSTEM. Eve Marder * (SPON: D.L. Barker). Dept of Biol., UCSD, La Jolla, CA 92037.

The stomatogastric ganglion of the lobster, *Panulirus interruptus*, contains 30 neurons, 23 of them are excitatory motor neurons which innervate striated muscles which move the stomach. Each ganglion has 2 PD neurons which are the sole motor innervation of the dorsal dilator muscle. Choline acetyltransferase (CAT) assays have been done on single, physiologically identified motor neuron somata. PD somata showed CAT activity in 16/18 somata assayed. The values range from 4-30 pmoles Acetylcholine (ACH) produced/cell/hr, with an average of 13 pmoles Ach/cell/hr. Bath application of Ach (with .1 mg/ml Tensilon) causes tension production in the dorsal dilator muscle. Threshold for contraction is 1×10^{-6}M Ach and maximal response is produced by 2×10^{-5}M Ach. D-tubocurare competes the Ach-induced tension. No other putative neurotransmitter has been found to cause tension production in this muscle. Nerve stimulation induced contraction and Excitatory Junctional Potentials (EJPs) in the dorsal dilator muscle are reversibly blocked by d-tubocurare. Iontophoresis of Ach onto dorsal dilator muscle fibers produces depolarizations of the fibers. Experiments in progress include Ach iontophoresis at the nerve terminal to show that the reversal potentials and the ion channels of the Ach response are the same as that of the synaptic response. The data strongly suggest that Ach is the neurotransmitter at the PD-dorsal dilator synapse in the stomatogastric system of the lobster, thus suggesting that some crustacean excitatory neuromuscular synapses can be cholinergic. EM is a Predoctoral Fellow of the Scottish Rite, Office of Schizophrenia Research. Research was funded by grants USPHS NS 09322 and NSF GB-39945 to Dr. Allen Selverston.

429 DENERVATION OF THE PRIMARY OLFACTORY PATHWAY: SPECIFIC BIOCHEMICAL CHANGES. Frank L. Margolis, Nelson Roberts*, Janet Feldman* and Donna Ferriero.* Roche Institute of Molecular Biology, Nutley, New Jersey 07110.

As part of a continuing program to study the biochemistry of the primary olfactory pathway, we have evaluated the effects of both olfactory bulbectomy and peripheral deafferentation in mice. Peripheral deafferentation of the primary olfactory pathway by stringent intranasal irrigation with a zinc sulfate solution results in a marked decrease in olfactory bulb weight, shrinkage of the glomerular layer of the olfactory bulb and specific disappearance of the unique olfactory marker protein from the olfactory bulb. These changes are irreversible for several months. In contrast, no alterations were seen in the activities of three neurotransmitter-metabolizing enzymes, or in sixteen high affinity "neurotransmitter" uptake systems, or in the levels of cyclic nucleotides in the olfactory bulbs. However, the level of the dipeptide carnosine (β-alanyl-L-histidine) but not of other amino compounds fell precipitously and irreversibly following peripheral deafferentation. Surgical removal of the olfactory bulb results in the rapid specific decrease of the level of the unique marker protein in the olfactory epithelium. This treatment does not cause any alteration in the normally low levels of three neurotransmitter-metabolizing enzymes in the olfactory epithelium. The level of carnosine in the epithelium does, however, fall reversibly following bulbectomy only to return later to control values. This may be the first biochemical correlation of the reported morphological regeneration of the olfactory receptor cells after bulbectomy. The function of this dipeptide and its possible correlation with the olfactory marker protein are currently under investigation.

430 THE INFLUENCE OF VESTIBULAR RECEPTORS ON VISUAL MOTOR CONTROL. Charles H. Markham, Michael S. Estes* and Robert H.I. Blanks*. Dept. Neurology, Sch. Med., UCLA, Los Angeles, CA 90024.

The influences of vestibular receptors on visual motor control were studied in cats maintained under C-1 spinal cord transections and local anesthesia. The receptors of the utricle, posterior canal, and saccule were each studied using direct bipolar electrical stimulation. In the case of the utricle, stimulation induced bilateral pupillary dilatation and bilateral (0.4 to 3.0 diopter) lens change in an anti-accommodative direction. Similar effects were noted on stimulating the posterior canal, but not the saccule. The bilateral pupillary dilatation and anti-accommodative lens shift could still be induced two weeks after ipsilateral superior cervical sympathectomy. The effects were also noted after transection of the medial longitudinal fasciculi (MLF). Thus it is concluded that these effects take place by a reduction of parasympathetic tone to the eye, and that the mediating pathways from the vestibular complex to the Edinger-Westphal nucleus pass through brain stem regions other than the MLF. This work was sponsored in part by NASA Grant NAS 9-11907.

431 CLEAVAGE OF MEMBRANE-BOUND PROTEINS OF MYELIN. Neville Marks, Alice Grynbaum* and Abel Lajtha, N.Y.State Res.Institute for Neurochemistry, Ward's Island, N.Y. 10035.

Measurement of the enzymatic digestion of proteins and proteolipids within the myelin sheath is important in understanding the etiology of demyelination. To measure susceptability to digestion, myelin was purified from rat brain, suspended in buffer with brain cathepsin D (enzyme:substrate 1:40) and breakdown of the protein moieties evaluated by disc-gel electrophoresis in SDS (Greenfield et al., J.Neurochem. 18, 2119,1971) and compared to the effects of trypsin and pepsin. The incubation conditions were 2 mg myelin/0.5 ml buffer at 37° for 3-5 hr. Digestion was terminated by lyophilization and the residue defatted with ether/ethanol (3:2 v/v). Myelin proteins were dissolved in a solvent containing 1% SDS and β-mercaptoethanol and then electrophoresed on 15% acrylamide gels, stained with Fast Green FCF, and the band densities measured. Brain cathepsin D and pepsin caused a marked (60-80%) decrease in the levels of 'fast' and 'slow' basic proteins in comparison to 40-50% for the Folch-Lees' proteolipid, and only 15% for the high M.Wt.(Wolfgram) material; enzymic breakdown produced smaller cleavage products in the M.Wt. range of ca.10,000 daltons. In the case of trypsin the 'slow' basic protein was more susceptible to breakdown (70%) than the fast (44%)while the Wolfgram was degraded to a greater extent (65%) than with cathepsin D and pepsin. Breakdown of myelin proteins points to their presence at or near the surface of the membrane at sites accesible to hydrophilic agents. Degradation of proteins within the lipid matrix is consistent with the formation of diffusible (toxic) peptides known to be involved in demyelination (e.g., encephalitogenic peptides and EAE). Supported in part by Grant U.S.P.H.S. NB 03226 and National Society for Multiple Sclerosis 874-A-1.

432 A SELF ORGANIZING FEATURE DETECTING NEURONAL NET. William B. Marks (SPON: H. C. Lansdell). Lab. of Neural Control, NIH, Bethesda, Md. 20014.

The features of a series of patterns occurring in an array of afferent nerve fibers were defined as the independently occurring components of the patterns. The initially incorrect strengths of the connections from the afferents to an array of nerve cells were slowly changed under the influence of the correlations in the activities of the nerve cells. The changes were such as to decrease the intercell correlations in activity and to lead to connections for which the activities of the cells were uncorrelated. That is, the cells came to detect the (uncorrelated) features of the series of patterns presented. The changes were made by subtracting from the strengths of each input connection to a cell an increment proportional to the strength of the corresponding input connection of each other cell with correlated activity, and proportional to the (signed) degree of correlation. There was an indeterminacy in the final connections that was related to the fact that certain linear combinations (orthogonal ones) of uncorrelated signals are also uncorrelated. It can be shown that if the activity of each cell becomes uncorrelated not only with the activity of every other cell, but also with its square, that this indeterminacy will be eliminated. We are presently examining additional rules for changing strengths of connections so that these higher correlations will also be moved toward zero. Thus it is possible for the strengths of the connections of a neuronal net, guided only by correlations within the net, to change and converge to a configuration such that the cells are selectively sensitive to the uncorrelated features of the afferent patterns.

433 DISTRIBUTION OF HOMOCARNOSINE-CARNOSINE SYNTHETASE IN RAT BRAIN AND ORGANS OF VARIOUS SPECIES. F. D. Marshall, Jr. and Ronald H. Ng*. Department of Biochemistry, The University of South Dakota School of Medicine, Vermillion, South Dakota 57069

The assay of the enzyme catalyzing the synthesis of the dipeptides, carnosine and homocarnosine, was carried out by a slight modification of procedures previously described (Skaper, Das and Marshall, J. Neurochem. 21, 1429-1445, 1973). Since a similar enzyme has been reported in muscle and possibly liver, assays were performed on the 100,000 x g supernatant of various organs from four different animals, rat, mouse, chick, and frog. In general, muscle and brain had the greatest activity; heart had some, and liver very little. There were variations in activity among these species.

A regional distribution of the enzyme was determined on rat brain from the 0-30% saturated ammonium sulfate fraction. The greatest activity was found in olfactory bulb, with medulla and pons having high activity. The cerebellum, caudate nucleus area, diencephalon, and cerebrum all had less activity. [This work was supported by a grant from Huntington's Chorea Foundation, Inc.]

434 THE CEREBRAL RELEASE OF CATECHOLAMINES DURING FEEDING IN THE RAT. G. E. Martin* and R. D. Myers (SPON: J. Altman). Laboratory of Neuropsychology, Purdue University, Lafayette, Indiana, 47907.

An intracerebral injection of norepinephrine (NE) or dopamine (DA) elicits feeding behavior, whereas the depletion of the endogenous stores of these two amines by 6-hydroxydopamine causes a profound impairment in ingestive behavior. As a result, a catecholamine mechanism in the hypothalamus has been implicated in the central control of food intake in the rat, monkey and other species. During various states of satiety or deprivation of the rat, as well as when the animal was in the act of feeding, the local release of catecholamines from hypothalamic sites or into the ventricular system was examined. The cerebral pool of catecholamines was labelled by ^{14}C-norepinephrine, ^{14}C-dopamine, or ^{14}C-dopa injected into the lateral ventricle. By means of the push-pull perfusion technique, the output of the amines and their metabolites was determined by thin-layer chromatography and liquid scintillation spectrometry. An increase occurred in the efflux of NE over the control level in the third ventricle as the animal consumed food. Following the perfusion of either the lateral ventricle or the anterior hypothalamus, an increase in the output of amines during any of the experimental conditions was not reliably observed. However, the localized perfusion of desmethylimipramine (DMI) resulted in a 2-20 fold increase in the amount of NE recovered in the push-pull effluent. Additional support is thus provided for a partial role of catecholamines in the behavior of feeding and/or some aspect of satiety.

435 CHOLINERGIC PERFUSION OF THE CAT'S LOCUS COERULEUS: EFFECT ON RESPIRATION AND SLEEP. Joseph M. Masserano* and Carl D. King* (SPON: P. D'Encarnacano). Dept. Pharmacol., Univ. Tenn. Medical Units, Memphis 38163

The role of the locus coeruleus (LC) is a subject of intense investigation. Studies have been performed in which the LC has been either lesioned or chemically stimulated; results have varied from a complete cessation of rapid eye movement sleep (M. Jouvet, Ergeb. Physiol. 64: 166, 1972) to the production of cataplectic-like behavior (M. Mitler, et al., Sleep Res. 2: 68, 1973). Most such studies have failed to examine effects of LC manipulation upon vital signs, as heart rate (HR), blood pressure (BP) and respiratory rate (RR). Changes in these functions could affect the results of a sleep study. Since the LC's innervation is via cholinergic axons ending upon the adrenergic neurons within the LC, we looked at the effects of cholinergic perfusion -- acetylcholine (ACh) and carbachol (C) -- of the rostral pons. Bilateral push-pull cannulae were implanted using the coordinates of Henley (Ph.D. Thesis, Univ. Penn., 1971). Cats, maintained under pentobarbital anesthesia, were perfused for 4 hrs. with varying doses of ACh and C. Both ACh and C (1 µg/µl/min.) produced drastic increases of the RR, but variable effects upon HR and BP. ACh (0.1 µg/µl/min.) produced a slight elevation of the RR. At a dose of 0.001 µg/µl/min., ACh caused no change; saline controls likewise were without effect. This lowest dose of ACh was perfused into the pons of freely moving cats implanted with electrodes for the measurement of sleep-wakefulness behavior. There followed an increase of total sleep time, with large amount of slow wave sleep. The data indicate that the rostral pons is part of the brain stem system which regulates respiration. The sleep data may indicate (1) that the cat's LC is part of a sleep system and that ACh stimulation thus produces sleep, or (2) that the cat's LC is important for arousal and that ACh may inhibit the LC, thereby diminishing arousal and allowing sleep to develop.

436 Myelofugal Unit Activity In Lumbar Primary Afferent Neurons, G. Keith Matheson and Robert D. Wurster. Depts. Anat. & Physiol., Stritch Sch. Med., Loyola Univ. of Chicago, Maywood, Ill. 60153

The dorsal root reflex is a compound potential comprised of antidromic action potentials generated in primary afferent neurons by presynaptic inhibitory mechanisms. The neurotransmitter, now held to be gamma-aminobutyric acid (GABA), initiated the antidromic reflex activity by depolarizing the primary afferent terminals. Single unit discharges occurring spontaneously in the central stumps of transected dorsal roots are also held to be generated by the GABA mediated presynaptic inhibitory mechanism. Bicuculline and picrotoxin are known blockers of the GABA presynaptic mechanism and when injected systemically they block the DRR; however, they do not block the spontaneous dorsal root activity. Lioresal, a GABA derivative, also blocks the DRR but by a different mechanism than bicuculline or picrotoxin; it too, does not block the spontaneous unit activity. Several different varieties of spontaneous unit activity have been observed. Their conduction velocities range from 40 m/s to 100 m/s. Some units have irregular discharge patterns, while others are synchronized to a particular neural event, e.g., respiration, proprioceptor activity. Spontaneous activity can be seen in the dorsal roots of spinal (C-1) and intact preparations. In the intact preparation, GABA blockers cause an increase in the rate of spontaneous unit discharge. It is thought, that this spontaneous activity is mediated by a neuronal mechanism similar to that for presynaptic inhibition, but via another neurotransmitter.

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437 ELECTRON MICROSCOPIC ANALYSIS OF POST-LESION SYNAPTIC GROWTH. Dee Ann Matthews*, J. R. McWilliams*, Carl W. Cotman and Gary S. Lynch (SPON: J. Victor Nadler). Dept. Psychobiol., Sch. Biol. Sci., UCI, Irvine, 92664

Removal of entorhinal input to granule cells in the dentate gyrus results in the reorganization of synaptic inputs as measured by light and electrophysiological analysis. In electron microscopic studies, we have found that a rapid growth of new synapses and a proliferation of existing synaptic populations fill in the precise lamina of the outer two-thirds of the granule cell dendrites formerly composed of terminals from the entorhinal cortex. At four days after a complete unilateral entorhinal lesion, seventy-five percent of the synapses in the outer molecular layer of the anterior dentate gyrus degenerate. The time course of degeneration is long. Degenerating synapses, particularly those formed with complex dendritic spines, exist up to 60-120 days post-lesion. The time course of degeneration is also differential. Degeneration is most rapidly removed in the entorhinal zone nearest the granule cell bodies and more slowly in the outer zone. The glial response is rapid, with the hypertrophy of astroglia preceeding the appearance of microglia. Vacant postsynaptic densities are evident and are found in contact with all structures present. Throughout the degeneration period, particularly after four days, the number of terminals increases as degeneration disappears. Eventually, the former entorhinal zone becomes populated with numerous small terminals, as well as some large multiple-contact terminals, both of which are similar in general appearance to normal terminals. Our data indicate that new synaptic growth extensively repopulates the vacated terminal field after entorhinal lesions.

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438 MECHANISM OF POTENTIATION OF THE ALCOHOL WITHDRAWAL REACTION BY DRUGS WHICH INHIBIT NOREPINEPHRINE SYNTHESIS. H. Randall Matthews. Program in Neurostructure and Function, University of Texas Medical School, Houston, Texas 77025.

The Goldstein inhalation model (JPET 180:203,1972) has been employed in studying the effects of prolonged ethanol intoxication and withdrawal in mice on brain biogenic amine levels and turnover rates, and in studying drug induced changes in these neurotransmitters with respect to their effect on the withdrawal reaction. Pyrazole was given during intoxication as an alcohol drhydrogenase inhibitor in order to stabilize the blood ethanol levels. In controls given pyrazole alone, the NE level was decreased by 35% in three days. The brain NE level was also decreased by 35% during three days of ethanol intoxication. Following withdrawal, the NE level decreased by a further 18% in 4 hr, remained at a minimum from 4-12 hr, then began to increase. The withdrawal reaction peaks at 12 hr, and its intensity is proportional to the product of the average blood alcohol level and duration of intoxication. Thus, when the duration of intoxication was decreased from three to two days, the intensity of the withdrawal reaction was reduced by 1/3, and the drop in NE during intoxication and following withdrawal was also reduced by 1/3. Reserpine, pyrazole, and disulfiram all increased the intensity of the withdrawal reaction. α-Methyltyrosine did not. In each case, the intensification of the withdrawal reaction was proportional to the decrease in NE, while the duration correlated with the time during which NE remained at a minimum. In each case, the withdrawal reaction appeared to reach its maximum and begin to diminish at the same time the NE level began to increase. Since α-methyltyrosine did not intensify the withdrawal reaction, it is concluded that inhibition of NE synthesis at the level of dopamine-β-hydroxylase is involved in the withdrawal reaction.

439 LABYRINTHINE CONTROL OF CAT FORELIMB MOTONEURONS. R.A. Maunz*, M. Maeda* and V.J. Wilson. Rockefeller Univ., New York, N.Y. 10021.

We have studied the labyrinthine influence on forelimb motoneurons in decerebrate, decerebellate cats by means of intracellular recording. Stimulation of the labyrinth with single or multiple shocks causes predominantly EPSPs, bilaterally, in elbow extensor (long, lateral and medial heads of triceps) and in shoulder (supra- and infraspinatus) motoneurons. Sometimes the predominant effect is an IPSP, especially on the ipsilateral side. The shortest pathway is trisynaptic (latency range 2.5-5 msec for EPSPs, 3-5 msec for IPSPs), and there is no significant latency difference between ipsi- and contralateral actions. Stimulation of the contralateral labyrinth is generally more effective. Because these synaptic potentials are unaffected by section of the MLF, but are abolished by lateral lesions in the lower medulla, they are presumably due to the lateral vestibulospinal tract. In flexor motoneurons (biceps) labyrinthine stimulation often produces inhibition bilaterally, although mixed excitatory and inhibitory, or even mainly excitatory effects may occur. Ipsi- and contralateral latencies are similar (3.5-5 msec for IPSPs). These potentials are also unaffected by MLF section. When individual semicircular canals are stimulated, synaptic potentials are produced in some motoneurons. These are also predominantly EPSPs in extensors and IPSPs in flexors, independent of the particular canal stimulated. Labyrinthine control of the forelimb musculature is less direct, and less precisely organized, then control of the neck musculature. (Supported by grants NS 02619 & NS 05463.)

440 PROTEIN SYNTHESIS AND THE SENSORY INDUCTION OF SUSCEPTIBILITY TO AUDIOGENIC SEIZURES IN C57BL/6 MICE. S. C. Maxson, P. Y. Sze and A. Towle.* Dept. Biobehavioral Sciences, Univ Connecticut, Storrs, Conn. 06268

Several lines of evidence suggest that in C57BL/6 mice, the sensory induction ("acoustic priming") of susceptibility to audiogenic seizures is dependent, in part, upon protein synthesis. Both cycloheximide and puromycin, which block protein synthesis by different mechanisms, antagonize the development of this acoustic sensitization. Cycloheximide (30 mg/Kg, i.p.) at 1/2 hr prior to the initial auditory stimulus (IAS) markedly reduces the "acoustic priming," whereas post-treatment 1/2 hr after the IAS does not. Similarly, intraventricular injection of puromycin (100 µg to 200 µg) 2 hr prior to the IAS blocks the development of this seizure susceptibility, whereas the same treatment immediately after the IAS has no effect on its development. Since pretreatment with these drugs antagonizes acoustic priming and post-treatment does not, the development of the susceptibility to audiogenic seizures appears to require protein synthesis for only a brief time (1/2-1 hr) post stimulation. Furthermore, of the three discrete and incremental stages in the development of susceptibility of this strain, only the first which occurs between 1 and 5 hr post stimulation is sensitive to the effects of protein synthesis inhibitors. Successful transfer of acoustic priming by brain extract from experienced to naive C57BL/6 mice at two other laboratories appears to support our hypothesis that in this strain the sensory induction of susceptibility to audiogenic seizures depends, in part, upon protein synthesis. They also suggest that there may be a brain specific protein formed as a result of the IAS. However, in our laboratory brain extracts from experienced mice which are taken either immediately after the IAS or at 11 days after the IAS have no effect upon the susceptibility of naive mice. Thus, our studies suggest that if there is a transferable molecule(s), it occurs in sufficient quantity to be effective only during a brief period post stimulation.

441 A NEUROPHYSIOLOGICAL ANALYSIS OF THE ANTEROLATERAL SPINAL CORD NEURONS CONTRIBUTING TO PAIN PERCEPTION IN MAN. David J. Mayer, Donald D. Price and Donald P. Becker. Dept. of Physiol. and Neurosurgery, Med. Col. of Va., Richmond, Virginia 23298.

Little information is available concerning the physiological properties of second order afferent axons conducting nociceptive information in the anterolateral quadrant (ALQ) of the spinal cord in man. In these studies we have examined threshold, frequency, and refractory period characteristics of an ALQ neural population, stimulation of which produces pain in man. Subjects were 15 conscious humans undergoing percutaneous anterolateral cordotomy for relief of intractable pain. Stimulation consisted of one second trains of 0.2 msec constant current rectangular wave pulses. Pain threshold ranged from 200 - 800 μa (at 50 pulses/sec), but the majority of thresholds were below 400 μa. Frequency of stimulation was an important variable in determining the ability of ALQ stimulation to elicit pain. A linear relationship was found between stimulation frequency and the percentage of subjects reporting pain. This relationship ranged from 5 - 20 Hz with 100% reporting pain at 20 Hz and 0% at 5 Hz. Increases in stimulus frequency up to 500 Hz did not produce pain when stimulation intensity was just below pain threshold at 50 Hz, but much smaller increments in frequency did increase pain once pain threshold was reached. The neuronal refractory period for pain in these subjects was between 0.8 and 1.5 msec. The refractory period and threshold data obtained in this study are similar to those found by Price and Mayer (Soc. Neurosci, 1974) for nociceptive cells in the ventral half of the dorsal horn in the monkey and suggest that activation of these cells is a sufficient condition to produce pain in man. Supported in part by grants DA00576-01 and NS10251-02.

442 RESPONSES OF HIPPOCAMPAL UNITS TO TONAL STIMULI IN AWAKE AND SLEEPING RATS. Lawrence E. Mays and Phillip J. Best. Dept. of Psychology, Univ. of Virginia, Charlottesville, Va. 22901.

Single cell activity was recorded from chronically implanted electrodes in fascia dentata and the CA-1 field of dorsal hippocampus in unrestrained rats during presentations of tonal stimuli. In the first experiment 32% of the cells were reliably inhibited by the tonal stimuli and 26% were augmented. Most of these cells (73%) habituated under rapid tone presentation. The second experiment showed that tonal stimuli caused changes in activity in more cells when the tones aroused the animal from sleep (75% affected) than when the tone was presented to an awake animal (18% affected). In both experiments all affected facia dentata cells were inhibited. However, 36% of the affected CA-1 cells were augmented. The data indicate that the hippocampus undergoes dramatic changes during arousal from sleep. It appears that previously found changes in hippocampal unit activity during conditioning might be due to conditioned changes in the capability of stimuli to arouse the animal from sleep.

443 CHANGES IN AMINO ACID LEVELS IN BRAIN AREAS OF RATS DURING DRUG-INDUCED BEHAVIORAL EXCITATION. W.J. McBride, J.N. Hingtgen* and M.H. Aprison, Sect. of Neurobiology, Inst. of Psychiatric Research, Depts. of Psychiatry and Biochem., Indiana Univ. Med. Center, Indianapolis, Ind. 46202.

It is possible that certain amino acids may be important in affecting behavior. Therefore, experiments were initiated to determine if changes in the levels of glycine (Gly), GABA, aspartate (Asp) and glutamate (Glu) occurred in different CNS areas of excited animals. In these studies, behavioral excitation was induced in adult, male Wistar rats working on a Sidman shock-avoidance schedule (RS 20: SS 10; 1.6 ma; 0.5 sec duration) by administration of 2 mg/kg tetrabenazine (TBZ) 18 hr after iproniazid pretreatment (50 mg/kg). With respect to values obtained for control animals (no drugs; no training), the following significant differences ($P < 0.05$) were found for the drug-induced excited animals: (1) the levels of GABA were higher in the telencephalon (T), diencephalon-mesencephalon (D-M), and cerebellum (C); (2) the levels of Glu were higher in the T and D-M; and (3) the levels of Asp were lower in the D-M, C and pons-medulla oblongata. These observed differences did not appear to be a result of the injected drugs per se since subsequent studies with untrained rats showed no differences in the levels of these amino acids between animals injected with iproniazid and TBZ and those injected with saline. Another series of experiments indicated that the training experience alone could account for the differences observed between the excited animals and the control group for Glu but could not account for the GABA and Asp differences. Consequently, it is possible that these latter two amino acids may be involved in the drug-induced behavioral excitation of these animals. (Supported in part by research grants from NIMH (MH 03225-15) and from the Ind. Assoc. for the Adv. of Mental Health Research and Education).

444 DISCHARGE PATTERNS OF PONTINE UNITS DURING DESYNCHRONIZED SLEEP. Robert W. McCarley and J. Allan Hobson. Dept. Psychiatry, Harvard Medical School, Boston, Mass. 02115.

Evidence from anatomical, lesion, pharmacological, electrical stimulation, and extracellular unit recording studies points to the pontine reticular formation, and especially the gigantocellular tegmental field (FTG) as a site critical for generation of the desynchronized phase of sleep (D). Using autocorrelation techniques on extracellularly recorded stationary discharge sequences, we studied the discharge pattern of 61 FTG, 24 central, lateral, and posterior tegmental field, 15 tegmental reticular, and 8 pontine grey units during spontaneous D episodes in unanesthetized cats. There was no evidence for a high degree of discharge regularity, and hence no supporting evidence for "pacemaker" cells that might become spontaneously active during D and generate the signs of this state. Unit discharge could best be characterized on a tonic-phasic continuum. FTG units showed the most phasic pattern, having runs or clusters of discharges that lasted up to 2 - 4 sec, with intervening periods of silence or lesser discharge activity. Units in the other areas showed a more tonic or sustained (but not regular) discharge pattern. Comparisons among recording sites in the FTG revealed the clustered discharge pattern to be most intense at sites with the highest giant cell density. Furthermore, units in the FTG with a high degree of discharge rate change from waking and synchronized sleep to D had a high degree of clustered discharges. Thus, there is a three way correlation between recordings made at sites with many giant cells, high discharge rate increases on transition to D and high intensity of clustered discharges. It is concluded that the clustered discharge pattern is characteristic of units that several converging lines of evidence implicate in D sleep generation.

445 Comparison of Supersensitivity to Acetylcholine and Carbachol in Chronically Denervated Rat Diaphragm. Marjorie Geller McConnell. Dept. Pharmachol., Col. Phys. & Surg., Columbia Univ., New York City, 10032.

Rat diaphragms were denervated by left phrenicectomy. Changes in tissue sensitivity, receptor density and acetylcholinesterase activity accompanying denervation were monitored. Sensitivity to acetylcholine and carbachol was measured in vitro (isometric tension). It was found that supersensitivity developed to acetylcholine and carbachol with the same time course but sensitivity to acetylcholine was greater than to carbachol. Receptor density was estimated by α-bungarotoxin binding studies. The increase in tissue binding of α-bungarotoxin accompanying denervation closely paralleled the increase in sensitivity to carbachol. Following denervation, there was a marked fall in acetylcholinesterase activity. This observation was considered important because acetylcholine, but not carbachol, is metabolized by cholinesterases. The data thus support two conclusions: 1.) denervation supersensitivity to carbachol is mainly due to increases in receptor density, and 2.) denervation supersensitivity to acetylcholine is due to a combination of increased receptor density and decreased acetylcholinesterase activity. These conclusions would account for the relatively greater supersensitivity that develops to acetylcholine.

446 A TECHNIQUE FOR PRODUCING MATHEMATICALLY PREDICTABLE ETCHED MICROELECTRODES. James G. McElligott, Jonathan R. Aldeghi*, Michael H. Loughnane* and Ronald J. Tallarida*. Dept. of Pharm., Temple Sch. of Medicine.

Metal microelectrodes have been used extensively for almost three decades to investigate the electrical properties of individual neurons. Unfortunately, the preparation of these electrodes has remained an art that is dependent upon an individual's skill and craftsmanship. The generally accepted method of microelectrode fabrication is by passing an etching current through a wire that is repeatedly and rhythmically inserted into an acid solution. Our approach to the problem consists of a mathematical description of the etching process in terms of several variables, such as, the rate and depth of insertion and the magnitude of the etching current. A general iterative numerical solution for the electrode profile has been developed. In this solution, the iterations correspond to the sequential immersions and the general solution is a simple formula involving sums of harmonic progressions. The validation of this mathematical model has been accomplished by means of an electromagnetic driver to which the electrode wire is attached. The depth and rate of insertion can be accurately controlled by an oscillatory voltage applied to the electromagnetic's coil. Control of the etching current derived from the immersion parameters allows microelectrodes of predictable and repeatable shapes to be generated. (Supported by USPHS Grant # RO1 - NS 10488).

447 THE DISTRIBUTION IN HUMAN POST MORTEM BRAIN TISSUE OF ENZYMES CONCERNED WITH NEUROTRANSMITTER METABOLISM. E. G. McGeer, P. L. McGeer and H. C. Fibiger. Kinsmen Laboratory of Neurological Research, Department of Psychiatry, University of British Columbia, Vancouver, Canada.

The distribution in human post mortem brain tissue of 5 enzymes associated with neurotransmitter metabolism (glutamic acid decarboxylase [GAD], choline acetyltransferase [CAT], tyrosine hydroxylase [TH], acetylcholinesterase [AChE], and dopa decarboxylase [DD]) was determined by a study of 50-150 areas in each of 60 brains, and compared with similar but less detailed data on other mammalian species. TH in the striatum showed a sharp decrement with age in humans. The decrement was less in rats but was still greater than for the other enzymes that were measured. The pre-mortem condition of the patient seemed to be more important to the absolute levels of the enzymes measured than the post mortem delay in obtaining tissue. Prolonged coma prior to death resulted in substantial enzyme deterioration. Abnormally low levels of CAT and GAD were found in extrapyramidal structures in Huntington's chorea. Reductions in TH and GAD were found in these same structures in Parkinson's disease.

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448 IMMUNOHISTOCHEMICAL LOCALIZATION OF CHOLINE ACETYLTRANSFERASE IN CERTAIN STRUCTURES OF THE CENTRAL NERVOUS SYSTEM. P. L. McGeer, E. G. McGeer and V. K. Singh*. Kinsmen Laboratory of Neurological Research, Department of Psychiatry, University of British Columbia, Vancouver, Canada.

Mapping of the cholinergic structures in the nervous system has been handicapped by the lack of a suitable histochemical procedure. It has long been recognized that a specific and sensitive histochemical method for choline acetyltransferase would make cholinergic mapping possible. Choline acetyltransferase has been purified from human neostriatal tissue. Monospecific antibodies to the purified enzyme have been produced in rabbits. Frozen sections from human, beef, or rat central nervous system tissue have been fixed briefly in ether and incubated with dilutions of immune rabbit serum. Normal rabbit serum, or immune rabbit serum treated with purified choline acetyltransferase has been used to treat control sections. These sections have then been counter-stained with fluoroscein-conjugated goat anti-rabbit serum. In the spinal cord positive staining for CAT was obtained for anterior horn cells and their ventral processes; axonal processes for posterior roots showed no positive staining. Staining of cells and their processes in the striatum was also found.

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449 MATURATION OF RESPIRATION AND HEART RATE DURING SLEEP IN KITTENS. Dennis J. McGinty, Ted Baker*, Susan Hamada* and Michael Stevenson*. VAH Sepulveda, Calif. 91343 and Dept. Anat., UCLA, Los Angeles 90024

The characteristics of cardiac and pulmonary function are altered during the waking (W) - slow wave sleep (SWS) - rapid-eye-movement sleep (REM) cycle. Specific cardiac and respiratory events, such as apneic episodes, have been implicated in sleep-related diseases and abnormalities, including the sudden infant death syndrome. To pursue these concepts, measurements of heart rate and respiratory rate changes were made in normal and sleep-deprived kittens at 10, 20, and 40 days of age during states of sleep and wakefulness. The incidence of apnea and EKG waveform changes were also noted. All parameters were recorded continuously during 12-hr. sessions in the presence of mothers and littermates 2-3 days after surgical implantation of electrodes. During maturation, respiratory rate first declined between 20 and 40 days during waking (92 to 66 b/m) and REM (44 to 36 b/m), while SWS respiration declined after 10 days (46 to 38 b/m). Apneic episodes typically lasting less than 10 seconds were observed in all kittens during both SWS and REM, but never during W. Heart rate declined between 10 and 20 days during SWS (233 to 180) and REM (220 to 185) but changed little during W (254). Both respiration and heart rate exhibited large variations during REM. Following 12 hours' sleep deprivation several kittens exhibited cardiac arrhythmias with ventricular ectopic beats and prolonged QRS complexes. In addition, a low birth weight kitten exhibited a persistent apnea and cyanosis during sleep, and finally died. Both sleep apnea and cardiac arrhythmias persisted during both SWS and REM, but always disappeared during waking.

450 BULK ISOLATION OF LARGE NEURONAL PERIKARYA FROM ANTERIOR SPINAL CORD. D. L. McIlwain and Patsy Capps-Covey*. Dept. Physiol., Sch. Med., Univ. North Carolina, Chapel Hill, N. C. 27514.

Purified bulk fractions of neuronal cell bodies ranging between 50 and 150 microns in their smallest diameter can be isolated from bovine anterior spinal cord. Dispersed perikarya from collagenase-treated cervical and lumbar spinal enlargements are first fractioned by isopycnic centrifugation on a discontinuous sucrose gradient. Contaminants and neuronal perikarya less than 50 μ in diameter which are found in that fraction are then largely removed by sieving the preparation with nylon filters of different aperture sizes. Forty to 75,000 purified neuronal perikarya with processes of varying lengths are recovered in a typical day's preparation, depending upon the amount of starting material used, and 80 to 100% of these are larger than 50 μ. Results of analyses on selected chemical constituents of the isolated cell bodies (e.g. RNA/DNA ratios, acetylcholinesterase activity) are comparable to those obtained with bulk-isolated cerebrocortical neurons or microdissected spinal neurons. (Supported by USPHS Grants FR-05406 and MH-11107)

451 GROWTH CONE VESICLES: ANALOGY TO THE AMOEBA CONTRACTILE VACUOLE. *James A. McKanna** *(SPON: D.C. Goodman). Department of Anatomy, S.U.N.Y. Upstate Medical Center, Syracuse, New York 13210.

Neuronal growth cones contain 200 nm dia. smooth vesicles and 50 nm dia. coated vesicles, both of which have morphologically similar counterparts in the amoeba contractile vacuole system; and functional considerations suggest that the two membranous systems play analogous osmoregulatory roles. In protozoans, the function of contractile vacuoles has been thought to be the extraction of excess water that had "osmotically leaked" into the cytoplasm. This simplistic model has now been rejected due to demonstration of high membrane water permeability and better understanding of the colloidal properties of cytoplasm. Contractile vacuoles function to rectify cellular water imbalance that appears to arise from asymmetric gel/sol transformations of cytoplasmic proteins. In amoeboid movement (or cytoplasmic streaming), water is taken up by the protein molecules as they transform from gel to sol. The hydrated sol proteins stream to the advancing pseudopodial tip where they undergo gelation, releasing water. Thus the streaming results in an asymmetric distribution of water, and the operation of a fluid segregation system is necessary to maintain the water/electrolyte balance essential to cell integrity. In amoeba, the excess water is segregated by 50 nm dia. coated vesicles which subsequently fuse and contribute their contents to larger uncoated vesicles and vacuoles which finally expel the fluid from the cell by fusion with the plasmalemma. We feel that active amoeboid movement of growth cones creates water imbalance which necessitates a fluid segregation system; and we suggest that the morphologic similarity of the vesicles in growth cones with those in amoeba indicates their role in osmoregulation.

452 FINE STRUCTURAL LOCALIZATION OF GLUTAMATE DECARBOXYLASE IN SYNAPTIC TERMINALS OF RAT SPINAL CORD. Barbara J. McLaughlin, Robert Barber*, Kihachi Saito*, and Eugene Roberts. Div. Neurosci., City of Hope Medical Center, Duarte, CA. 91010.

Glutamate decarboxylase (GAD), the enzyme which synthesizes the neurotransmitter γ-aminobutyric acid (GABA), has been localized by immunocytochemical techniques at the EM level in dorsal horn laminae I-VI and in the motor nuclei of rat spinal cord. Adult Wistar rats were perfused with 4% paraformaldehyde, 0.1% glutaraldehyde in 0.12 M Millonig's buffer, pH 7.2. The lumbosacral spinal cord was removed, sectioned transversely into 75 μ slices and GAD was localized as described previously (PNAS:71, 1974). Many more GAD-positive terminals were observed in the outermost dorsal horn laminae (I-III) than in deeper laminae (IV-VI). In laminae I-III, GAD-positive knobs, presynaptic to dendrites, were more common than positive knobs presynaptic to cell bodies and other axonal terminals. In laminae IV-VI, both axosomatic and axodendritic GAD-positive presynaptic terminals were observed frequently, and presynaptic GAD-positive axo-axonal synaptic contacts were also seen. In the motor nuclei of the ventral horn, GAD-positive synaptic terminals were less numerous than in the dorsal horn. Presynaptic GAD-positive knobs were observed on small and large dendrites as well as on motoneuron somata. Some of the GAD-positive knobs also appeared to be presynaptic to large axonal terminals synapsing on motoneurons. The large number of GAD-containing synaptic terminals observed in the outermost dorsal horn laminae of rat spinal cord is consistent with biochemical evidence that GAD and GABA are concentrated in this region. The observation of GAD-positive terminals presynaptic to other axonal terminals in both dorsal and ventral horns suggests that GABA may be the major transmitter mediating presynaptic inhibition in the spinal cord. Supported by NIH Grants NS-01615, MH-22438 and NS-09578.

453 SEIZURES INDUCED BY CEREBELLAR STIMULATION IN FREELY MOVING PRIMATES. Joseph W. McSherry* and John J. Hablitz, Neurophysiology Dept., The Methodist Hospital and Baylor College of Medicine, Houston, Texas 77025.

Rhesus monkeys (Macaca mulatta) were prepared with chronically implanted stimulating and recording electrodes. The cerebellar arrays consisted of a 3x3 matrix of platinum electrodes embedded in silicone preformed to lie over the vermal and paravermal regions of the anterior lobe of the cerebellum. Stainless steel screws were placed bilaterally over frontal, central, and parietal regions of cortex for EEG recordings. Epileptic foci were created in the motor cortex of the right hemisphere by intracortical injection of alumina hydroxide cream.

A focus of cortical spiking evolved in the motor cortex approximately 2 weeks after the alumina cream injection. These spikes were accompanied by myoclonic movements of the extremities. High frequency stimulation (100 Hz, 3-10 V, 1 msec pulses) was applied to pairs of cerebellar electrodes to observe its effect on spike rates. Electrographic seizures were initiated by this stimulation and were accompanied by clonic movements of the extremities.To our knowledge, this is the first time cortical seizures have been induced by cerebellar stimulation. No spontaneous seizures have been noted to date in these animals although fits can be elicited reliably by cerebellar stimulation.

These results and those previously reported concerning EEG changes in freely moving primates receiving cerebellar stimulation attest the usefulness of this model. These results extend observed species variability in cerebellar-neocortical interaction, variability which is presumably due to differences in the phylogenetic development of these structures.

454 RAT SKELETAL MUSCLE NECROSIS FOLLOWING AMINE UPTAKE BLOCKERS OR PARGYLINE PLUS SEROTONIN. Herbert Y. Meltzer and Sneh L. Rastogi*. Univ. Chicago Pritzker Sch. Med., Dept. Psychiatry, Chicago, Ill. 60637.

Parker and Mendell (Nature 247: 103, 1974) reported that imipramine plus serotonin (5-HT) i.p. produced focal necrosis of rat skeletal muscle. The lesions were said to resemble those of Duchenne muscular dystrophy (DMD) and were attributed to ischemia or to direct myotoxicity. The blockade of 5-HT uptake by imipramine was believed to reproduce an abnormality of 5-HT uptake reported in blood platelets from patients with DMD (Murphy et al., Arch. Neurol. 28: 239, 1973). We have found that pretreatment with the amine uptake blocking drugs: chlorpheniramine, chlorimipramine, desimipramine or imipramine plus 5-HT subcu. produced varying amounts of muscle fiber necrosis in the soleus and vastus lateralis muscles of Sprague-Dawley rats. There was no relationship between the reported capacity of these drugs to block neuronal 5-HT uptake and the degree of necrosis produced. Serotonin alone or following three days of ouabain treatment (to inhibit Na^+, K^+-adenosine triphosphatase) did not produce necrosis. Serotonin following pretreatment with the monoamine oxidase inhibitor, pargyline, also produced muscle necrosis. The necrosis produced by the amine uptake blockers or pargyline plus 5-HT was blocked by the 5-HT blocker, methysergide, but not by the adrenergic blockers, propanalol or dibenzilene. Prior denervation also inhibited the necrosis produced by chlorpheniramine plus 5-HT. The possibility that the necrosis produced by these treatments is due to acetylcholine release is proposed. (Supported by USPHS MH grants 18,396 and 25,116; Dr. Meltzer is recipient of Research Scientist Development Award 5-K02 MH 47,808).

455 STABILITY OF MONOSYNAPTIC CONNECTIONS FOLLOWING PERIPHERAL NERVE CROSS UNION. L. M. Mendell and J. G. Scott*. Dept. Physiology, Duke Medical Center, Durham, N. C. 27710

These experiments test whether monosynaptic connections in the cat can rearrange to match a foreign peripheral termination of either the Ia fiber or motor axon (i.e. myotypic respecification). In 4-8 day old kittens a portion of the medial gastrocnemius (MG) nerve and the entire lateral gastrocnemius-soleus (LGS) nerve were divided; the proximal end of each was sutured to the distal end of the other. About 1 year later the projections of single normal and cross united MG Ia afferent fibers to MG and LGS motoneurons with crossed and uncrossed axons were investigated. The original identity of motoneurons and Ia fibers was established in each case by activation from identified muscle nerves proximal to the nerve union. The motor axon terminations were determined by observing which muscle twitched during intracellular motoneuron stimulation; the Ia fiber termination was established at the end of the experiment by cutting nerves entering the muscles until the discharge disappeared. These precautions were required because occasionally motor axons regenerated to the unintended muscle, to 2 muscles or failed to make functional contact with any muscle. Single MG Ia axons normally project to (i.e. evoke EPSP's in) 94% of MG motoneurons but to 66% of LGS motoneurons. LGS Ia afferents normally project to 60% of MG motoneurons. No significant changes were seen in the frequency of central connections either to motoneurons with crossed axons or from Ia fibers with crossed axons. It is concluded that these monosynaptic connections in the kitten cannot undergo myotypic respecification. (Supported by NIH:NS 08411, NS 34608, GM00929).

456 INFLUENCE OF HEAD-POSITION ON EXCITATION-PATTERNS OF OCULOMOTOR NEURONS DURING NYSTAGMUS. D. L. Meyer+, D. Schott+, U. Büttner+ and K.-P. Schaefer+. (SPON: T.H. Bullock). Department of Neurosciences, Sch. Med. and Neurobiology Unit, UCSD and Neurobiology Unit, University of Goettingen, Germany.

40 oculomotor neurons have been recorded during optokinetic nystagmus with the head in various positions. With the head in e. g. a position towards the right optokin. stimulation towards the left resulted in an increased rate of nystagmus (head 90° right caused nystagmus beat-frequency to increased about 60 %) and in distinct changes of the activity patterns of oculomotor neurons. E. g. neurons in the right internal rectus nucleus displayed a more "tonic" behaviour when the head was in a fixed position towards the right and showed more "phasic" firing pattern when the head was left of the mid-position. All changes were seen during fast and slow nystagmus phases as well as in the resting position of the eye. Optokinetic stimulation with steps of 1° revealed that also the increase of activity per degree of stimulation was altered by the head-position. All experiments have also been carried out under the influence of Curare in order to eliminate stretch-receptor afferents from eye-muscles. The general oculomotor behaviour has not been influenced by the application of this drug. These findings are interpreted as demonstrating interactions of neck-proprioceptive afferents with the oculomotor system.

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Abstract withdrawn

458 STUDIES ON THE DEMONSTRATION AND PURIFICATION OF A SYNAPTIC MEMBRANE GLUTAMATE BINDING MACROMOLECULE. Elias K. Michaelis. Dep't. Human Development, Univ. of Kansas, Lawrence, Ks. 66045

These studies were designed to investigate the glutamate-interacting site on neuronal membranes that possibly functions as the "physiologic receptor" for the CNS excitatory activity of this amino acid. After tissue preparation using standard subcellular fractionation techniques, ^{14}C-L-glutamic acid binding to various rat brain subcellular fractions was measured by means of equilibrium dialysis in the presence of an excess of D-glutamate. The synaptic membrane fraction exhibited the highest binding affinity at ligand concentrations in the range of 0.1-1.4 μM. The synaptic membrane binding was both stereospecific, being little affected by a thousandfold excess of D-glutamate, and reversible. This glutamate-synaptic membrane interaction was partially blocked by 1 μM concentrations of both excitatory (L-aspartate, L-cysteine sulfinic acid) and inhibitory (GABA, Glycine, β-alanine) amino acids while being unaffected by non-neuroactive amino acids. L-Glutamate binding was not dependent on the presence of Na+ and varied in a biphasic manner with changes in Ca++ concentration. The membrane glutamate binding component can be solubilized by treatment with 0.25% Triton X-100, and this solubilized entity was found to be sensitive to proteolytic digestion, as well as to treatment with phospholipase C. It also strongly interacted with concanavalin A, and this interaction has been utilized in recent attempts at purification by means of affinity chromatography. On the basis of its sensitivity to the presence of both the excitatory and the inhibitory amino acids, the glutamate binding macromolecule resembles more closely the physiologic receptor than it does the neuronal glutamate transport system.

459 SOME EFFECTS ON OFFSPRING PRODUCED BY INJECTING PREGNANT MICE WITH SUB-ANESTHETIC DOSES OF PHENOBARBITAL. Lawrence D. Middaugh, Carroll A. Santos III*, & John W. Zemp. Med. Univ. of S. Car., Charleston, So. Car. 29401.

Offspring of C57BL/6J mice injected with phenobarbital (20-,40-, or 80 mg/kg) daily for the last third of pregnancy differed from control offspring on several measures. Offspring of dams receiving 80 and 40 mg/kg doses of phenobarbital had higher infant mortality than controls. Body weight at 60 days of age was somewhat less for treated animals at all doses. Offspring of treated animals also differed from controls on several behavioral measurements after maturity. Male but not female offspring of treated animals (40 mg/kg) had increased locomotor activity in the open field when tested at 75 days of age. Male offspring were further tested on a one trial passive avoidance task. Latencies for entrance into the shock compartment of a two compartment box were similar for treated and control animals during the conditioning phase of the task. On the test phase 24 hrs. later, treated animals re-entered the shock chamber much earlier than controls. Finally, both male and female offspring of dams receiving phenobarbital (20- and 40 mg/kg) responded less than controls on an operant task in which responding was maintained by progressively increasing fixed ratio schedules of reinforcement. The response decrement in treated animals was particularly noticeable on schedules which required a large number of responses per reinforcement. An interpretation consistent with behavioral changes noted is that phenobarbital has produced prolonged changes in offspring reactivity to stimuli, perhaps through altered neural and/or endocrine systems associated with arousal. (Supported by USPHS Grant #DA-0041 and S. C. State Approp. to MUSC for Biomed. Res.)

460 EFFECTS OF WEARING TELESCOPIC SPECTACLES ON THE VESTIBULO-OCULAR RESPONSE OF RHESUS MONKEYS. F.A. Miles and J.H. Fuller, Lab. Neurophysiology, NIMH, Bethesda, Md. 20014

The vestibulo-ocular reflex (VOR) helps to maintain a stable retinal image by generating compensatory eye movements to offset the effects of head rotations. It is known that the performance of this open-loop control system is sensitive to vision-reversal in humans[1], and the present experiments were undertaken to see if the VOR of the Rhesus monkey could be modified by changing the visual input associated with head movements using a slightly different paradigm. The gain of the VOR (eye rotation/head rotation) was measured in Rhesus monkeys before and after wearing telescopic spectacles, by measuring the compensatory eye movements which resulted when the animal was passively oscillated to and fro about a vertical axis in total darkness. The VOR of 3 normal Rhesus monkeys had a gain of 0.9-1.0 and this value could be raised or lowered when telescopic spectacles of positive and negative power, respectively, were worn for 2 or 3 days. Thus, x2.0 magnifying lenses increased the gain of the VOR by up to 50%, and x0.5 diminishing lenses decreased the gain by up to 30%, within 3 days. Recovery back to normal gain following removal of the spectacles took 1-2 days. These findings demonstrate adaptive plasticity in the VOR and suggest the importance of visual input in the long-term maintenance of appropriate vestibulo-ocular responses.

1. Gonshor, G. and Melville Jones, G. J. Physiol. 234: 102-3P, 1973

461 DIRECTIONAL HEARING IN THE LOCUST, Schistocerca gregaria. Lee A. Miller, Inst.of Biol., Odense Univ.,DK-5000,Denmark.

This study was undertaken to determine the extent to which the locust ear responds to pressure and pressure-gradient components of a sound stimulus. The ears of 29 insects were investigated under controlled acoustic conditions. Animals were divided into 4 weight groups (WG) according to the amount of tissue found between the ears. These were: 1.03-1.99 mg, 2.00-8.99 mg, 9.00-49.99 mg, and 50.00-186.20 mg. Activity in the auditory nerve was recorded at 45° intervals from 0°(ear towards sound source) to 180° to 80msec shaped pulses with frequencies of 2, 3.5, 5, and 15kHz at various intensities (measured dB re. $2x10^{-5}$ N/m^2). The number of spikes/stimulus were counted manually and computer analyzed. The auditory threshold at 0° did not vary by more than 5-10dB among WG's. They were: 27-32dB at 2kHz, 17-25dB at 3.5kHz, 25-34dB at 5kHz, and 36-41dB at 15kHz. When the effect of diffraction caused by the insect's body is taken into consideration, all directional plots, except those at 15kHz in WG's 2 and 3, show a 5 to 14dB decrease in sensitivity at 180° re. 0°. No "figure 8" directional plots were obtained. The directional sensitivity plots of animals in WG's 1 and 4 were almost identical, showing a decrease in directional sensitivity from 2 to 5kHz. Theory predicts that the locust ear should function more as a pressure receptor at high frequencies (10kHz and above)(A.Michelsen,J.comp.Physiol.71:49,1971). This appears to be the case for WG's 2 and 3 at 15kHz. At frequencies from 2 to 5kHz the ear appears to respond as a combined pressure and pressure-gradient receptor.

462 CHLORIDE SENSITIVE PATHWAYS IN THE PERFUSED RETINA EYECUP PREPARATION OF THE MUDPUPPY. Robert F. Miller and Ramon F. Dacheux.* Neurosensory Laboratory, SUNY at Buffalo, Dept.of Physiology, Buffalo, N.Y. 14214

The electrophysiological organization of the mudpuppy retina is dependent on the presence of chloride ions. If Cl^- is replaced by a suitably large anion (sulfate, methylsulfate, Propionate), highly selective changes occur in the retinal network; these changes are most easily appreciated by an examination of ganglion cell activity. A chloride-free environment results in a loss of ganglion cell discharge which follows the onset of a light stimulus but an enhancement of the "off" discharge. Spontaneous activity is usually increased and often appears as a regularly spaced bursting discharge pattern. These results are identical to the effects of a chloride-free environment recently observed in the rabbit retina (1). Intracellular recordings in the mudpuppy eyecup show that receptors are relatively unaffected by the removal of Cl^-. Horizontal cell recordings show either a complete loss of the light evoked response or a reduction in amplitude as the cell is hyperpolarized. This hyperpolarization is accompanied by a decrease in cell conductance. Depolarizing and hyperpolarizing bipolar cells are differently affected, in many but not all cases, by the removal of Cl^-. The on depolarization of on-off amacrine cells is abolished in a Cl^- free medium while the depolarizing off-response is preserved. These results enable one to propose models of the retinal network which underlie the pathways subserving on-center, off-center, and on-off ganglion cells.

(1) Miller, R.F. & R.F. Dacheux. Science 181: 266-268, 1973.

463 EFFECTS OF MORPHINE & NALOXONE ON CATECHOLAMINE AND CALCIUM UPTAKE IN RAT STRIATAL SLICES. Sheldon L. Miller* and Joseph Harris. Dept. of Neurobiology, Barrow Neurological Institute Phoenix, Arizona 85013.

Narcotic inhibition of catecholamine reuptake in the rat striatum appears to be modulated by calcium (Ca^{2+}) uptake and Ca^{2+} concentration. Extending our earlier experiments (Int. Soc. Neurochem., Budapest 3: 237, 1971) to Dopamine (DA), (^3H) norepinephrine (NE), and $^{45}Ca^{2+}$ uptake in the striatum, rat striatal tissue slices were analyzed after (a) morphine (M) or Naloxone (N) were added in vitro, (b) acute injection of morphine or naloxone in vivo, (c) chronic morphine pellet implant, and (d) naloxone precipitated withdrawal.

In vitro, both M and N inhibited NE and DA uptake but only N decreased Ca^{2+} uptake. In contrast, acute M injection decreased only NE uptake, while N decreased uptake of DA, NE, or Ca^{2+} in a medium containing lowered Ca^{2+} concentration. Chronic morphinized striatal slices showed decreased DA uptake as a function of time; as dependency developed, reuptake returned to control levels. La^{3+} a competitive inhibitor of Calcium binding reduced DA as well as Ca^{2+} uptake, both effects which were reversed by increasing Ca^{2+} concentration. This study indicates the difference between agonist and antagonist action on both catecholamine and Ca^{2+} reuptake as well as showing the variations due to mode of narcotic administration.

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464 WINNING, LOSING AND THE CNV. Victor Milstein, Joyce G. Small, Joe Moore* and Gary Gans*. I.U. School of Medicine and Larue D. Carter Hospital, 1315 West 10th Street, Indianapolis, Indiana 46202.

Psychological processes of attention, arousal, emotional involvement and expectation, influence contingent negative variation (CNV) responses whether or not the experiment requires motor behavior on the part of the subject. Earlier we found that psychological influences on the CNV are more readily observable in the absence of motor responses, for the latter are associated with negative foreperiod DC shifts (motor potentials) which may obscure the contribution of other factors. In this study, we examined the contribution of psychological and personality variables on the CNV while employing a procedure requiring no motor responses during recording. Ten adult volunteers (5 men and 5 women) spun a pointer to a wheel to select by chance a particular combination of visual and auditory stimuli that would be associated with winning or losing money. The experimental design called for presentation of 4 stimulus combinations during each trial with systematic attachment of bonuses and penalities to either or both stimuli. Two monetary values of bonuses or penalities (5¢ or 50¢) were used in the experiment. Subjects were told that they could win up to $20.00 and were guaranteed a minimum of $2.50 even if they lost.

All of the neutral and different financially meaningful stimulus combinations were averaged separately off-line and DC amplitudes were compared during preparation, anticipation and feedback periods. Analysis of the group data revealed differences between the various experimental conditions, but there were few significant sex differences. When individual CNV's were examined, there were features which differentiated between the experimental conditions. These were related to performance on tests of field dependency, autokinesis, and laterality of eye movement as well as scores on pencil and paper tests of rigidity and internal vs external locus of control.

465 FACILITATION OF TWO-BAR RATIO PERFORMANCE BY EXTERNAL CUES IN SEPTAL RATS BUT NOT IN NORMAL RATS. James C. Mitchell and Kenneth E. Kratz*
Dept. Psychology, Ks. State Univ., Manhattan, Ks. 66506

This research tested the hypothesis that rats with septal lesions should show deficits on tasks requiring the use of response produced cues and should be aided by the addition of external cues. Six rats with septal lesions and 6 normal rats were subjects. Following surgery, subjects were shaped to respond to a two-bar ratio schedule requiring 6-8 responses on one bar followed by 1 response on another bar to obtain water. When less than 6 or more than 8 responses were made on the first bar, reinforcement was not delivered. Three normals and 3 septals received extensive (30-36 45 min. sessions) training and then an external cue was added. A light appeared over bar 1 until 6 responses were made and then shifted to bar 2 until it was pressed. These subjects received an additional 24-30 sessions. A second group of 3 septals and 3 normals were trained on the same schedule except that the light was used during the original shaping and subsequent training. They received 30-36 sessions. Frequency distributions of the number of responses on the first bar prior to responding on the second bar were analyzed for the last 12 sessions for cued and uncued conditions. Normals learning without a cue responded appropriately (6-8 times) on the first bar 54% of the time and septals did so 36% of the time. When the external cue was added, septals improved, responding appropriately 65% of the time, but normals did not improve. For the groups with the external cue present at the beginning of training, normals showed 56% and septals 87% appropriate responding. Septals were aided by the external cue whether it was present from the beginning of training or added later after stable performance had been obtained. Surprisingly external cues did not facilitate performance of normal subjects.

466 BEHAVIORAL TOLERANCE TO N,N-DIMETHYLTRYPTAMINE. S. R. Mitchell, J. M. Beaton, R. J. Bradley, J. R. Smythies*, F. Benington* and R. D. Morin*.
Neurosciences Program and Dept. of Psychiatry. Univ. of Ala. in B'ham. 35294.

Hallucinogenic, methylated derivatives of tryptamine and 5-hydroxytryptamine (5-HT) have been suggested as the endogenous psychotoxins responsible for schizophrenia. In fact both tryptamine and 5-HT are present in brain along with enzymes which have been shown in vitro to convert them to N,N-dimethyltryptamine (DMT), 5-OH-N,N-Dimethyltryptamine (bufotenine) and 5-methoxy-N,N-dimethyltryptamine. DMT is a potent short acting hallucinogen producing effects in humans and animals similar to those caused by LSD. It can be argued that if DMT were produced by schizophrenics then they would rapidly become tolerant to it. Therefore it could not be the cause of the disease. Previous attempts to demonstrate tolerance to DMT have either failed to find it (Cole and Pieper, Psychopharmacologia, 29, 107 (1973) Gillin et al. Biol. Psychiat. 7, 213 (1973) or have given equivocal results (Kovacic and Domino, Fed. Proc. 33, 1903, 1973). We now report the development of tolerance to DMT in hooded rats using a modified Sidman avoidance schedule. In the first phase of the study 10 mg/kg of DMT was injected i.p. at the start of a 100 minute trial. By the fifth day tolerance (defined as a return to initial, i.e. baseline saline levels) had developed in 3 of 4 animals. In the second phase, using 15 mg/kg, tolerance developed in 2 of 3 animals after 19 days. The intolerant animal showed no tolerance after 43 days of drug. These data indicate that individual differences may play a role in the development of tolerance to DMT. Some animals however, demonstrate complete behavioral tolerance to high doses.

This investigation was supported in part by NIH grant RO1-MH24177-01.

467 CEREBELLAR CORTICAL AND NUCLEAR ACTIVITY DURING PAROXYSMAL CEREBRAL DISCHARGES. J. Mitra and R.S. Snider. Center for Brain Research, University of Rochester Medical School, Rochester, New York, 14642

A focal epileptogenic discharge in the sensori-motor cortex of the cat can induce a prominent change in the activity of the Purkinje cell (P) and the nucleus interpositus cell (NIP). The details of these discharges have been studied following local penicillin application on the pial surface of the cerebrum and recording altered cerebellar activity by way of microelectrodes oriented in and adjacent to P and NIP. There was a reciprocal increase and decrease of cortical and nuclear cells synchronous with cerebral epileptogenic activity (CEB). Usually, interictal spikes induced P inhibition in one part of a folium and facilition in an adjacent part. Simultaneous with the increased P activity there was decreased NIP activity. During prolonged cerebral seizures, there were erratic P interrelationships with NIP in which both may increase or decrease simultaneously or change independently. Causes of these changes are being investigated. They are not due to fluctuations in blood pressure or heart rates. (Supported in part by NINDS #06827 and 04592).

468 ROLE OF STRIATE CORTEX AND SUPERIOR COLLICULUS IN VISUAL GUIDANCE OF SACCADIC EYE MOVEMENTS IN MONKEY. Charles W. Mohler and Robert H. Wurtz, Lab of Neurobiology, NIMH, Bethesda, Md. 20014

We have made striate cortex and combined cortical-collicular lesions which demonstrate that both structures can provide visual guidance information to oculomotor centers. Rhesus monkeys were trained to make visually guided saccades between a fixation point and targets 15' of arc in diameter. A saccade that missed the target by more than 2° horizontally or 3° vertically as measured by EOGs was arbitrarily called an error. To measure visual function independently of eye movements, each monkey was also trained in a perimetry task, i.e., to detect a 200 msec spot of light at different points in his visual field while continuing to fixate. Following lesion of striate cortex there was a dramatic increase in errors of both saccadic accuracy and visual detection in a restricted part of the visual field. However, by 6 weeks post lesion, saccadic accuracy and visual detection deficits had largely disappeared, but a slight increase in the standard deviation of the saccades remained. We then lesioned that portion of ipsilateral colliculus relating to the same visual field area affected by the cortical lesion. The collicular lesion resulted in errors of saccadic accuracy and visual detection that were confined to the portion of the visual field which had been affected previously by the cortical lesion no recovery occurred within 3 months after the collicular lesion. There were no saccadic accuracy or visual detection errors in the part of the visual field presumably affected by only the colliculus lesion. Our experiments show that 1) removal of striate cortex and superior colliculus eliminates the visual information necessary for accurate guidance of saccades, 2) either striate cortex or superior colliculus can provide visual guidance for saccades, and 3) the deficit following either cortical or combined lesions is primarily visual rather than oculomotor.

469 THE FREQUENCY OF HUMAN POSTURAL SWAY. A. Willem Monster and H. Chan*. Temple University Health Scs. Cntr., Phila., 19141

Recordings were made of A/P sway in normal adults during quiet standing with eyes closed (center of pressure on both feet; knee, hip and trunk position; ankle flexor-extensor muscle activity; and acceleration of the body's center of mass). The frequency spectrum for A/P sway shows oscillations to be concentrated on the low frequency side of a band extending from .1 to 1.0 Hz. The sway time course is nonstationary and nonperiodic. Oscillations around the ankle joint have a peak-to-peak amplitude of roughly one degree. The oscillation frequency increases and sway becomes more periodic when the supporting surface is either slanted or the body inclined relative to the vertical. The muscle force required to stabilize the body in a leaning position, decreases muscle extensibility. Passive resistance can then make up as much as one fourth of the total resistance to stretch. The rise in motoneuron pool excitability simultaneously lowers the threshold for compensatory reflexes. At 3 to 4 degrees forward, the predominant frequency has shifted from .2 to .5 Hz, indicating an effective 3-fold increase in the stiffness of the system; larger forward angles shift the center of pressure so far forward as to cause the heel to lift. However, in the erect position, passive resistance and compensatory reflexes are less able to counteract the disequilibrium moments resulting from spontaneous body-mass movements. There is, therefore, a nonlinear behaviour with muscle force adjustments depending on the characteristics of various reflex loops. This causes the wide spread in the sway frequency spectrum. (Supported by RT-8/R 237, Social and Rehab. Services.)

470 FORMATION OF MYELIN IN THE OPTIC NERVE AND TRACT OF NORMAL AND DARK REARED CATS. Claire L. Moore*, Ronald E. Kalil* and Whitman A. Richards Dept. of Psychology, M.I.T., Camb., Ma. and Dept. of Anatomy, Univ. of Wisconsin, Madison, Wi.

The postnatal development of myelin in the optic nerve and tract of normal and dark reared cats has been studied quantitatively with light and electron microscopy. In the newborn cat few myelinated fibers (3% of the population) are seen in the optic tract. Until the end of the second postnatal week, the total number of myelinated axons in the tract remains low (23%). At this time, however, there is an explosive increase in the rate of myelination and by the end of the third postnatal week 67% of the optic tract axons have acquired a myelin sheath. Thereafter, the number of myelinated axons increases gradually, reaching adult levels (100%) at 12 weeks. Between 12 weeks and adulthood the average myelin thickness for a given axon size doubles. During this period the distribution of axon diameters also broadens to include more large fibers, although the peak of the distribution remains unchanged at approximately 1μ. Curiously, the peak diameter of the unmyelinated fiber distribution also remains relatively invariant with age at 0.5μ until myelination is completed. At one and two weeks postnatal the percent of myelinated fibers in the optic nerve is greater than in the tract indicating that myelination proceeds in a retinofugal direction. Dark rearing from birth appears to have no significant effect on the growth of optic tract fibers or their myelination. (Supported by NIH EY-0115, EY-00742 and by the Teagle Foundation.)

471 EFFECTS OF N,N-DIMETHYLTRYPTAMINE (DMT) ALONE AND AFTER PRETREATMENT WITH METHIOTHEPIN, CHLORPROMAZINE OR HALOPERIDOL ON EVOKED POTENTIALS IN THE VISUAL SYSTEM OF THE CAT. R.H. Moore*, K. Hatada*, and E.F. Domino, Lafayette Clinic, Detroit MI 48207 and Univ. of Mich, Ann Arbor MI 48104.

The purpose of this investigation was to study the effects of DMT on electrically evoked potentials in the visual system. Stimulating electrodes were placed stereotaxically in the optic chiasm (OC) and optic radiation (OR) of ketamine-chloralose anesthetized, gallamine paralyzed artificially respired cats. A 2M-NaCl glass recording microelectrode was inserted into the lateral geniculate nucleus (LGN) and a surface recording electrode was placed on the visual cortex. DMT was given i.v. in doses from 10 μg/kg to 3.2 mg/kg. Each dose of DMT was given following complete recovery from the previous one. A significant decrease in the amplitude of the evoked potential produced by OC stimulation was observed with 32 μg/kg of DMT. The LGN postsynaptic potential was completely abolished with 1 mg/kg. The potentials produced by stimulation of the OR which antidromically excites the LGN and orthodromically excites the visual cortex were not altered until 3.2 mg/kg of DMT was given and then only slightly. Pretreatment with methiothepin (1 mg/kg i.v.) antagonized the effects of DMT. Now 1 mg/kg of DMT was required to significantly reduce the postsynaptic LGN potential and 3.2 mg/kg to abolish it. Methiothepin shifted the DMT dose effect curve to the right. In contrast, chlorpromazine (CPZ , 1 mg/kg i.v.) or haloperidol (HPD, 1 mg/kg i.v.) potentiated the effect of DMT. Complete cessation of the postsynaptic LGN potential occurred with 320 μg/kg of DMT in animals pretreated with either CPZ or HPD. These drugs shifted the DMT dose effect curve to the left. The results indicate 1) DMT acts before the cell bodies of LGN neurons, 2) DMT does not significantly block geniculo-cortical transmission, 3) methiothepin antagonizes the effects of DMT while 4) CPZ and HPD in the doses used potentiate the effects of DMT on LGN transmission.

472 TROPHIC EFFECTS OF DEAFFERENTATION ON SYNAPTIC ENDINGS OF GOLGI TYPE II CELLS IN THE MEDIAL GENICULATE BODY OF CATS. D. Kent Morest, Dept. Anat., Harvard Med. Sch., Boston, 02115.

Synaptic structure in the ventral nucleus of the medial geniculate body changes after lesions of the corticogeniculate (CT) and colliculogeniculate (CL) tracts. Small CT endings, synapsing on somata and proximal dendrites of Golgi II cells (local interneurons), normally contain spherical and flat vesicles. Two days after ablation of the ipsilateral auditory cortex these endings enlarge and have bigger, entirely spherical vesicles. A few days later CT endings degenerate. Small, medium, and large CL endings resemble CT endings in vesicular and membrane morphology but lack flat vesicles and synapse on proximal dendrites of thalamocortical cells and distal dendrites of Golgi II cells. By 2-4 days after ablation of ipsilateral posterior colliculus CL endings show changes like those of degenerating CT endings. By 4-6 days many CL endings shrink and darken; by 6-8 days most disappear. In contrast to axonal endings, large dendritic endings of Golgi II cells with big pleomorphic vesicles synapse on thalamocortical dendrites and receive CL and other endings of noncortical origin. Four days after ipsilateral collicular ablation many dendritic endings enlarge, form filopodia, and fill up with smooth endoplasmic reticulum and vesicles: they look like growth cones. By 6-8 days these endings regain normal appearances. Such trophic changes in Golgi II dendritic endings occur in normal adult cats at a low rate. This rate is greatly accelerated by partial deafferentation. If these dendritic endings are growing, they may form new synapses, but they always maintain the same pattern of synaptic relations with thalamocortical cell dendrites and axonal endings of noncortical origin in both normal and deafferentated cases. (Supported by USPHS grants 1 R01 NS06115 and 1 K04 NS42538)

473 PHOSPHORYLATION OF BRAIN NUCLEAR PROTEIN IN GOLDFISH AFTER BEHAVIORAL TRAINING. L. Morioka*[1], V. G. Allfrey*[2] and J. L. Sirlin[1]. [1]Cornell Univ. Med. Coll. and [2]Rockefeller Univ., New York, N.Y. 10021.

Total phenol-soluble acidic proteins were extracted from purified saline-washed nuclei (Teng et al., J. Biol. Chem. 246:3597,1971) obtained from whole brain. Uptake of ^{32}P-phosphate into these proteins increases linearly during 90 min after i.c. administration. The isotope was given for 40 min to fish (a) trained in a new swimming skill (T) (Kaplan et al., Brain Res. 56:239,1973) and (b) exercised in a whirlpool (W) both for 4 hr, as well as (c) passive controls (C). By that time ^{32}P is distributed uniformly to cell protein in telencephalon, optic lobes, cerebellum and vagal lobes-medulla of all T, W and C. SDS-polyacrylamide gel electrophoresis showed increased phosphorylation (cpm/slice) in acidic proteins of intermediate molecular weight (3-7 x 10^4 daltons) in T compared with W or C. By contrast, electrophoresis of total histones revealed no significant differences in phosphorylation among T, W and C. Studies in other systems have indicated a correlation between phosphorylation of acidic proteins and genome derepression. Preliminary data are that cyclic AMP administered i.c. at a dose which results in facilitation of behavioral performance (Dyer et al., Abs. Soc. Neurosci. Third Ann. Meet. p270,1973) increases phosphorylation of some acidic protein fractions. Effects of cyclic GMP at doses which inhibit performance are under study. (Supported by USPHS 5S01 RR05396)

474 MIDBRAIN RAPHE NEURONS: SENSITIVITY TO CORTICOSTEROIDS. Sarah S. Mosko* and Barry L. Jacobs (SPON: C. G. GROSS). Dept. Psychol., Princeton Univ., Princeton, N.J. 08540

The sensitivity of single units in the midbrain raphe to elevations in circulating levels of corticosterone and hydrocortisone was examined in intact and adrenalectomized adult male rats under chloral hydrate anaesthesia. Intravenous administration of 10 µg or 1-5 mg corticosterone to intact rats failed to induce consistent changes in the spontaneous activity of raphe neurons. Approximately one-third of the units tested did not respond to this hormone. Of those which did respond, most were depressed by 10 µg of corticosterone, while the predominant response to higher dosages was an increase in discharge rate. In addition, response magnitudes were greater to the 1-5 mg dosages: the mean reduction in discharge rate was 24% for 10 µg, and the mean increase in discharge rate was 76% for 1-5 mg corticosterone. The majority of raphe neurons (55%) were unaffected by the administration of hydrocortisone (5.25 mg). No consistent direction of response was observed among those neurons whose rates of discharge were altered by hydrocortisone, and the magnitude of such responses were typically small (less than 30%). Similar results were obtained when corticosterone and hydrocortisone were administered to adrenalectomized rats. We conclude that neuronal activity of the midbrain raphe nuclei is neither dramatically nor homogeneously affected by these corticoids.

475 DIFFERENTIAL PROJECTIONS OF TWO SECTORS OF THE INFEROTEMPORAL CORTEX IN THE RHESUS MONKEY. Mark Moss* (SPON: H. Mahut). Psychology Dept., Northeastern Univ., Boston, Mass. 02115.

Behavioral studies with monkeys demonstrated that while the posterior inferotemporal cortex (PIT) participates mainly in visual perceptual processes, the anterior inferotemporal cortex (AIT) is more specifically involved in visual learning. In addition, the results of my past behavioral investigations indicate that anterior but not posterior inferotemporal lesions result in impairments similar to those seen after entorhinal or hippocampal ablations. Such dissociation of effect after selective removals within the inferotemporal cortex could be understood if only the anterior sector had close anatomic connections with the hippocampus. Therefore, selective ablations were made in either the anterior or the posterior inferotemporal cortex in the rhesus macaque and the resulting terminal degeneration was charted using the Fink-Heimer silver impregnation technique. The findings showed that AIT sends projections to the lateral portion of entorhinal cortex, limited to the banks of the rhinal sulcus and to the lateral and ventral portions of the frontal lobe. The PIT, however, has projections to the prefrontal cortex, concentrated in the upper bank of the lower limb of the arcuate sulcus. Thus, the results provide some anatomic basis for the common behavioral effects seen after ablations of either the anterior inferotemporal cortex or the hippocampus.

476 ASPECTS OF THE DEVELOPMENT OF AFFERENT PROJECTIONS TO THE OLFACTORY CORTEX. G. F. Moxley* and J. L. Price. Dept. Anat., Washington University Sch. Med., St. Louis, Mo. 63110

The pattern of termination of fibers from the olfactory bulb to the prepiriform cortex in neonatal rats has been studied in autoradiographic experiments with injections of labeled amino acids into the olfactory bulb. In 1- and 2-day-old rats the laminar pattern of termination of bulbar fibers in the outer part of layer I (IA) of the cortex which is seen in the adult is already established; however, the proportion of layer I occupied by fibers from the olfactory bulb is significantly greater in neonatal than in adult rats. In 6-day-old rats, the laminar patterns are intermediate between those of the adult and the newborn. In another series of experiments, one olfactory bulb was ablated, either at birth or at 2 months of age; 2-3 months later injections were made into the prepiriform cortex, and the animals prepared for autoradiography. In the animals with olfactory bulb ablation at 2 months, there is obvious gliosis in the lateral olfactory tract, and in the outer part of layer I, and layer I as a whole is markedly shrunken as compared with the contralateral side. Conversely, in animals with neonatal ablations, layer I is within 10% of its normal thickness. The labeled axons from adjoining areas of the prepiriform cortex, which are normally restricted to the deep part of layer I (IB), extend out to the pial surface, suggesting that in these experiments the cortical axons have come to occupy dendritic segments normally reserved for fibers from the olfactory bulb. (Supported by N.I.H. grant No. NS 09518-04.)

477 CONTROL OF SINGLE FORELIMB MUSCLES BY INPUT-OUTPUT LINKAGES IN MOTOR CORTEX. John T. Murphy, Yiu-chi Wong* and Hon C. Kwan*. Dept. Physiol., Univ. of Toronto, Toronto, Ontario, Canada M5S 1A8.

Primary endings of muscle spindles were selectively activated by low amplitude passive displacements of single forelimb muscles controlling flexion and extension about the wrist in regionally anesthetized, paralyzed cats. Responsive neurons were identified in contralateral pericruciate cortex. For a single muscle, two spatially discrete aggregates of such neurons were found: the first was located in the peri-dimple region of the posterior cruciate gyrus and the second in the lateral cruciate gyrus. The form of each aggregate was roughly cylindrical, with diameters of 0.5-1.0 mm. The latency of the responses was short (11 msec), and identical for each set. When transmission through peri-dimple cortex was blocked by local cooling, the response in the lateral cruciate column was not significantly changed as a result. Thus the pathway from muscle spindle to the lateral cruciate gyrus is not dependent on the integrity of peri-dimple cortex. The aggregate in lateral cruciate gyrus was further investigated by cytoarchitectonic studies of the responsive region identified by electrolytic marking. On the basis of a concentration of pyramidal neurons in layer V and the paucity of neurons in layer IV, this region was identified as belonging to the 4γ area. Output characteristics of the column were studied by application of intracortical microstimulation after reversal of paralysis. Current pulses of low intensity (20 μA) were delivered to the region identified by physiological criteria as being the central field of neurons in area 4γ responsive to afferent input from a single muscle. These experiments showed a selective contraction of the same muscle from which the input arose. The results provide a possible mechanism for rapid adjustments in cortical output in response to unanticipated loads or sudden changes in load. Supported by the MRC of Canada and the Atkinson Foundation.

478 THE CONSEQUENCES OF INTRAFUSAL-EXTRAFUSAL CO-ACTIVATION IN AMPHIBIAN MUSCLES. K.S.K. Murthy & A. Taylor * . Depts. of Surg. and Physiol., Coll. of Med., Univ. Arizona, Tucson, Arizona 85724

The independent and dual fusimotor system found in mammals presumably helps to confer flexibility on the motor control system. By contrast, in amphibia intrafusal innervation is by branches of the motor axons supplying extrafusal muscle. We have studied the functional consequences of this arrangement in frogs and toads by recording the discharge of spindle afferents during active contraction of the main muscle caused by ventral root stimulation. The parallel intrafusal activation helps to prevent spindle silencing during active shortening. It also produces an unexpectedly large extra discharge at the onset of contraction and during relaxation. If the spindles in amphibia have excitatory synapses on homonymous motoneurones, this represents a case of positive feedback. However, the dynamics of the spindle behaviour revealed in this study restrict the positive feedback effectively to the early part of the contraction. This provides for a speeding up of the contraction while still preserving stability. The conspicuous sensory discharge at the end of active contraction might be expected reflexly to prolong contraction. However, this probably does not happen because of withdrawal of other sources of excitation of the motor neurones.

479 MARIJUANA EXTRACT AND CANNABIDIOL DIFFERENTIALLY AFFECT OPERANT PERFORMANCE AS A FUNCTION OF DEPRIVATION. Richard E.Musty, Richard Sands* and Elisaldo A.Carlini*. Dept. Psychobiol., Escola Paulista de Medicina, São Paulo, Brazil

Performance on operant tasks as a function of duration of deprivation produce an inverted U curve known as the activation performance curve (Psychol.Rev. 66: 367, 1959). Delta-9-tetrahydrocannabinol produces depression of performance on operant tasks and it is possible that this depression reflects a shift in the activation performance curve. Rats were tested on a variable-interval (VI) operant task at 12, 24, 48, 72 and 96 hrs of food deprivation and were treated with marijuana extract distillate (MED), at 7.5 and 11.25 mg/kg, cannabidiol (CBD), at 15 mg/kg, or combinations: 7.5 mg/kg MED + 15 mg/kg CBD, or 11.25 mg/kg MED + 15 mg/kg CBD. VI performance was depressed by MED alone, and was greatest at low levels of deprivation, but produced no change in peak performance. Performance was not depressed by CBD, but peak performance was shifted upward. Combinations of CBD and MED produced potentiation of depression which was greatest at low and high levels of deprivation. It was concluded that MED depresses the activation performance curve and does not shift it, that CBD shifts it, and CBD potentiates the depression produced by MED.

480 DOPAMINE UPTAKE IN THE SOMATIC CELL HYBRID LINE NX31. Paul R. Myers* and William G. Shain* (SPON: D.O. Carpenter). Dept. of Neurobiol., Armed Forces Radiobiology Research Institute, Bethesda, Md. 20014.

The uptake and metabolism of the catecholamine dopamine has been investigated *in vitro* using the cell line NX31. NX31 is a clone isolated from a hybridization between N18TG2 neuroblastoma and 13-day-old mouse sympathetic neurons. This hybrid has been found to possess a number of characteristics usually assigned to adrenergic neurons, to include dopamine transport. The uptake system has a saturable component at low dopamine concentrations and a non-saturable component seen at high dopamine incubation concentrations. The apparent K_m for the saturable component was 3-5 x 10^{-5}M, with a V_{max} of 6 x 10^{-7} mol/g/min. The non-saturable component was linear through 5mM dopamine. The high affinity transport component was sensitive to temperature with a Q_{10} of 4.7 between 25°C and 37°C. Furthermore, results from experiments with a number of pharmaceuticals showed that benztropine, d-amphetamine sulphate, and reserpine are potent uptake inhibitors of the high affinity component. Results from metabolic studies have shown that monoamine oxidase is the only catabolic enzyme present with activity. No catechol-O-methyl transferase activity was detected. These results indicate that cells in culture may display neurotransmitter uptake systems with different kinetic properties than those found in differentiated nervous systems. NX31 showed a lower affinity for transport of dopamine and required higher dopamine concentrations for saturation. In addition, this cell line has a non-saturable dopamine accumulation. In contrast to this, the saturable component was sensitive to temperature and various drugs which are known to inhibit dopamine uptake *in vivo*. Despite these dissimilarities, a homogeneous cell population *in culture* lends itself to further investigations of neurotransmitter membrane transport.

481 CHEMICAL SENSITIVITY OF THE DORSAL SPINOCEREBELLAR TRACT NEURONS IN RELATION TO VARIOUS SENSORY INPUTS. N.R. Myslinski, M. Randic, and M.E. Ledgere*. Dept. Biochem. Pharm., Tufts Univ. Sch. Med., Boston, 02111.

Using a microiontophoretic method in conjunction with dye-marking of cells we have studied the chemical sensitivity of the cat dorsal spinocerebellar tract (DSCT) neurones to various putative neurotransmitters (glutamic, aspartic and gamma-aminobutyric acids, glycine, acetylcholine and monoamines) in relation to their sensory inputs from muscle, cutaneous and joint receptors. Irrespective of the type of excitatory sensory input, a majority of DSCT neurones were excited by L-glutamic and L-aspartic acids, L-glutamate being somewhat more powerful. In several cells, both L-glutamic acid diethylester and L-methionine-DL-sulphoximine blocked glutamate and aspartate-induced excitations, while only depression of synaptically evoked neuronal firing was observed. The latter was particularly evident in the DSCT cells receiving cutaneous inputs. In some cells, 1,2-dimethoxyaporphine potentiated glutamate action. GABA and glycine depressed the firing of DSCT cells whether spontaneous or evoked by adequate stimulation of various sensory receptors. The depressant effect of GABA was specifically blocked by bicuculline, and that of glycine by strychnine. Acetylcholine (ACh) excited more than half of all DSCT cells tested, being somewhat more effective in the cells receiving inputs from muscle receptors and pressure receptors located in the foot pads. In some DSCT cells atropine blocked ACh-induced excitation. Norepinephrine excited a number of DSCT cells receiving inputs from muscle receptors, while depressant effects were predominant in the cells receiving afferent inputs from hair receptors. In confirmation of previous findings, the DSCT cells receiving muscle input were found to be always within the Clarke's column, however, the cells with input from hair receptors were located outside the column.(Supported by NIH grant NS11174-01 and NSF grant 6B37864).

482 FAST AXOPLASMIC TRANSPORT IN RATS: A MEASUREMENT OF RATE AS A FUNCTION OF AGE. I. Nadelhaft and F. Ronco*. VA Hospital, Pgh., Pa. 15240 and Dept. Neurological Surgery, Sch. Med., Univ. Pgh., Pa. 15261

The speed of fast axoplasmic transport was measured in Sprague-Dawley, male rats of three age categories: pre-pubescent (27-39 d), young (91-129 d), adult (262-334 d). Tritiated leucine was hydraulically injected through a fine glass micropipet into the fifth lumbar dorsal root ganglion. The ganglion and sciatic nerve were removed several hours after the injection, cut into 2 mm pieces, and prepared for scintillation counting. The downflow activity profile is typical for this type of experiment showing a peak at the ganglion followed by a fairly flat portion extending to a front which then slopes down to the background level. The distance between the peak and the front is linearly dependent upon the time between injection and sacrifice. The results of the measurements made thus far are as follows:
pre-pubescent (8): 314 ± 14, young (10): 373 ± 26, adult (8): 371 ± 19.
The numbers in parentheses are the number of animals; the rates are measured in units of mm/day. The difference between young and adult are statistically insignificant whereas the difference between pre-pubescent and young (or adult) are significant.

483 REPRESENTATION OF THE CORNEA IN THE BRAINSTEM OF THE RAT. S. Nagano*, J.A. Myers* and R.D. Hall. Research Laboratory of Electronics, M.I.T., Cambridge, Mass. 02139.

Most of the units that responded to tactile or electrical stimulation of the cornea were found in a region on the ventromedial border of the trigeminal nuclei that extends from the principal sensory nucleus to nucleus caudalis of the spinal complex. The region includes the reticular formation (RF) adjacent to the trigeminal nuclei at all rostrocaudal levels. One class of units responded to light punctate tactile stimuli and relatively low electric currents; another class of units required greater pressures and higher currents. The corneal receptive fields of low-thresh old units were generally larger than those of high-threshold units. Units in both classes had receptive fields that included other orbital or periorbital tissues. Most of the units in the ventromedial trigeminal border region (VMTBR) had minimum spike discharge latencies for electrical stimulation of 5-12 msec, the distribution being bimodal. Approximately 70% of the low-threshold units had short minimum latencies (5-8 msec); long (9-12msec) and short minimum latencies were distributed about evenly among high-threshold units. None of the response properties noted above served to distinguish units in VMTBR that were clearly in the trigeminal nuclei from those that were clearly in RF. A few units that responded to stimulation of the cornea were widely scattered in RF, sufficiently distant from the reticular units in VMTBR to be considered a different population. Mean minimum response latencies of the scattered RF units were longer than those of VMTBR units, but the distributions overlapped considerably. Only a few scattered RF units were spontaneously active. About 10% of the units tested responded to stimulation of the contralateral cornea. (Supported by NIH Grant 5 P01 GM14940-07)

484 STUDIES IN RAT AND RABBIT OF THE TISSUE DISTRIBUTION OF INTRAPERITONEALLY ADMINISTERED N:N-DIMETHYLATED TRYPTAMINES. N. Narasimhachari, D. A. Callison* and R.-L. Lin*. Galesburg State Research Hospital, Galesburg, Illinois 61401

N:N-Dimethyltryptamine (DMT), 5-methoxy-N:N-dimethyltryptamine (5-MeODMT) and bufotenin were administered ip at dose levels of 2 and 4 mg to untreated rats and rabbits and to animals pretreated with tranylcypromine (Parnate), a monoamine oxidase inhibitor. Levels of the compounds in whole brain and discrete brain areas and in blood, heart, lung, liver and kidney were determined at different time intervals after injection. The compounds were identified by two-dimensional thin-layer and gas liquid chromatography, and by gas chromatography-mass spectrometry (GC-MS) and were quantitated by mass fragmentography during GC-MS. The results obtained by this selective and sensitive methodology will be presented and their significance in relation to our studies on the role of these compounds in schizophrenia will be discussed.

DMT and 5-MeODMT were detected in whole brain and in discrete regions of the brain within minutes after their injection and remained for more than 4 hr. The levels were higher in animals pretreated with Parnate. DMT and 5-MeODMT were identified in liver, lung, kidney and heart at intervals varying from 15 min to 4 hr, but were not found in the bloodstream after 30 min. Bufotenin did not pass the blood-brain barrier and was found in the lung and liver as a conjugate (glucuronide). The control animals, which received physiological saline, did not show DMT or DMT-like substances in brain or in any other tissue examined (Heller et al. 1973, Life Sci. 13: 313).

485 DEGENERATION IN THE NUCLEUS OF ORIGIN OF PREGANGLIONIC FIBERS TO THE CILIARY GANGLION FOLLOWING CILIARY GANGLIONECTOMY IN THE CHICK. C. H. Narayanan. Dept. Anat., LSU Med. Sch., New Orleans, La. 70119.

The precise central source of preganglionic fibers to the avian ciliary ganglion has not been clearly established. It was therefore decided to examine the problem with special regard to the location of preganglionic neurons by retrograde changes following ciliary ganglionectomy. The surgical removal of the ciliary ganglion was performed unilaterally in day old chicks. Survival time extended from 3 to 9 days following surgery. Postmortem dissections of both orbits were carried out to check: a) the effectiveness of the operation, and b) the preservation of orbital tissues in order to assess the degenerative changes in the oculomotor complex. In the animals sacrificed 3 days after surgery, ciliary ganglionectomy resulted in a severe loss of cells in the medial accessory nucleus; in the lateral accessory nucleus, a small number of intact neurons were recognizable. With longer postoperative survival periods (6 to 9 days after surgery) both divisions of the accessory oculomotor nucleus showed complete cellular degeneration. The other nuclei of the oculomotor complex were unaffected by the operation. These observations provide unequivocal evidence that the accessory oculomotor nucleus might indeed be the avian homologue of the Edinger-Westhphal nucleus.

486 FUNCTION OF ANKLE REFLEXES IN HUMAN POSTURE CONTROL. Lewis M. Nashner, Lab. of Neurophysiology, Good Samaritan Hospital & Medical Center, Portland, Oregon.

Two components in the torque response of the ankle joints to rotation contribute to stabilization of antero-posterior sway in humans. The inherent stiffness of the ankle joint muscles while at fixed levels of activation, the "muscle response," was sufficient to provide asymptotic postural stability within all subjects so long as the supporting base was rigid and angular deviations were small ($\leq$ .10-0.15°) i.e., the torque resisting rotation during the first 50 msec was at least equal in magnitude to the destabilizing torque due to gravitational forces which is also proportional to the rotation angle of sway.

Reflex responses of monosynaptic latency were seldom seen, and never did they contribute a significant change in ankle torque. The excitability of long-latency, active reflex responses, 110-130 msec, varied among subjects and according to the specific task. In some subjects this component produced significant torque only when functionally productive to postural stability, then disappeared within 4-6 trials after transition to a task in which it was either counter-productive, of no use, or hyperactive. In other subjects, this component was never seen. All of the observed task-reflex response combinations, however, were "acceptable" in that with each, a stable posture was maintained. In conclusion, the function of the long-latency reflex is revealed, but only after it is first viewed as one in a number of optional modes of adaptive postural control.

487 HYPERTENSION OF ADRENOMEDULLARY ORIGIN FROM LESION OF ANTERIOR HYPOTHALAMUS IN RAT. Marc A. Nathan and Donald J. Reis. Dept. Neurol., Lab. Neurobiology, Cornell U. Med. Coll., New York, 10021

Bilateral electrolytic lesions of the anteromedial hypothalamus in rats resulted in the development within 2 hours of arterial hypertension (mean pressure of 161mm Hg), and, as reported by Maire & Patton (Am. J. Physiol. 178:315, 1954), increased motor activity and hyperthermia, leading in many instances to death sometimes with pulmonary edema. Hypertension developed with similar latency and magnitude in paralyzed, ventilated rats indicating its independence of increased motor activity. The hypertension is also independent of elevated temperature, since animals made hyperthermic by warming remained normotensive. The hypertension was associated with a 50% reduction in cardiac output and a 160% increase in peripheral resistance and it was blocked by phentolamine. Bilateral adrenalectomy, adrenal demedullation or adrenal denervation performed prior to lesions prevented the development of hypertension but not hyperactivity. We conclude that hypertension after anterior hypothalamic lesions is due to a massive release of adrenomedullary catecholamines. The findings suggest that structures lying in or passing through the anterior hypothalamus exert a selective tonic inhibition of the adrenal medulla. (Supported by NIH Grants NS3346, NS0486 and NASA NGR-33-010-179).

488 EFFECTS OF ADRENAL GLUCOCORTICOIDS ON SYNAPTOSOMAL UPTAKE OF L-TRYPTOPHAN. L. Neckers* and P. Y. Sze (SPON: E. Thoman). Dept. of Biobehavioral Sciences, University of Connecticut, Storrs, Connecticut 06268

In a medium containing 5 X 10^{-2} M Tris-HCl, pH 7.3, 0.2 M NaCl, 5 X 10^{-3} M α-propyldopacetamide, and ^{3}H-L-tryptophan, two uptake systems for tryptophan could be identified kinetically in synaptosomes prepared from mouse brain and incubated at 30°C. Km was estimated as 6 X 10^{-5} M for the low affinity system (LAS) and 3 X 10^{-7} M for the high affinity system (HAS). A significant increase in Vmax with no change in Km was found in HAS by the addition of 10^{-6} M hydrocortisone acetate or 10^{-5} M corticosterone or treatment of the mice with either hormone in vivo (20 mg/kg, i.p.). HAS in synaptosomes from adrenalectomized mice showed a decrease in Vmax with no change in Km. At no time was either Vmax or Km of LAS found changed. Synaptosomes loaded with ^{3}H-L-tryptophan showed a significant reduction in the rate of exit of the label when glucocorticoids were present. The apparent increase in synaptosomal tryptophan uptake by glucocorticoids may be in part due to an action blocking the efflux of the amino acid. (Supported by USPHS grants AA 00297 and RR 00602).

489 THE DISTRIBUTION, ACTIVITY, AND FUNCTION OF CILIA IN THE FROG BRAIN. D. J. Nelson*, E. M. Wright*, and J. S. Frank*. (SPON: R. K. Orkand) Dept. Physiol., Sch. Med., UCLA, Los Angeles, 90024.

The distribution, activity and function of the cilia in the brain was studied using in vitro preparations of the frog choroid plexuses and ependyma. Scanning electron microscopy revealed that 20-40 cilia, about 20μ long, project from the cells of the choroidal epithelium and ependyma into the ventricular system of the brain. These cilia beat at a constant frequency which ranged from 5-20 cps. Ciliary activity was enhanced by ATP, c-AMP, theophylline, and acetyl choline. Enhancement of activity varied as a function of the basal activity level of individual preparations but never increased beyond a maximum of 30 cps. Ciliary activity could be predictably inhibited by DNP, IAA, Ni^{++}, La^{+++}, and Co^{++}. Ciliary motion produced a flow of csf over the surface of the cells lining the ventricles, and in the choroid plexus this flow reduced the effective thickness of the unstirred layer adjacent to the epithelium by about 100μ. From measured dimensions of the frog brain, it is estimated that greater than 75% of the csf within the ventricles is mixed as a direct result of ciliary activity. The rate of ciliary activity is shown to effect not only the circulation of the csf but also the exchange of solutes between the csf and the extracellular fluid compartment of the brain across the ependymal cell layer. (Supported by NIH grant USPHS-NSO9666 and in part by U.S. Public Health Service Training Grant 5 TO1 GMOO448-13.)

490 MEMBRANE ELECTRICAL PROPERTIES ASSOCIATED WITH MORPHOGENESIS IN L CELLS: RELATIONSHIP BETWEEN DIVALENT CATIONS, CYCLIC NUCLEOTIDES, AND PROSTAGLANDIN E_1 (PGE_1). P. Nelson, M. Henkart and B. Ransom*. NICHD, NIH, Bethesda, Maryland 20014.

L cells, a continuous cell line probably of fibroblast origin, undergo morphologic changes in response to a number of agents and are technically favorable for combined morphologic and electrophysiological study. We have measured membrane potential (E_M) and conductance (G_M) with intracellular electrodes in X-irradiated, non-dividing L cells after treatment with reagents that alter cell shape. Untreated cells are capable of undergoing a characteristic hyperpolarizing activation (HA) spontaneously or in response to certain stimuli. During HA the membrane potential and conductance increase. Intracellular injection of Ca mimicks the changes in membrane properties during HA. These observations suggest that a response elicited at the surface membrane may involve an increase in intracellular Ca ion concentration. Treatment with dibutyryl cyclic AMP (db cAMP) for 3-4 hrs produces similar increases in E_M and G_M accompanying an increase in cell process formation. Dibutyryl cyclic GMP, on the other hand, produces a decrease in G_M and some rounding up of the cells. A23187, a drug which acts as a Ca ionophore in some systems does not produce a change in membrane properties similar to the Ca injection, and, in fact, blocks the HA. The HA response is also blocked by Co^{++}. PGE_1 elicits a marked morphologic change without changing the surface membrane properties. We are attempting to correlate these results with time lapse and fine structural data including that presented in the following paper.

491 ULTRASTRUCTURE OF NEURONS IN TURTLE BRAINSTEM RETICULAR FORMATION. Donald B. Newman* (SPON: R. Schmidt). Dept. Anat., Stritch Sch. Med., and Lab. Comparative Neurology, Loyola Univ., Maywood, Ill. 60153.

Large, medium, and small neurons were previously identified in the brainstem reticular formation (RF) of Natrix, Constrictor, Pseudemys, Caiman, and Iguana using Nissl and Golgi-Cox techniques. Since no ultrastructural studies have been done on the reptilian RF, specimens of Pseudemys were double perfused with phosphate-buffered paraformaldehyde-glutaraldehyde mixtures, post-fixed with osmium tetroxide, and embedded in Epon for electron microscopy. Three distinct neuronal types were observed which closely resembled their counterparts observed with the light microscope. Large neurons, with angular perikarya 60 μ in length containing dense clumps of rough endoplasmic reticulum (Nissl substance), golgi apparatus, lysosomes, and tubular mitochondria, bear massive (20 μ wide) primary dendrites containing numerous parallel neurotubules. Medium neurons with angular perikarya 30 μ in length bear slender (5 μ to 7 μ wide) primary dendrites often coursing 80 μ in one plane of section. Their cytoplasmic organelles resemble those of large neurons. The somata and primary dendrites of the large and medium neurons are covered with numerous axon terminals containing either spherical or pleomorphic vesicles. The long primary dendrites of the medium neurons have an especially extensive covering of presynaptic elements. Small neurons possess oval perikarya 15 μ in length, oval nuclei with dense homogeneous karyoplasm, and a thin rim of clear cytoplasm. They are often surrounded by oligodendrocytes. The close correlation of neuronal sizes and shapes using light and electron microscopy strengthens the impression that three distinct neuronal populations exist in the reptilian brainstem RF. (Supported by PHS Grant NS 10137)

492 EXTRACELLULAR FIELD POTENTIALS AND CHANGES IN POTASSIUM ION CONCENTRATION IN CATFISH CEREBELLUM. C. Nicholson, R. Volkind* and W. Young.* Div. of Neurobiology, Dept. of Physiology & Biophysics, University of Iowa, Iowa City 52242.

Local electrical stimulation of cerebellar surface in the catfish *Corydoras aneus* elicits laminar field potentials in the molecular layer. Comparison of these potentials with similarly evoked responses in the cerebella of other species indicates that they consist of a presynaptic parallel fiber volley and a postsynaptic Purkinje cell dendritic spike component. Repetitive stimulation (1/sec) can modify the field potential amplitude and prolonged stimulation can result in a rapid reduction and complete failure of the response. Direct measurement of extracellular K^+ with a micropipette containing an ion-selective resin (Corning 477317) reveals that extracellular K^+ increases transiently during the period of local stimulation. Prolonged stimulation can trigger large extracellular K^+ increases which continue to rise after stimulus cessation and slowly return to near-baseline levels over periods of several minutes. The latter phenomena are correlated with a negative shift in extracellular potential and can be identified as spreading depressions. Thus, electrical events in the catfish cerebellum can lead to changes in extracellular K^+, and it is hypothesized that such changes in K^+ influence the excitability of the parallel fiber-Purkinje cell system. We conclude that intrinsic modulation of extracellular K^+ may be functionally significant in the catfish cerebellum. (Supported by USPHS research grant NS-09916 from NINDS)

493 THE ANTAGONISM OF AMINO ACID RESPONSES BY CHOLINOLYTIC AGENTS IN THE ISOLATED FROG SPINAL CORD. R. A. Nicoll, Dept. of Physiol, State Univ. of New York at Buffalo 14226

It is generally believed that the convulsant properties of such drugs as strychnine and picrotoxin arise, in part, from their ability to antagonize amino acid mediated synaptic inhibition in the central nervous system. The fact that a number of cholinolytic agents also have potent excitatory effects on central neurons, suggests that these agents might also interfere with amino acid mediated transmission. Thus the effects of a number of cholinolytic agents on amino acid responses were analyzed in the isolated, hemisected frog spinal cord. The amino acid responses were recorded from the primary afferent terminals (PATs) and motoneurons (MNs) by sucrose gap technique. 20mM $MgSO_4$ was added to block indirect synaptic effects. The cholinolytic agents were tested against the following amino acids: glutamate (GLU), GABA, β-Alanine (BALA) and glycine (GLY). Curare antagonized the GABA and BALA depolarization of PATs and their hyperpolarization of MNs. This action is identical to the action of picrotoxin but 50 times weaker. Atropine selectively antagonized BALA depolarizations of PATs and the BALA and GLY hyperpolarization of MNs. This action is identical to the action of strychnine, but 50 times weaker. Nicotine also antagonized BALA and, to a small extent GABA, depolarizations of PATs, but its action was very weak. Dihydro-β-erythroidine, tetraethylammonium (TEA) and gallamine had no effect on the amino acid responses. It is suggested that the excitatory action of curare arises from its ability to antagonize GABA mediated synaptic inhibition (cf. Hill et al Nature 240: 51, 1972), while the excitatory action of atropine may be related to its ability to antagonized glycine mediated synaptic inhibition. The excitatory action of TEA and gallamine may arise from the ability of these drugs to block the delayed increase in K^+ conductance during the action potential (cf. Grinnell, J. Physiol. 210: 17, 1970.

494 ASCENDING PATHWAYS IN THE POSTERO-LATERAL FUNICULUS OF THE MONKEY SPINAL CORD. Daniel E. Nijensohn* and Frederick W. L. Kerr. Mayo Foundation, Rochester, Minnesota 55901

The organization and central connections of the ascending sensory system in the postero-lateral funiculus (P.L.F.) of the spinal cord of the Macaca mulatta were studied. Unilateral postero-lateral cordotomies were done in four adult monkeys at the C2-3 levels. The animals were perfused with phosphate buffered paraformaldehyde solution after fourteen days postoperative survival. Transverse sections of the spinal cord and brain stem were stained by the Nauta-Gygax and Fink-Heimer techniques. The selectively silver impregnated degenerated axons were microscopically charted on projected drawings of the sections. A complete transection of the P.L.F. was obtained in one animal and partial superficial lesions were made in the other monkeys. Besides the dense "en-passage" fiber degeneration found along the known pathway of the dorsal spinocerebellar tract, mostly ipsilateral terminal degeneration was seen in the medullary reticular formation and in the paleo-olivary complex. Projections were seen to the parvocellular nucleus of the medulla oblongata, to the dorsal and ventral accessory olives and a smaller contribution to the lateral cuneate nucleus. No fibers were seen in the lateral reticular nucleus. More rostral projections are under observation.

495 PROJECTION OF TOOTH PULP AFFERENTS TO THE SPINAL TRIGEMINAL COMPLEX. Samuel G. Nord and Ronald F. Young.* Departments of Neurology and Neurosurgery, Upstate Medical Center, Syracuse, NY 13210

Few cells activated by electrical stimulation of the tooth pulp have been reported in studies of the trigeminal nucleus caudalis. Yet the pulp is identified with pain and the nucleus caudalis is known to be a principal relay in the facial pain projection system. In the present experiments, unit activity was recorded from the medullae of paralyzed (Flaxedil), lightly anesthetized (Nembutal) cats during electrical stimulation of the ipsilateral maxillary and/or mandibular canine tooth pulp. Isolated pulses were delivered through concentric bipolar electrodes placed in direct contact with the pulp. Ordinarily, responses consisted of four or fewer spikes. However, occasional units responded with trains of up to 20 spikes when stimulation was well above threshold. The distribution of response latencies was wide but positively skewed, with most of the values ranging from 7 to 16 msec. Some cells could be activated only by stimulation of one of the canine teeth, but others could be excited by stimulation of either tooth. Several units also fired to electrical or to coarse mechanical stimulation of oral or peri-oral structures. In such cases, response latencies and densities were markedly different than those obtained by pulp stimulation. Pulp units were localized in histological sections by identifying electrolytic microlesions made at, or near, bulbar recording sites. All but a few of the cells were situated in a zone of the dorsolateral medulla where cell bodies of the nucleus caudalis merge with those of the lateral reticular formation. It is significant that this zone has been shown in past experiments to include a population of neurons which is responsive to painful stimulation of restricted regions of the face and buccal cavity.

496 THE IDENTIFICATION OF RELAY NEURONS IN THE DORSAL LATERAL GENICULATE NUCLEUS OF PRIMATES BY THE METHOD OF RETROGRADE TRANSPORT OF HORSERADISH PEROXIDASE. J.J.Norden*. (SPON: R.Fox). Dept. Psychology, Vanderbilt U., Nashville, TN 37202.

In order to identify neurons in the LGN projecting to striate cortex, small amounts of horseradish peroxidase were injected into area 17 of 11 owl monkeys (Aotus trivirgatus), two rhesus monkeys (Macaca mulatta), and one bushbaby (Galago senegalensis). In all three species, restricted injection sites resulted in columns of labeled cells extending through all the relay layers of the LGN. In labeled areas of the parvocellular layers in owl and rhesus monkeys, virtually all neurons contained the reaction product (94-98%), indicating a nearly complete lack of interneurons. In the magnocellular layers, the labeled areas were narrower, but again it appeared that nearly all of the neurons (up to 97%) projected to striate cortex. Interlaminar zones are narrow in the rhesus monkey and it was difficult to clearly assign neurons to these zones rather than layers. However, these zones appeared to have both labeled and unlabeled neurons. In the owl monkey, a broad interlaminar zone is found between the internal parvocellular and the internal magnocellular layers and this zone contains many neurons. Less than 60% of these interlaminar neurons were labeled, suggesting that many may be interneurons rather than relay neurons. The results suggest that in contrast to some other mammals, the primate LGN has few interneurons and these, if they exist, are almost completely confined to the interlaminar zones. (Supported by NIMH training grant MH-08107 and NSF grant GB-36779).

497 DIRECT GUSTATORY PROJECTIONS TO VENTRAL FOREBRAIN IN RATS. Ralph Norgren. The Rockefeller Univ., New York, N. Y. 10021.

Axons arising from the pontine taste area (PTA), an obligatory relay for gustatory information reaching the thalamus, also project directly into the ventral forebrain region called substantia innominata (SI) (Norgren & Leonard, JCN 150: 217, 1974). The PTA lies close to the cells of origin of ascending adrenergic axons, particularly locus coeruleus. The axons reaching SI, therefore, might represent a portion of the adrenergic system rather than the gustatory system. To test this possibility stimulating electrodes were positioned in the vicinity of SI. Another set was implanted in the thalamic taste area (TTA) under electrophysiological guidance. Tungsten microelectrodes were used to record from single units in or near PTA. Units were tested for gustatory sensitivity and antidromic activation from both TTA and SI. The criteria for antidromic driving were (1) constant latency at high frequency and near threshold stimulation, and (2) susceptibility to collision blockage. Of 25 PTA units sensitive to sapid stimuli, 11 could be antidromically driven from the ventral forebrain. Most of these (10) could also be activated antidromically from the TTA. Neurons sensitive to tongue thermal stimuli (2), or touching the hard palate (1) were also antidromically driven from SI. Cells sensitive to other trigeminal stimuli (touching vibrissae, lips, teeth, or jaw stretch), and all but one with no obvious peripheral sensitivity could not be activated through the stimulating electrodes. The data do not rule out the possibility that the forebrain projection from PTA is adrenergic, but it does establish that gustatory information reaches the ventral forebrain without intervening thalamic or cortical synapses. Supported by NIH grant NS 10150 and NSF grant GB 25001X.

498 RETINAL PROJECTIONS IN THE LONGNOSE GAR. R. Glenn Northcutt and Ann B. Butler. Dept. Zool., Univ. of Michigan, Ann Arbor, Mich. 48104 and Dept. Anat., The George Washington Univ., Wash., D.C. 20037.

Twelve juvenile specimens of Lepisosteus osseus L. underwent unilateral suction aspiration of the retina under MS222 anesthesia. After survival times of 7-60 days at 26° C, the animals were sacrificed by transcardial perfusion of normal saline followed by 10% formalin. After further fixation in 10% formalin, brains were embedded in albumin-gelatin, frozen, and sectioned at 30μ. Sections were processed with modifications of the Nauta silver impregnation method. Most fibers decussate in the optic chiasm and then course through the preoptic and rostral hypothalamic nuclei where some may terminate. Contralateral fields of degeneration in the thalamus lie in a dorsal neuropil area medial to the optic tract and in a ventral neuropil area associated with a cell plate. Terminal fields are also found in areas which correspond to nuclei in teleost fish named rotundus, corticalis, and area pretectalis. An additional terminal field is associated with a small group of cells ventral to the latter nuclei. Cells which form laminae in the optic tectum of the gar show less migration from the periventricular zone than do those in teleosts, and the laminae are less clearly defined. Fibers entering in the medial and lateral optic tracts course beneath the most superficial layer. Degeneration is present in the deep half of the superficial zone and in the superficial half of the central zone. Ipsilateral retinal fibers course in the lateral half of the optic tract, then leave the tract and course around the medial aspect of nucleus rotundus. Ipsilateral projections could not be traced beyond the region of area pretectalis. Supported by NSF Grant 40134 to RGN.

499 CAROTID SINUS BARORECEPTOR RESPONSES TO RECURRENT TRAPEZOIDAL PRESSURE PULSES. Harvey B. Nudelman and Ramachandra Srinivasan, Departments of Psychiatry and Neurobiology, The University of Texas Medical School at Houston and Texas Institute for Rehabilitation and Research, Houston, Texas 77025.

Recurrent trapezoidal pressure pulses were applied to the carotid sinus of cats while recording from single fibers. This type of input provides information about the baroreceptor's response to pressure and the rate of change of pressure. The salient features of the instantaneous frequency response of the baroreceptor were a near linear rise to a dynamic peak overshoot and an adaptive fall from the peak that has two distinct phases, an early rapid fall followed by a slow decay. The relationship between the rate of change of the pressure and the rate of change of instantaneous frequency was investigated. The slope of the linear rise could be fitted to a power function of the pressure velocity, i.e., slope = K (pressure velocity)$^{\alpha}$. The fact that α and K varied with the size of the pressure step indicates that the dynamic coupling of the sinus wall to the baroreceptor is history-dependent, i.e., it depends on the step-size and mean pressure of the recurrent pressure input. The effect is such that as the magnitude of the pressure step increases, the slope decreases.

500 INTRARETINAL MEASUREMENT OF LIGHT-INDUCED CHANGES IN EXTRACELLULAR POTASSIUM. Burks Oakley* and Daniel G. Green, Bioengineering Program and Vision Research Lab, University of Michigan, Ann Arbor, MI 48104

We have used a potassium-specific microelectrode to measure transient changes in potassium ion concentration in extracellular space, $[K^+]_e$, of the frog retina. This electrode is a modification of a previous design (Walker, Anal. Chem., 43, 89-93A, 1971). The tip of a glass micropipette is beveled to a hypodermic needle profile and is then filled with K^+ ion-exchanger solution, which forms a membrane permeable to K^+. A potential is generated across this membrane whose magnitude is proportional to the logarithm of $[K^+]_e$. The measured electrode potential is the sum of the ion-exchanger potential and the potential of the fluid outside of the tip, and is consequently a measure of both $[K^+]_e$ and any biological potentials. Our K^+-specific microelectrode typically shows a selectivity for K^+ over Na^+ of 70:1 and a response time to a step change in $[K^+]$ of <10 msec. When a K^+-specific microelectrode is advanced into the frog eyecup from the vitreal side, a normal electroretinogram (ERG) is recorded in response to a flash of light. As the electrode penetrates the retina, a much different response is recorded, having a longer time course, larger amplitude, and greater sensitivity than the intraretinal ERG b-wave. This response is attributed to a change in $[K^+]_e$, since it can be recorded at light levels which are too dim to produce a measurable ERG b-wave. The waveform of the K^+-response changes as a function of retinal depth. After advancing the electrode 80-100μ into the retina, a maximum light-induced increase in $[K^+]_e$ is recorded. However, a light-induced decrease in $[K^+]_e$ is recorded at a depth of 125-175μ. The maximum responses correspond to a change in $[K^+]_e$ of ±20%.
(Supported by NIH Grants EY00379 and GM-01289)

501 "ROUTING" OF FAST TRANSPORTED MATERIALS IN NERVE FIBERS. S. Ochs and J. Erdman*. Dept. of Physiol., Ind. Univ. Sch. Med., Indianapolis, Ind. 46202

Using the relatively long length of dorsal root fibers available in the L7 dorsal root ganglion of the larger rhesus monkey, a difference in the character of axoplasmic transport was found for the T-shaped cells of the ganglion, one branch ascending in the dorsal root, the other descending in the sciatic nerve. After injecting the L7 ganglion with ^{3}H-leucine, the labeled proteins were found to move out into the two branches at equal rates as shown by the similarity in the positions of the typical crests of fast transported activity in the dorsal root and sciatic nerve. There was, however, 3-5X more activity present in the crests in the sciatic nerves (Ochs, J. Physiol. 227: 627, 1972). This poses a problem insofar as the two branches arise from the same unipolar dorsal root ganglion cells. The difference in the amount of transported activity in the two branches may be explained by a smaller overall diameter of the fibers in the dorsal root as compared to the nerve. The smaller total cross-sectional area could thus account for the difference in the amount transported. A comparison of fiber diameters in the dorsal root and sciatic nerve was therefore made. The histograms of the nerve fiber diameters on the two sides of the ganglia and their overall cross-sectional areas were found to be closely similar. The results therefore implicate a special internal "routing" mechanism within the nerve fibers whereby certain materials can be preferentially moved out into one branch or the other. The "transport filament" hypothesis can account for these findings. The microtubules are seen in EM preparations to pass in unbranched fashion down the parent stem fiber into each nerve branch. Materials bound to the transport filament can thus be moved preferentially over one set of microtubules into one nerve branch or the other depending presumably on the destination and the differing functional roles of the components transported.

502 ROLE OF LEVER RESPONDING AND WATER REINFORCEMENT IN ALTERING CATECHOLAMINE (CA) METABOLISM. Michael W. Oglesby* and Lewis S. Seiden, Dept. of Pharmacol. & Physiol. Sci., Univ. of Chicago, Chicago, Ill.

Rats treated with alpha-methyl-tyrosine (aMT) and performing in an operant chamber with water reinforcement have lower concentrations of brain CAs than aMT-treated controls (Schoenfeld & Seiden JPET 167: 319-327, 1969). In the present experiments a yoked-control design was used to investigate the relative importance of lever-press responding and water reinforcement in altering CA metabolism. Rats were assigned to one of three control groups or one of two operant chamber groups (performing on a variable interval 30-sec. schedule of water reinforcement or yoked control). Each performing rat was paired with a yoked rat; when the performing rat received a reinforcement, water was presented to the yoked rat. On the test day rats were injected with aMT(100mg/kg) 1 hr. pre-session and killed 2-hr. later. As compared to controls, both performing and yoked rats had lower dopamine concentrations in the caudate nucleus and lower norepinephrine concentrations in the pons-medulla. Thus, specific brain regions are involved in the enhanced metabolism of CAs. In addition, the lever press response appears not to be a critical variable in producing the effect. In a second study, the yoked-control rats received no water when the dipper was activated, and only the performing animals had lower CA concentrations. This experiment demonstrates that stimuli associated with the activation of the dipper do not cause increased CA metabolism. Results from both experiments suggest that the increased metabolism of CAs in rats performing operant behavior is a function of water reinforcement.

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503 EFFECT OF BRAIN EXTRACT ON CHICK EMBRYO MUSCLE CELLS IN CULTURE. T. H. Oh* (SPON: L. Guth). Lab. of Neurochem., NINDS, NIH, Bethesda, Md. 20014.

Aqueous extracts of brain accelerate the development of acetylcholinesterase activity (AChE) of embryonic muscle fibers in vitro (Oh et al., Science 178: 1298, 1972) and retard the loss of AChE of adult fibers in vitro (Lentz, Science 171: 187, 1971). The present study further characterizes the effects of brain-spinal cord extracts on the morphological and biochemical differentiation of muscle cells grown in vitro. The brain-spinal cord extract was prepared from 13-day-old chick embryos by centrifuging a 1:1 homogenate (in Hanks' balanced salt solution) for 1 hour at 40,000 g. Dissociated thigh muscle cells taken from 13-day-old chick embryos were maintained in collagen-coated plastic dishes. The media contained salts, serum and extract of decapitated chick embryo. Mature myotubes with cross-striations developed earlier in the presence of 10% brain extract as compared to the control cultures. AChE and protein content of muscle cultures grown in the medium containing brain extract were significantly higher than those of control cultures. Addition of brain extract significantly increased C^{14} leucine incorporation into muscle protein as compared to the control cultures. The nerve extracts prepared by centrifugation for 2 hours at 100,000 g was equally effective. Boiling the extract for 3 min or heating to 60°C for 10 min abolished its ability to stimulate muscle differentiation and protein synthesis. Mature myotubes maintained in the absence of brain extract degenerated after a few weeks in vitro. Addition of the brain extract to degenerating cultures produced redifferentiation of muscle cells. The results indicate that a soluble, heat-labile neural factor is responsible for differentiation, maturation, and maintenance of muscle cells in vitro.

504 ENHANCED VERBAL PERFORMANCE FOLLOWING HUMAN THALAMIC STIMULATION. George A. Ojemann. Dept. Neurol. Surg., Univ. of Wash., Seattle 98195.

Stereotaxic operations for the treatment of dyskinesias provide an opportunity to study the effects of human lateral thalamic electrical stimulation on tests of language and memory. When the human lateral thalamus is stimulated during input of verbal information, cued recall for that information after a six second standard distraction is significantly more accurate than under nonstimulation conditions (Brain 94:225). Does this enhanced ability to retrieve verbal information after lateral thalamic stimulation during input extend to longer periods, where mechanisms of long term memory would be involved? Some dyskinetic patients show a dysnomia, a difficulty in naming objects, for 10-14 days after the thalamic lesion, especially when placed in left thalamus. It was tested in this study by the ability to name a series of achromatic slide pictures of objects with common names. Comparison between the magnitude of this dysnomia on the second postoperative day for objects with and without stimulation during input at operation was made. In an unselected series of 20 patients undergoing thalamotomy, 10 demonstrated dysnomia at testing on the second day after operation. Nine of these 10 made fewer errors on objects with stimulation at operation than would be expected from performance on objects without stimulation at operation ($T=1$, $p<.01$). Two days after operation, mean error rate for objects with stimulation at operation was 56% of that expected from performance on objects without stimulation at operation. Four days after thalamic surgery, another patient with a pre-existing dysnomia from a stroke also demonstrated fewer than expected errors on objects where thalamic stimulation had occurred at the operation. Human thalamic stimulation during input enhances the accuracy of verbally identifying this same verbal material several days later. This effect is present even with pre-existing dysnomia, and may be useful in the treatment of language disorders. Supported in part by Grant NS 04053.

505 DIVERSE AFFERENT RESPONSES FROM THE HORIZONTAL SEMICIRCULAR CANAL IN RHINOBATOS PRODUCTUS. Dennis P. O'Leary, Robert F. Dunn and Vicente Honrubia*. Depts. Surgery and Anatomy, Sch. Med., UCLA, Los Angeles, 90024.

Semicircular canal afferent responses from isolated guitarfish labyrinths were studied to determine whether specific response types derive from local anatomical regions within the crista. A linear system unit impulse response (UIR) and gain and phase spectrum were determined for each of 120 afferent fibers from a cross-correlation of the spike train response with a pseudorandom (white noise) rotational acceleration input. The UIR characteristics were indeed found to be correlated with relative position of separate parent nerve bundles which morphological studies suggest project in systematic patterns to different regions of the crista. UIR's from central nerve bundles showed an initial deflection followed by a decay toward the baseline with a slight overshoot analogous to a linear system first-order lead-lag UIR. In contrast, UIR's from the rostral and caudal bundles showed a rising component followed by a slower decay toward the baseline analogous to an overdamped second-order UIR. We excluded the possibility that the UIR diversity derived from time-dependent degenerative changes in the isolated preparation. These results suggest alternatives to the classical view that semicircular canal afferents encode direct responses to mechanically simple fluid-cupula displacements. Each afferent could be considered tuned, in a signal detection theory sense, to a particular range of head accelerations analogous to the afferent encoding of specific stimulus features described for other sensory systems. (Supported by NIH grants NS09440, NS09692 and NS09823.)

506 TRANSMEMBRANE CHANGES IN HIPPOCAMPAL NEURONS: HYPERPOLARIZING ACTIONS OF NOREPINEPHRINE, CYCLIC AMP, AND LOCUS COERULEUS. A. P. Oliver and M. Segal. Lab. of Neuropharmacology, SMR, IRP, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032.

Hippocampal pyramidal neurons (P-N) receive norepinephrine (NE) containing fibers from the nucleus locus coeruleus (LC: Segal et al., Life Sci., 1973). NE and cyclic AMP imhibit spontaneous firing of P-N cells as does electrical stimulation of the LC (Segal and Bloom, Brain Res., 1974). We have recorded the transmembrane potential changes in P-N during LC stimulation or when NE or cyclic AMP were iontophoresed extracellularly. All three tests hyperpolarize P-N with some increase in membrane resistance. Mean resting potentials for all cells were 33.7 mV (91 cells) with mean input resistance of 7.4 Megohm. Average hyperpolarization and resistance increase following NE were 2 mV, 1 Megohm (14 cells); after cyclic AMP 5 mV, 3 Megohm (11 cells); after LC stimulation 2 mV, 1.9 Megohm (28 cells). No correlation could be found between the magnitude of membrane resistance and potential changes for any test. Cyclic AMP appeared more potent than NE. Intracellularly applied cyclic AMP produced similar effects (1 mV, 2 Megohm, 31 cells) supporting the direct nature of the inhibition. These data confirm the noradrenergic nature of LC inhibition of hippocampal P-N and support the proposal that cyclic AMP could mediate this response.

507 PATTERNS OF DORSAL HIPPOCAMPAL UNIT ACTIVITY. Charles E. Olmstead and Phillip J. Best. Dept. Psychiatry, Mental Retardation Ctr., NPI, UCLA, Los Angeles, CA 90024, and Dept. Psychology, Univ. Virginia, Charlottesville, VA 22901.

Previous research indicated that at least 4 temporal patterns of spontaneous single cell activity might exist in the dorsal hippocampus. Using chronically implanted rats, it has been possible to identify these 4 classes of units and to describe their temporal characteristics on the basis of interspike interval, interburst interval, and intraburst interspike interval; they are designated here as decrescendo (31.6%), single (54.1%), theta (12.2%), and hi-freq (2.1%). A differential distribution of these 4 cell types for the various laminae of the hippocampus and fascia dentata was found. The decrescendoes predominated in the stratum pyramidale of the Regio Superior of Cajal, while the single and theta types were found in higher ratios in the deeper layers and in the fascia dentata. The hi-freq were all found in the strata alvelar-oriens. A study of these same cells during natural sleep and waking and during the presentation of tones demonstrated that the decrescendo and single types exhibited their slowest activity during paradoxical sleep, whereas the theta cells showed their highest rates. Awakening, occurring spontaneously or artifically produced by a tone, induced a decrement in firing both in the theta and single cells. For the decrescendoes, tonal awakening produced a decrement, while the immediate effect of spontaneous waking was an increment in firing. These data suggest that some of the variability in the regional differences in rate of spontaneous activity during sleeping and waking (Olmstead, Best, & Mays, 1973) might be due to differential sampling of cell types. (Supported by USPHS Grant MH-16478, awarded to Phillip J. Best.)

508 GAMMA-AMINOBUTYRIC ACID BINDING SITES IN NERVES AND MUSCLE MEMBRANES AND BICUCULLINE INHIBITION. R. W. Olsen. University of California, Riverside, California 92502

Binding of [^{14}C]-gamma-aminobutyric acid (GABA) at 0° to mouse brain particulate fractions and crayfish muscle membranes in the presence of 0.1 mM amino-oxyacetic acid was detected by equilibrium dialysis and filter assays. Total brain or cerebellar gray matter fraction P_2, synaptosomes, and myelin fractions showed identical properties: maximum binding 6 nmole GABA/mg protein, K_D = 25 μM in filter assays, slightly less in dialysis assays. Competitive inhibition occurred with 2,4-diaminobutyrate (K_I40μM), β-hydroxy GABA(K_I50μM), β-guanidinopropionate(K_I100μM), and imidazole acetic acid(K_I500μM). No inhibition occurred with 0.1 mM picrotoxin, 1 mM azide, 1 mM 2,4-dinitrophenol, or 0-10mM β-mercaptoethanol. Noncompetitive inhibition was observed with chlorpromazine(K_I0.1mM), imipramine(K_I0.2mM), and bicuculline(K_I 0.5mM). Bicuculline solubility was 1 mM above pH 5.5; the compound showed a slow ($t_{\frac{1}{2}}$ = 45 min) UV spectral change above pH 5.5 correlated with lactone ring opening and loss of inhibitory activity. Thus bicuculline neutralized to pH 7 before assay did not inhibit GABA binding. Bicuculline(0.1mM) also inhibited GABA uptake at 37° by fraction P_2. All the 0° binding was inhibited by Na-free buffer, 0.5mM chlorpromazine, or mild detergents such as Triton X-100 or cholate;80% was destroyed by osmotic shock. Frozen tissue gradually lost activity. 100% of the binding is consistent with Na gradient dependent uptake into membrane-bound space and therefore physiological receptor sites for GABA in brain are present in quantities too low to detect by GABA binding assays. By contrast, the properties of crustacean muscle membrane GABA binding sites (B_{max} = 40 pmoles/mg protein, K_D= 0.7 μM) are different and more consistent with synaptic receptor sites. (Supported by NSF Grant GB-42032).

509 SPINAL CORD TRANSECTION: RESULTS OF IMPLANTING CULTURED EMBRYONIC SPINAL CORD AT THE TRANSECTION SITE. Mary I. Olson and Richard P. Bunge. Dept. Anat., Washington Univ. Sch. Med., St. Louis, 63110.

Previous experiments have demonstrated the survival and maturation of hemisections of cultured embryonic rat spinal cord (SC) implanted with minimal trauma into the SC region of adult rats (Thuline and Bunge, 1972). In the present experiments a complete SC transection was performed at the T11 level in adult rats and strips of 15 day cultured embryonic SC 10-15 mm in length were placed to bridge the transected region. Of 27 adult rats subjected to transection, 14 received implants and 13 served as controls. Eight of the controls and 10 of the experimental animals survived for long-term observation and subsequent histological examination. Two experimental animals showing substantial return of hindlimb walking movements were found to have incomplete cord sections. Extensive tissue loss in the distal SC region was observed in only two animals with hindlimb areflexia. The remainder had well preserved distal SC regions, and were hyperreflexic. An equal small number (2) of control and experimental animals with complete SC transection showed some slight return of hindlimb use in walking. Histological examination showed that in no case did any substantial portion of the SC implant survive and provide a bridge between the cut cord ends. We conclude that this method of using SC transplantation is ineffective in sponsoring functional recovery; the substantial tissue reaction to the trauma of spinal cord transection apparently precludes the survival of the implanted tissue. In future experiments efforts to control the acute edema and host tissue reaction to injury, followed by later implantation of embryonic SC, may be advantageous. (Supported by NIH-NINDS Grant NS-09923)

510 FORNIX LESIONS BLOCK THE INCREASED LIGHT AVERSION USUALLY OBSERVED AFTER SEPTAL LESIONS. David S. Olton*, Paul G. Jenko*, and Fred H. Gage III*. (SPON: E. K. Silbergill), Dept. Psychol., Johns Hopkins University, Baltimore, Md. 21218.

A three compartment apparatus was used to measure the preference of rats for three different light intensities. Each rat was tested preoperatively and following each of two operations. The results demonstrate that: (a) normal rats and rats undergoing control operations exhibit remarkably stable preferences for the different light intensities: (b) septal lesions either following or preceding control operations alter behavior so that more time is spent in the darker compartments; (c) fornix lesions preceding a septal lesion by 20 days or fornix lesions made simultaneously with a septal lesion completely block the increased dark preference usually observed following septal lesions; (d) fornix lesions following septal lesions by 20 days do not alter the increased dark preference induced by the septal lesion; (e) fornix lesions either preceded or followed by a control operation do not alter the light-dark preference. These data demonstrate that septo-hippocampal fibers carried by the fornix play an integral role in the increased light aversion usually observed following septal lesions. The data are also consistent with those from a previous experiment demonstrating that the "hyperreactivity" usually observed after septal lesions can be blocked by a preceeding fornix lesion.

511 EFFECT OF DYNAMIC MECHANICAL LOADING ON FROG SCIATIC NERVE. Ayub K. Ommaya, Thomas A. Gennarelli* and Larry Thibault*. Surgical Neurology Branch, National Institute of Neurological Diseases and Stroke, National Institutes of Health, Bethesda, Maryland 20014

Previous studies of the reversible and irreversible effects of mechanical trauma on level of consciousness and such physiologic indices as the somatosensory evoked potential have not shown how such modulation of neural functions occurs in response to applied loads. Apparatus to test the nature of this phenomenon at the cellular level in simpler neural systems has been designed. Initially, we are studying alterations in the compound action potential (CAP) of frog sciatic nerve when dynamic transient hydrostatic pressure plus normal and shearing strains are applied. This complex loading is analogous to that seen in head injury but with controlled variation of load amplitude and duration. Reversible decrease in CAP was noted at 0.8 atm. peak pressure (for 10 msec.) with restoration of the original waveform completed at about 10 minutes. At 1.5 atm. peak pressure (for 10 msec.) the CAP did not recover fully after initial abolition. These graded functional changes could not be correlated with structural alterations recorded by conventional histologic technique; histochemical (Na-K. ATP ase) and chemical (K ion flux) methods seeking such correlations are being evaluated.

512 THE INFLUENCE OF ANGULAR POSITION AND VELOCITY OF THE ELBOW ON THE DISCHARGE RATES OF INTERPOSITUS NEURONS (CAT). N. Onoda* and J. E. Burton. Division of Neurosciences, City of Hope Natl. Med. Ctr., Duarte, California 91010.

This report describes responses of interpositus neurons to passive step and sinusoidal manipulation of the angle of the intact elbow joint. For many of these cells, a linear relationship was found between static discharge rate and angular position of the joint over a range of up to 50^{o}. For small amplitudes of sinusoidal manipulation ($1\text{-}5^{o}$) at frequencies of 0.02 to 0.5 H_z, the discharge rates of these cells were modulated approximately sinusoidally and with nearly constant modulation amplitudes. Between 1 and 7.5 H_z, however, the modulation amplitude increased rapidly and the discharge became intermittent, occurring during less than half of each cycle. Although the phase angle was usually difficult to measure exactly, it clearly varied from less than 30^{o} at the lowest frequencies to approximately 90^{o} of phase advance at the highest frequencies. The behavior of these interpositus neurons was thus indicative of a responsiveness to both the displacement and the velocity components of the sinusoidal stimuli.

513 THE ONTOGENY OF SUPRASPINAL INPUT TO CHICK SPINAL CORD: A BEHAVIORAL STUDY. Ronald W. Oppenheim. Dept. of Mental Health, Box 7532, Raleigh, N. C. 27611.

The development of neuromuscular activity (motility) in the trunk and limbs of the chick embryo was examined after making spinal "gaps" in the cervical spinal region at 2-days of incubation. All preparations were checked by dissection or histology for verification of the "transection". Motility was observed and recorded in embryos from 4 to 19 days of incubation (hatching occurs on days 20-21). Contrary to some previous claims spinal preparations between 4 and 10 days of age exhibited no modifications in, (1) the frequency of activity, (2) the temporal rhythm or periodicity of motility, (3) the pattern or form of movements, or (4) reflex responses. Beginning at about 10 days, and continuing up to day 20, however, certain of these parameters began to deviate from controls. For example, the temporal rhythm of the movements was modified, and during the period known as the prehatching stage the spinal embryos failed to exhibit coordinated hatching movements. Spinal embryos after day 10 also exhibit a striking difference in their response to strychnine injections; whereas normal 10-15 day old embryos exhibit a transient, but reliable, increase in motility after strychnine injection, spinal embryos failed to demonstrate such a response even when the dose was several orders of magnitude greater than that required by controls. Attempts are underway to identify some of the structural features of CNS development which may account for the above functional phenomena.

514 EFFECTS OF THE SPACE FLIGHT ENVIRONMENT DURING THE APOLLO 17 MISSION TO THE MOON ON THE BRAIN OF THE POCKET MOUSE. J. M. Ordy, K. R. Brizzee and W. A. Haymaker. Delta Regional Primate Research Center, Covington, La. 70433 and Ames Research Center, NASA, Moffett Field, Ca. 94035.

Astronauts have reported "light flashes" in their exploration of space and also changes in homeostatic mechanisms of adaptation. Extensive logistical and metabolic requirements in life support systems preclude the use of the most nonhuman species in sufficient numbers for evaluation of cosmic radiation and adaptation to prolonged space flight. As faculative homeotherm, the small pocket mouse, P. longimembris adjusts its metabolic rate at rest or in response to deprivation or environmental change. Its small size and weight (7-11 g), adjustment of metabolic rate, homeothermic temperature regulation, hypoxic and radiation tolerance, independence of drinking water and minimal excretion make it uniquely suited for inclusion in self-contained life support systems on prolonged space missions. A Biological Cosmic Ray Experiment (BIOCORE) was undertaken with the heteromyid pocket mouse to determine the effects of cosmic ray particle radiation on the eyes and brain and the effects of isolation in space on adaptation to the space flight environment during the 13 day Apollo 17 circumlunar mission. Lesions, presumed to be of "flight related" origin were observed in the olfactory epithelium in Apollo 17 flight mice but not in controls. The hypothalamic-pituitary-adrenal axis is critically involved in adpatation to all environmental challenges. Comparisons were made of physical appearance at recovery, changes in body weight and food intake in relation to cellular alterations in the neuroendocrine axis between Apollo 17 flight mice and controls. These comparisons indicated that "torpor" in the pocket mouse represented a unique mechanism of metabolic adaptation but that it may also preclude rapid adaptation to unexpected environmental challenges encountered in space flight environments.(Supported by NASA Grant RFP-2-23344 (AC-69.)

515 FACIAL UNITS AND LID CLOSURE IN SLEEP. John Orem, Jacques Y. Montplaisir, and William C. Dement. Sleep Disorders Laboratory, Stanford Medical Center, 94305.

Although closure of the lids is one of the hallmarks of sleep, essentially no experimentation was done on the problem. In the present study, single cells were recorded from the facial nucleus to elucidate the mechanisms involved in lid closure during sleep. Chronic cats implanted with bolts for atraumatic head restraint were recorded with tungsten microelectrodes. Upper and lower lid movements and positions were registered with mechanically operated transducers which attached to the lid margins. Sleep parameters were recorded by usual techniques, including a recording of PGO activity in the LGB and occipital cortex. Cats were sleep deprived 12 hours before recordings. The results revealed that 1) Closure was not a single event occurring only at the onset of sleep, but rather a continuing process appearing throughout sleep at a mean of 2.6 closure movements per minute, and 2) that the sleep closure process involving a simultaneous approximation of the two lids represents an active contraction of the M. orbicularis oculi. Facial nucleus neurons related to spontaneous and reflex (5th nerve stimulation, visual threat) closures in wakefulness also fired during the closures of slow wave sleep. These pulsatile episodes of activity consisted of either bursts of discharges on a background of silence or increases above a spontaneous rate. Typically these cells demonstrated an acceleration followed by a deceleration in their rate of firing at the time of the closure and the duration of firing was closely related to the time to peak of the movement which varied from 100 to 1600 msec. Some of these neurons have been identified as motoneurons by antidromic stimulation of the zygomatic branch of the facial nerve. These results reveal an active, continuing process of closure throughout slow wave sleep.

516 SPATIAL PROBABILITY-LEARNING BY ALCOHOLIC KORSAKOFF PATIENTS. Marlene Oscar-Berman, Barbara J. Sahakian*& Gunilla Wikmark*
Aphasia Research Center, Boston V.A. Hosp., and Neurology Dept., B.U. School of Medicine, Boston, Mass., 02130.

The limbic system has traditionally been regarded as a neural substrate for motivational processes. In Korsakoff's syndrome, widespread damage is present in limbic structures as well as in the dorsomedial thalamic nuclei, a region linking the limbic system with prefrontal cortex. The present study employed a probability-learning situation in order to measure the sensitivity of patients with Korsakoff's disease to changes in reinforcement contingencies. Performance of 10 alcoholic Korsakoff patients was compared to that of 10 normal and 10 alcoholic control subjects on each of three different schedules of spatial probability-learning (50:50, 70:30 and 30:70) using monetary reinforcement and a correction procedure. There was evidence that the Korsakoff patients were less sensitive than normals to the effects of reward. For example, on the 70:30 and 30:70 schedules, choice ratios by normal subjects approximated the reinforcement ratios, but the choice ratios of Korsakoffs remained close to 50%. In addition, the Korsakoffs made an abnormal number of perseverative errors, the greatest proportion of which occurred early in training. On most measures, performance by alcoholic controls fell between that of the other two groups. The data from this study support the view that Korsakoff's disease due to chronic alcoholism, leads to a complex pattern of behavioral deficits.

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517 PHARMACOLOGY OF ACIDIC AMINO ACIDS STUDIED ON ISOLATED FROG SPINAL CORD. Ante L. Padjen. Lab of Neuropharmacology, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032.

Sucrose gap recording from spinal roots was used to analyze the effects of glutamic acid (GA) and related compounds on the membrane potential of motoneurones (MN) and primary afferents (PA) in the isolated hemisected frog spinal cord. Indirect responses were abolished by adding 20 mM Mg to a constantly perfused Ringer solution. Relative depolarizing activities of different amino acids were determined from dose - response curves. Aspartic acid (ASP) was equally potent, while DL-homocysteic acid (DLH) and N-methyl DL-aspartic acid were 20 to 40 times more potent than GA. A natural cyclic analog of GA, kainic acid (KA), was about 500 times more potent in depolarizing MN and PA than GA. Its threshold conc was around 50 nM and the depolarization was characterized with a slow risetime and even slower recovery, in a way similar to DLH effects, but different from GA. Several proposed GA blocking agents were tested (alpha-methylglutamic acid, L-glutamic acid diethylesther, L-methionin-DL-sulphoximine). They showed partial antagonism against GA and ASP and variable effects against DLH and KA. In higher concentrations (1 mM) agonistic effects were observed. The use of KA and derivatives may provide a better insight into the molecular properties of glutamic acid receptors in CNS.

518 THE ORGANIZATION OF PROJECTIONS FROM NUCLEUS MAGNOCELLULARIS TO NUCLEUS LAMINARIS IN THE CHICKEN. Thomas Parks and E.W Rubel. Dept. Psychol., Yale Univ., New Haven, CT. 06510.

In the avian brainstem, nucleus angularis (NA) and nucleus magnocellularis (NM) each receive a topographic projection from the cochlea and are thought to be homologous to the mammalian dorsal and ventral cochlear nuclei, respectively (Boord and Rasmussen, J.Comp.Neurol.,140: 463, 1963). *The present study sought a detailed description of the organization of projections from functionally-defined portions of NM to the third-order* auditory neurons in the ipsilateral and contralateral nucleus laminaris (NL), a structure considered homologous to the mammalian medial superior olivary nucleus. Using 5-15 day old hatchling chickens and standard microelectrode recording techniques, the "characteristic frequency" of cells in an area of NM was determined. A small electrolytic lesion was then made through the recording electrode and, following survival periods of 18-48 hours, projections from the lesioned area were examined using the Fink-Heimer method. As previously reported for the pigeon, projections from NM terminate densely in a region immediately dorsal to the ipsilateral NL cell bodies and ventral to the perikaryon lamina on the contralateral side. This study further indicates that neurons in each discrete area of NM project in a point-to-point and symmetrical fashion onto NL neurons on both sides of the brain, preserving both the rostro-caudal and mediolateral organization of NM. *Thus, the neurons in NL receive spatially-segregated and symmetrical input from the two ears in such a way that the* tonotopic arrangement of NM is precisely maintained.

519 EFFECT OF CONTINUOUS ILLUMINATION ON THE ELECTRORETINOGRAM AND THE VISUAL EVOKED RESPONSE IN THE RAT. John G. Parnavelas*, Robert F. Spencer*, and Paul D. Coleman. Dept. Anat., Sch. Med. & Dent., Univ. Rochester, Rochester, NY 14642.

Effects of exposing albino rats under continuous illumination from birth to 35 days were sought in recordings of the electroretinogram (ERG) and the visual evoked response (VER). Control animals were raised from birth to the same age on a 12 hr light-dark cycle. The ERGs and VERs to 50 strobe flashes were recorded with Ag-AgCl electrodes and averaged by a computer. The ERGs recorded from rats raised under continuous illumination showed an absence of an a-wave and a markedly decreased b-wave. This is consistent with our histological findings which indicate the absence of approximately 50% of the photoreceptors in the retinae of these animals. Although there is a considerable degeneration of photoreceptors and a decrease in the amplitude of the ERG, the recorded VER contained all of the primary components and the amplitude was at least that of the controls. These findings indicate that somewhere in the visual pathway, between the retina and the visual cortex, there are specific neuronal changes which may compensate for the decreased number of receptor cells.

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520 LEUCINE INCORPORATION INTO PROTEIN BY BRAIN SLICES FROM ISCHEMIC GERBILS. K. Patel-Mandlik, J. F. Hartmann, and M. M. Cohen Dept. Neurol. Sci., Rush-Presby. St. Luke's Med. Ctr., Chicago, Ill. 60612

The incorporation of L[4,5-^{3}H]leucine by brain slices from control and experimental animals was measured since the incorporation of amino acids reflects protein synthesis by accepted routes. Ischemia was produced by occlusion of the common carotid arteries of the gerbil, a Mongolian desert animal. The animals were sacrificed after 15 to 60 min periods of carotid occlusion followed by 0 to 60 min in vivo recovery. Brain slices were incubated under adequate conditions for 30 min in presence of radioactive leucine following 15 min preincubation with cold leucine. The rate of incorporation of leucine into protein was expressed in molar quantities of leucine. The specific activity (S.A.) of protein was corrected for the S.A. of intracellular leucine. Slices from the control animal showed the rate of incorporation to be 0.16 nmol/mg protein/30 min. The rates were 0.12, 0.10, 0.07 nmol/mg protein/30 min in the slices from animals with 15, 30 and 60 min ischemia, respectively. Linear relationship was observed between logarithm of protein synthesis and time factor, and the correlation was -0.9 which was significant at 1%. Analysis of variance of S.A. of protein indicated significant difference between the control and experimentals. Changes occurred in the tissue pool of free amino acid, probably due to variations in ischemic conditions (with and without subsequent recovery period) and altered the S.A. of intracellular pool. However, the difference was not significant statistically and also, did not affect the above-mentioned correlation between rates of protein synthesis resultant of the ratio of S.A. of protein to S.A. of leucine.

521 EVIDENCE FOR DIRECTED GROWTH OF THE OPTIC TRACT IN FOREIGN NERVOUS TISSUE. Martha C. Paton* and Robert R. Capranica. Section of Neurobiology and Behavior, Cornell University, Ithaca, N.Y. 14850.

Eye primordia of *Rana pipiens* embryos have been autografted into the evacuated ear site during Shumway stages 16-19. Silver staining of a number of pre and post-metamorphic animals bearing such grafts has demonstrated that the transplanted optic nerve penetrates the medulla oblongata. The tectum that would normally have been innervated by the transplanted eye is significantly reduced in size. Intra-ocular injection of H^3-proline into transplanted eyecups and subsequent autoradiographic tracing of the optic nerve within the medulla has shown that the nerve tract ascends to the caudal border of the mesencephalon but then makes a 180° turn and descends in the dorsal-lateral white matter of the medulla. Grain counts suggest that axonal collaterals from this tract ramify among the acoustic and vestibular nuclei of the medulla. Neural activity has been recorded in the transplanted optic nerves in response to stimulation in the visual field of the transplanted eye. Optic tract fibers growing from ectopic retinas are therefore functional in terms of their electrogenic and axonal transport capabilities. After entering the CNS at the level of the medulla they are apparently incapable of penetrating the caudal border of the optic tectum. Our results suggest that direction of approach is critical in the normal development of the retinal tectal projection. However there is no indication of random dispersal of the transplanted optic fibers. The presence of a well-defined tract within the medulla suggest that these fibers are capable of responding to directional information in a foreign microenvironment.

522 FUNCTIONAL ROLE OF EFFERENTS TO THE AVIAN RETINA. Alan L. Pearlman and Charles P. Hughes*. Depts. Physiol. and Neurol., Washington Univ. Sch. Med., St. Louis, Mo. 63110

The bird remains the only animal in which the source of efferent fibers to the retina has been clearly defined. These arise in the isthmo-optic nucleus (ION) and terminate on the retinal amacrine cells, forming the final link in an anatomical closed loop. Receptive fields of ganglion cells from the pigeon retina were analyzed during extracellular microelectrode recordings in the optic tract. Four major types of ganglion cell receptive fields can be distinguished. Twenty-five percent of the receptive fields are relatively simple, responding at on and at off to stationary spots of light in the central region. All have inhibitory surrounds of varying strength. Motion sensitive units are similar to the on-off center type except that responses to stationary stimuli are absent or very weak while responses to moving stimuli are vigorous. Directionally selective units also have the same basic features but respond to moving stimuli well from the preferred direction and not at all from the null direction. The functional role of the efferents was studied by determining the effect on the ganglion cell receptive field on reversibly removing centrifugal influences, accomplished by local cooling of the ION. Removal of centrifugal influences produces a decrease in the responsiveness of most retinal ganglion cells. All of the major receptive field types are influenced in the same fashion; specific receptive field properties such as motion sensitivity or directionality are not altered. The efferents exert their influence on ganglion cells by way of the amacrine cells. These cells in Necturus appear to be inhibitory to ganglion cells. If amacrines have a similar effect in the pigeon, then decreased activity in the efferents leads to increased inhibition of ganglion cells, and increased activity in the efferents provides disinhibition.

523 MODIFICATION OF STRIATE CORTEX BY BRIEF PERIODS OF MONOCULAR VISUAL EXPERIENCE. Carol K. Peck and Colin Blakemore.* Dept. Psychol., Pomona College, Claremont, Ca. 91711 and Physiological Laboratory, Cambridge CB2 3EG, England.

Four kittens were reared without form vision by suturing the lids of both eyes and then, at 29 days of age, had the right eye open for a brief period (1, 6, or 20 hours). Six or 20 hours of monocular vision produced a marked bias in the ocular dominance of the visual cortex, but one hour did not. This contrasts with the effects of one hour of experience with a vertically striped environment in kittens of the same age, which is sufficient to bias the orientation preference of cortical neurons. Cortical neurons of kittens exposed briefly to the normal visual world also differ from the cortical neurons of kittens exposed briefly to stripes in general responsiveness and in receptive field types. Repetitive visual environments which contain a single orientation of contour may, therefore, have strong organizing effects on cortical physiology which are not duplicated by comparable periods of vision in environments with multiple contours.

524 PENETRATION OF PHENYLACETIC ACID ACROSS THE BLOOD-CEREBROSPINAL FLUID BARRIER. W. Pedemonte, M. Bulat*, and A. D. Mosnaim. Department of Pharmacology, The Chicago Medical School, Chicago, Illinois 60612

Phenylacetic acid (PAAc) is a major metabolite of 2-phenylethylamine in the central nervous system (Mosnaim et al., Amer. Soc. Neurochem. 5: 118, 1974). The passage of PAAc-1-C^{14} through the blood-cerebrospinal fluid barrier was investigated in cats after single intravenous injection of PAAc-1-C^{14} (5 mg/Kg) or its constant infusion (about 3 mg/h). PAAc-1-C^{14} was measured in samples (0.5 ml) of plasma and cerebrospinal fluid (CSF) taken from the inferior vena cava and cisterna magna, respectively. Soon after the intravenous injection of PAAc-1-C^{14}, its concentration in the blood was much higher than that in the CSF. However, the concentration of this acid decreased rapidly in the blood so that PAAc-1-C^{14} in the CSF approached and finally surpassed that in plasma. When the level of PAAc-1-C^{14} was kept constant in the plasma, its concentration in the CSF reached a plateau; the ration between the plasma and CSF concentration was about 11. If probenecid was given (200 mg/Kg, ip) at this time, PAAc-1-C^{14} increased to a new level both in the plasma and CSF while the ratio fell to about 6. The elevation of PAAc-1-C^{14} in the blood was probably due to the blocking effect of probenecid on secretion of PAAc-1-C^{14} by the kidney; the decrease in plasma/CSF ratio may indicate an active transport of PAAc-1-C^{14} from the CSF to the blood (Bulat and Živkovic, J. Pharm. Pharmacol. 25: 178, 1973).

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525 CROTALUS ADAMENTEUS SNAKE VENOM NERVE GROWTH FACTOR PURIFICATION.
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Optimal concentration levels of 10-20 nanogram/ml. of the nerve growth factor protein (NGF) will stimulate both neurite proliferation and extension as well as the overall metabolism of embryonic dorsal root ganglia and sympathetic ganglia of all ages. This is true both in vitro and in vivo. Treatment of animals with antibodies directed against NGF lead to immunosymphatectomies. NGF isolated from mouse submandibular gland is made up of non identical subunits α, β, γ (α_2 γ_2 β) which form a complex stable within a 5-8 pH range. When NGF has been isolated from snake venom in the past the purification procedures have taken place in the presence of denaturants such as urea or at pH 4 and 10.6 thus making any determination of the molecular species present impossible.

A purification of NGF from Crotalus adamenteus snake venom was carried out at physiological pH using ammonium sulfate precipitation, ion exchange chromatography and Sephadex gel filtration. An $\alpha\beta$ type complex form of NGF was isolated from Crotalus adamenteus. These subunits were found to freely interchange with $\alpha\beta$ subunits from mouse submandibular NGF under appropriate conditions although some differences between the physiochemical properties of both species were found. Supported by NIH grant NS 11211-02.

526 VISUALLY EVOKED RESPONSES IN PULVINAR, LATERAL GENICULATE AND VISUAL CORTEX TO PATTERNED AND UNPATTERNED STIMULI IN SQUIRREL MONKEY.
Kent M. Perryman and Donald B. Lindsley. Depts. of Psychology, Physiology and Psychiatry, and Brain Research Institute, UCLA, Los Angeles, Ca. 90024.

In 8 monkeys single unit post-stimulus-time histograms (PSTHs) and average evoked potentials (AEPs) were recorded from the same microelectrodes in inferior pulvinar and lateral geniculate nucleus during patterned (stripes and checkerboards, sizes 4.3° and 1.1°) and unpatterned (diffuse flash) stimuli. Also AEPs were recorded simultaneously from striate and prestriate cortex. The waking monkey sat in a stationary position facing a tangent screen with head fixed and only eyes free to move. During a terminal condition recordings were made under Flaxedil and tubocurarine to eliminate all eye movements. Differences in unit PSTHs and AEPs were found between patterned and unpatterned stimuli in inferior pulvinar and lateral geniculate; PSTH peaks at 50 and 100 msec were larger for patterned than unpatterned flashes and late components of AEPs were larger. Both striate and prestriate AEPs were larger to the patterned stimulus. Differential effects of both unit and AEP responses were found in the inferior pulvinar, but not lateral geniculate, when contour density and contrast border were changed; similarly, prestriate, but not striate, AEPs changed. Responses were obtained at all sites under Flaxedil-tubocurarine but the responses did not change for patterned versus unpatterned stimuli, or for controlled changes in contour density or contrast border. These results suggest that a secondary visual system involving pulvinar and prestriate cortex is more sensitive to patterned stimuli and changes in contour density and contrast border than the geniculo-striate system. Since these effects do not occur when the eyes are immobilized it is believed that they are dependent upon eye movements as well as changes in stimulus parameters.(USPHS grant NS8552)

527 OPIATE INDUCED FACILITATION OF SELF-STIMULATION BEHAVIOR IN THE RAT. Agu Pert and Robert C. Hulsebus*. Experimental Medicine Branch, Biomedical Laboratory, Edgewood Arsenal, MD 21010 USA

In experiment 1, rats were implanted with bipolar electrodes aimed for the posterior lateral hypothalamus and the ventral tegmental region. They were trained to self-stimulate these areas on a CRF schedule. When a stable performance baseline had been established, all animals received varying doses of morphine, levorphanol, codeine, heroine, methadone or dextrorphan. All pharmacologically active opiates produced a decrease in response rate 30 min. after an injection. This initial response depression was followed by an increase in self-stimulation rate at approximately 3 hours post-injection. The magnitude of response facilitation appeared to be related to the relative analgesic potency of these compounds. In experiment 2, rats implanted in the posterior lateral hypothalamus were administered 10 mg/kg of morphine over 20 days. Tolerance developed rapidly (3-4 days) to the initial depressant effects and appeared to parallel the development of tolerance to the analgesic effects of an equivalent dose. No tolerance was found for the facilitatory effects seen at 3 hours post-injection even after 20 days of administration. In experiment 3, rats implanted in the hypothalamus and ventral tegmental region were pretreated with either dl-alpha-methyl-tyrosine (α - MT) or p-chlorophenylalanine (PCPA) before the morphine administration. Pretreatment with PCPA had no significant effect on the facilitatory effect of morphine whereas α-MT produced a significant decrease. The facilitatory effect of morphine appears to be mediated through the catecholaminergic systems.

528 MECHANISM OF S-100-BASIC PROTEIN INTERACTION: METAL BINDING AND FLUORESCENCE STUDIES. A. S. Perumal* and S. P. Mahadik* (SPON: M. Glusman). Div. Neuroscience, N. Y. State Psychiatric Institute, New York, N. Y. 10032.

The specific interaction between the acidic protein, S-100, and bovine basic protein in the presence of Ca^{+2} (10^{-2}M) has been reported (Fed. Proc. 33:777, 1974). When other divalent cations were studied, Mn^{+2} at 10^{-3}M was also effective, as seen by immunoelectrophoresis with anti-S-100. The effect of metal ions on the individual proteins can be determined by fluorescence measurements. Fluorescence of S-100 is increased with Ca^{+2} but not with either Mn^{+2} or Mg^{+2}. On the other hand, fluorescence of basic protein is enhanced by Mn^{+2} but not by Ca^{+2} or Mg^{+2}. The effect of these ions on fluorescence can be reversed by EDTA. The binding of $^{45}Ca^{+2}$ and $^{54}Mn^{+2}$ to S-100 and basic protein was studied. Equilibrium dialysis experiments demonstrate that S-100 binds both Ca^{+2} and Mn^{+2} whereas basic protein binds only Mn^{+2}. Competitive binding studies indicate that Ca^{+2} and Mn^{+2} do not compete with each other; therefore, they have independent binding sites on S-100. Acrylamide gel electrophoresis reveals that migration of S-100 is changed in the presence of Ca^{+2} but not Mn^{+2}. The electrophoretic migration of basic protein was reduced in the presence of Mn^{+2}. These studies suggest that Ca^{+2} binding to S-100 or Mn^{+2} binding to basic protein results in a conformational change that leads to a stable interaction between these two proteins. Since the binding of Mn^{+2} does not result in any fluorescence change in S-100, it is likely that Mn^{+2} binding site is not in the vicinity of a tryptophan residue. (Supported in part by a grant from the National Multiple Sclerosis Society.)

529 ALTERATIONS OF RETICULAR RESPONSES DURING REPETITIVE VESTIBULAR, CUTANEOUS AND CORTICAL STIMULATION: CNS ANALOGS OF HABITUATION AND SENSITIZATION? Barry W. Peterson, Joel I. Franck* and Nancy G. Daunton*. The Rockefeller Univ., N.Y., N.Y. 10021

Responses of medial ponto-medullary reticular neurons to repetitive electrical stimulation of vestibular nerves, pericruciate cortex and several skin points were studied in cerebellectomized cats that were either decerebrated or anesthetized with chloralose. Many neurons studied were reticulo-spinal neurons, identified by antidromic activation from the lumbar spinal cord. Control responses, recorded at stimulus rates of 1/10 sec, were divided into different latency components by reference to PST histograms. The number of spikes in each component was then followed during step changes in stimulus rate. Typically all response components changed in parallel with the greatest changes in the later components. More than 90% of the responses to vestibular nerve and cutaneous stimulation decreased as the stimulus rate increased. The decrement often exhibited an early peak followed by partial recovery and then further decrement. Decrement was often observed at 1/4 sec or 1/2 sec and increased at higher rates. Decrement of a given response component was greatest at low stimulus intensities but at higher intensities later, more labile, components might appear causing the overall response to exhibit greater relative decrement. Responses to repetitive cortical stimulation typically exhibited an initial increase (especially at high stimulus intensities and rates) followed by a decline. The response after 150 stimuli was equally likely to be greater than or less than the control response. The observed response decrements and increments had many of the parametric features of behavioral and neuronal habituation and sensitization which suggests that reticular responses to repetitive stimulation are determined by the interaction of habituation and sensitization. Supported in part by Grants NSF GB 36927 & NS 02619.

530 MODIFICATION OF SINGLE UNIT RESPONSES IN THE CAT'S VISUAL CORTEX BY ELECTRICAL STIMULATION OF THE BRAIN. Robert W. Phelps and Karl H. Pribram. Dept. of Psychology, Stanford University, Stanford, CA 94305

The responses of single units in the visual cortex were recorded with extracellular microelectrodes from immobilized cats lightly anesthetized with nitrous oxide. Visual stimuli consisted of moving lines displayed on an oscilloscope by a computer which simultaneously triggered a biphasic stimulator and recorded and averaged the responses of each unit. Data were collected over progressive separations of the stimulus lines using a multiple histogram technique: Stimulus presentations at each separation were interleaved and individually averaged so changes in general responsiveness of a unit became distributed into all histograms of a "map". The effect of bipolar electrical stimulation of the gyrus proreus (frontal) or the gyrus compositus (posterior) on the response properties of a unit visually stimulated with two parallel lines moving in the preferred direction and orientation with various separations was measured. If the electrical stimulation at either site changed a unit's response at stimulus separations greater than 1°, the change was almost always manifested as an increased response at these separations as compared to the corresponding control. If the electrical stimulation changed the unit's response at stimulus separations less than 1°, posterior stimulation generally produced a smaller response and frontal stimulation an increased response. For units displaying an effect, the effect appeared at stimulus separations greater than or less than 1° but not at both. In either case, the first map after cessation of the electrical stimulation often showed a modified response which was not necessarily similar to the control nor to that displayed during the stimulation. The response slowly returned to pre-stimulation levels over the course of several minutes.

531 NEURAL CODING OF REINFORCING AND AVERSIVE CONDITIONING IN THE RAT. M. I. Phillips. Dept. Physiology, University of Iowa, Iowa City, Iowa 52242.

Unit activity was recorded from the auditory pathway and other brain areas of freely moving rats during a conditioning procedure. In the first phase of the procedure, habituation trials were given by presenting two tones. In the second phase the tones were associated with either an intermittent food reinforcement schedule or unavoidable shock. In the extinction phase the food dispenser and shock source were uncoupled from the tones. Each unit studied was followei throughout the three phases.

The aim of the experiment was to study neural encoding of positive and negative events. Unit responses were of two main types: a) clear discriminative responses to the two tones by i) increased frequency of firing to positive tones and ii) decreased firing to negative tones; b) responsiveness to both tones without discrimination. Type a responses were considered to be neural coding of positivity and negativity and were found in the midbrain, hypothalamus, the dentate gyrus and medial geniculate areas. Type b responses were found in all areas, but exclusively in the inferior colliculus. The difference between the unit responses in the cochlear inferior colliculus and medial geniculate suggests that as sensory input travels up the auditory pathway there is a transition in the coding of the sensory quality of the stimulus, such as pitch, to meaningful information, such as a conditioned stimulus. This transition of sensory input coding takes place at the medial geniculate level.

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532 IMMUNOHISTOCHEMICAL LOCALIZATION OF TYROSINE HYDROXYLASE BY LIGHT AND ELECTRON MICROSCOPY. Virginia M. Pickel, Tong H. Joh, and Donald J. Reis. Dept. Neurol., Lab. Neurobiology, Cornell U. Med. Coll., New York, 10021

We sought to determine the cellular localization of tyrosine hydroxylase (TH) in rat by the use of specific antibodies to the enzyme (Joh et. al. Pro. Nat. Acad. Sci. 70: 2767, 1973) and the immunohistochemical peroxidase-antiperoxidase (PAP) method (Sternberger et. al. J. Histo Cyto. 18:315, 1970). Brown peroxidase reaction product was localized to the cytoplasm and processes of sympathetic ganglion cells, and in brain to neurons demonstrated by histofluorescence to contain catecholamines. In brain norepinephrine (NE) neurons were distinguished from dopamine (DA) neurons by the absence of staining with a specific antibody to dopamine-β-hydroxylase in the latter. Specific peroxidase staining of medium intensity was observed in the cell soma, but not in the axons or terminals of NE neurons with antibodies to TH. In contrast to NE neurons, perikaria of DA neurons stained more intensely and axonal processes were well visualized permitting the tracing of pathways from cells to terminal areas. Increased accumulation of TH enzyme protein in NE neurons elicited by reserpine was paralled by increased peroxidase staining. Electron microscopy of DA neurons in the substantia nigra demonstrated PAP complexes primarily restricted to the endoplasmic reticulum. Peroxidase granules filled many of the unmyelinated axons in the substantia nigra. Immunochemical localization by the PAP method can be used for regional, ultrastructural, and semiquantitative analysis of the distribution of specific enzyme proteins.

(Supported by NIH grants and the Harris Foundation)

533 PROSTAGLANDINS IN NORMAL THERMOREGULATION. Q. J. Pittman*, W. L. Veale and K. E. Cooper*, Div. of Med. Physiology, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada.

Prostaglandins, when injected into the cerebral ventricles or the tissue of the anterior hypothalamic-preoptic area of animals of several species, produce a rapid febrile response. During a fever caused by bacterial pyrogen, prostaglandin in the cerebrospinal fluid is increased above normal levels. Therefore, it has been postulated that prostaglandins may be mediators of the febrile response to pyrogens. Salicylates and other antipyretics are believed to lower fever by inhibiting prostaglandin synthesis. Even though salicylates do not lower normal body temperature, there is evidence that they may lower body temperature by impairing heat conservation and production in animals exposed to a cold ambient temperature. Consequently, prostaglandins may be mediaters in the heat production and conservation pathways in the non-febrile animal. To test this hypothesis, rabbits were shorn and placed in a 10°C environment. Rectal temperature, ear skin temperature, shivering and respiration were monitored. Sodium salicylate in a dose of 300 mg in 3 ml of saline, was injected intravenously (i.v.), followed by a continuing infusion of 1.5 mg/min. This amount of salicylate was previously shown to lower a pyrogen fever by a reduction in shivering, an increase in respiratory rate and, on occasion, ear vasodilatation. Our results indicate that sodium salicylate, given i.v. in the non-febrile rabbit, maintaining its temperature in the cold, did not affect body temperature or any of the other parameters measured. If salicylates in the concentrations given do indeed inhibit the synthesis of prostaglandins, these data indicate that prostaglandins may not be essential to the maintenance of normal body temperature in a cold environment.

(Supported by Medical Research Council of Canada)

534 SUPRASPINAL INFLUENCES ON SPINAL INTERNEURON CHARACTERISTICS IN CHRONICALLY PREPARED CATS. Nathaniel G. Pitts and Irving H. Wagman. (SPON:Gary P. Moberg.) Dept. Animal Physiol., Univ. of Calif., Davis, 95616.

Cats were prepared with a spinal implant to make possible extracellular microelectrode recordings from single cells in the lumbar cord 10 days after surgery and without complications due to anesthesia or recent surgical procedures. Cats were immobilized with Flaxedil. 262 cells were studied. Bipolar electrodes were implanted in various brain structures. Cells of laminae 1 and 4-8 were classified by their responses to hair movement, touch, noxious skin pinch, and pressure of various degrees. Receptive field sizes ranged from 3cm^2 to 7x8cm ovals; no correlation could be made between these sizes and location in the cord of responding cells. 20% of the cells were unresponsive to any form of cutaneous stimuli. Of the units responding to skin stimulation only 25% (regardless of their location) were spontaneously active. Cells responding to noxious stimuli (10% of the total) invariably showed a wide dynamic range and were located in layers 1,5,6,7 and 8. Electric stimulation of the midbrain ret. form., red. n., central gray, pyramidal tract, and VPL was performed using 200 msec trains of 100 pps, (p.w. 0.3 msec) and effects on lumbar cord cells studied. Intensity used was slightly suprathreshold for eliciting a patterned motor response. 71% of cord cells responded to one or more brain loci stimulation. Such stimulation showed either excitatory or inhibitory influences on cells of layers 4 through 8 with no differential distribution according to lamina. Insufficient data were obtained from layer 1 cells. Our results do not indicate any differential effects of the various descending influences on cells of the various laminae. Further, we could not distinguish any differential effects on cells responding differently to peripheral stimulation. (Supported by USPHS Grants nos. NS07844 and RR00169; N. Pitts was supported by the Porter Foundation).

535 HAIR CELL TYPES IN GOLDFISH VESTIBULAR MACULAE. Christopher Platt. Dept. Elect. Eng. & Comput. Sci., Univ. California, Berkeley, Calif. 94720.

Vestibular hair cells in vertebrates show an unexplained diversity of types, based on surface morphology of the ciliary bundles. Among lower vertebrates, amphibians show that some differences between types seem to be developmental, but others suggest different functional capabilities (Lewis & Nemanic, Z. Zellforsch. 123:441, 1972; Lewis & Li, J. Morph. 139: 351, 1973). A comparative study of fishes allows tracing the phylogenetic origins of these different types to attempt to correlate structure with established function; the common goldfish was chosen for initial study because of its known vestibular responses to acoustic as well as gravistatic stimuli. Tissues were fixed in glutaraldehyde and osmium, dehydrated in acetone, and dried by the critical-point method using CO_2. Scanning electron micrographs show four distinct hair cell types in all three pairs of otolith organs: 1)"Emergent", with a kinocilium of variable length and few if any stereocilia, and found in the periphery of the macula. 2)"Transitional", with a kinocilium often several times the length of the short stereociliary bundle, and found between the periphery and the more densely populated regions of large cells. 3)"Pike", with a kinocilium roughly twice as long as the longest stereocilia, and very common in the utriculus, especially in a dense striolar-like band. 4)"Sheaf", the largest form, with a kinocilium nearly matched by the longest stereocilia in the bundle of graded lengths, and found very densely packed in the posterior sacculus and anterior lagena. No bulbed kinocilia, as in bullfrog auditory papillae, are present. There is no absolute correlation of these types with particular macular areas, but the great preponderance of "pikes" in the gravistatic maculae and "sheaves" in the acoustic maculae suggest they may represent specializations for transducing low and high frequency stimuli, respectively.

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536 **CHARACTERIZATION OF CYCLIC NUCLEOTIDE PHOSPHODIESTERASES IN NEURONAL AND GLIAL ENRICHED FRACTIONS OF RAT BRAIN.** W.J. Pledger*, G.C. Palmer* and S.J. Strada. Prog. in Pharmacology, The Univ. of Texas Medical School at Houston and Dept. of Pharmacology, the Univ. of New Mexico, Albuquerque, New Mexico.

Cyclic nucleotide phosphodiesterase (PDE) activities were measured in homogenates of enriched neuronal and glial fractions of rat cerebral cortex (CC), cerebellum (CB), hypothalamus (HY), brain stem (BS), midbrain-thalamus (MB-T), striatum (ST), and hippocampus (HIPP). Neuronal and glial PDE activities varied among brain regions. Specific activities of neuronal cAMP PDE (measured with 200 μM substrate) were greatest in ST>HY>HIPP>BS>CC>MB-T>CB; cGMP PDE (20 μM substrate concentration) activities were highest in neuronal fractions from ST>HY>MB-T>HIPP>CC>BS>CB. Ratios of neuronal to glial cAMP PDE and neuronal to glial cGMP PDE activities also differed between brain areas; the highest ratios were found in HY and the lowest in CB. Neuronal and glial fractions from CB displayed differences in cAMP PDE kinetic parameters; a higher affinity for cAMP as substrate was evident in neurons. Several different molecular forms of cAMP PDE could be isolated from 100,000 x g soluble supernatant fractions of sonicated rat cerebrum or cerebellum by isoelectric focusing techniques. Varied isoelectric profiles were obtained when glial or neuronal fractions were fractionated by these techniques. These forms differed in isoelectric points, substrate affinities, kinetic properties, and sensitivity to an endogenous protein activator of PDE. These results indicate the divergent character of multiple forms of PDE in different types of brain cells.

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537 ACTIVITY OF CORTICAL VISUAL NEURONS OF THE ALERT MACAQUE DURING PRESENTATION OF SQUARE-WAVE GRATINGS. Gian F. Poggio, R. William Doty,* and William H. Talbot.* Dept. of Physiology, The Johns Hopkins University School of Medicine, Baltimore, Maryland 21205.

Impulse activity was recorded from neurons in the foveal striate cortex of rhesus monkeys that had been trained to fixate binocularly by rewarding them for detecting small, abrupt changes in the intensity of a spot centered on a 4° luminous field (36 cd/m^2) which was superimposed on a larger background. During fixation the field was either uniformly illuminated or filled with a luminance-modulated grating of selected spatial frequency (0.5-26 cycles/degree of visual angle) and orientation. As the animal became alert to the task, cortical neuronal activity usually increased and often became more regular. Most cortical units responded to steady gratings and showed similar sensitivity to spatial frequency. They were best activated by gratings in the middle range of spatial frequencies, (5-10 c/d) and progressively less well activated by higher and lower frequencies. The response always decreased rapidly with increasing frequency; gratings at 20 c/d were commonly ineffective. Response attenuation at lower frequencies was usually less pronounced, and varied more in course among different units. For some neurons, 'inhibitory' effects were observed either at specific spatial frequencies or over a range of frequencies. About one half of the units responded similarly to gratings of different orientation; the other half displayed orientation sensitivity. Presentation of gratings alternating in phase by 180° at a temporal frequency of 5 Hz evoked responses with the same sensitivity to spatial frequency and orientation as those evoked by steady gratings. Alternating gratings usually elicited phase-locked responses but the pattern of discharge differed for different spatial frequencies. (Supported by PHS Grant #5 P01 NS06828)

538 MLF FIBER ACTIVITY IN MONKEY DURING VISUALLY ELICITED AND VESTIBULAR EYE MOVEMENT. Jordan Pola. Dept. Ophthal., The Johns Hopkins Univ., Baltimore, Md., 21205

It is well known that extraocular muscle motoneurons discharge at a rate proportional to eye position during fixation, to position and velocity during pursuit and vestibular movement, and show a burst or pause of activity for saccades. To determine the form of presynaptic neural behavior that produces the motoneuron discharge, single fiber activity was recorded in the medial longitudinal fasciculus (MLF), a major input to the eye muscle nuclei. The fiber activity was explored from the level of the III to the VI nuclei in alert, behaving monkeys whose eye position was measured with a search coil in a magnetic field. Three different fiber types were isolated which can be roughly classified as: burst-tonic fibers for horizontal eye movement; pause-tonic fibers for vertical movement; and vestibular fibers. Burst-tonic fibers discharged at a rate that increased as a function of contralateral eye position, burst during contralateral saccades, and paused for ipsilateral saccades. During pursuit and vestibular slow movement, the firing rate was related to both position and velocity. These fibers thus behave in the same way as motoneurons. Pause-tonic fibers discharged at a rate that increased as a function of either upward or downward eye position and paused for a saccade in any direction. Their activity was also related to the velocity of vertical pursuit movement. Vestibular fibers fired at a rate proportional to the velocity of head rotation. These results suggest that a significant portion of the position, velocity, and burst activity of extraocular muscle motoneurons is received via the MLF. The results also provide an explanation of some of the clinical signs of the MLF lesion syndrome.

539 CHLORPROMAZINE SELECTIVELY INHIBITS MONOAMINE UPTAKE BY SQUID SYNAPTOSOMES. Harvey B. Pollard and Jeffery L. Barker, Reproduction Research Branch and Behavioral Biology Branch, NICHHD, NIH, Bethesda, Md. 20014

The mechanism of action of chlorpromazine (CPZ) in the central nervous system is essentially unknown. It may have a specific action on synaptic transmission mediated by monoamines, either pre-synaptically by inhibition of transmitter uptake, or post-synaptically by blocking receptors. We have studied this problem by studying the effect of CPZ on uptake of radioactive, putative transmitters by synaptosomes from squid brain. Initial rates of transmitter uptake were measured at different substrate concentrations and temperatures. High affinity, specific uptake systems for L-noradrenaline (L-NA), serotonin (5-HT), aspartate, glutamate, choline and glycine were detected. CPZ (10^{-5}M) was found to inhibit only L-NA and 5-HT uptake. The mechanism of CPZ inhibition for L-NA and 5-HT was found to be competitive with K_I = 1.7 x 10^{-7}M and 2.5 x 10^{-7}M, respectively. The more general metabolic antagonists DFP, KCN and ouabain inhibited the uptake of all transmitters by a non-competitive mechanism with $K_{1/2} \approx 0.1$ mM. In seperate experiments it was noticed that CPZ did not alter the effects of L-NA and 5-HT on post-synaptic membranes of snail neurons. We conclude that the selective, antagonistic effects observed with squid synaptosomes may reflect a direct action of CPZ at pre-synaptic uptake sites. These observations with an invertebrate model may provide insight into the mechanism of CPZ's action in the vertebrate CNS.

540 CONTRIBUTION OF THE CAUDO-PUTAMEN TO SPONTANEOUS ALTERNATION IN RATS. Michael Potegal & Larry R. Squire. Dept. Behav. Physiol., N.Y. State Psychiatric Institute, N.Y., N.Y. 10032 & V. A. Hospital, San Diego, Cal. 92161.

Previous research (Potegal JCPP 69:756, 1969) has suggested that the caudo-putamen (CP) is involved in a system for egocentric spatial orientation. This observation, combined with evidence that the CP receives vestibular input, leads to the prediction that CP lesions should impair performance requiring vestibularly guided spatial orientation. Spontaneous alternation (SA) by rats of entries into the arms of a T-maze on successive trials appears to be such a performance. According to Douglas (JCPP 62:171, 1966) the direction of rats' responses during SA is controlled largely by vestibular information with a minor olfactory contribution from the odor trail of S's previous arm entry.

In our first experiment we found a significant, though small, SA deficit in rats with CP lesions when all relevant cues were available to guide SA. In another experiment we demonstrated that: 1) CP lesions severely impaired SA when it was controlled by spatial cues but not when it was controlled by olfactory cues. The reverse was true for olfactory bulb lesions. 2) In accord with previous work, posterior CP lesions produced a greater deficit than anterior lesions. The results support the hypothesis that the CP is involved in spatial orientation.

541 CONNECTIONS OF THE ACCUMBENS NUCLEUS IN THE SQUIRREL MONKEY. Ervin W. Powell and Robert B. Leman*. Dept. Anat., Sch. Med., UAMC, Little Rock, 72201

Reports from previous works have not given a distinct classification to the accumbens nucleus. Furthermore, there appears to be little knowledge of the connections of this nucleus. This work was undertaken to clarify the connections of this structure. Silver impregnation methods were used to discern some of the afferent fibers of the nucleus and autoradiographic techniques were used to locate target areas of efferent projections. Afferents were found to be predominantly from the septum. Other sources of possible afferents were the cingulate gyrus and the ventral nucleus of the diagonal band. No argyrophilia was observed in the accumbens nucleus following transection of the fornix body. On the basis of radioactive grains observed, the accumbens nucleus projects to the cingulate gyrus, septum, ventral nucleus of the diagonal band, lateral hypothalamus, midline thalamic nuclei, habenula, caudate, globus pallidus and substantia nigra. Efferent projections were distributed to both limbic and extrapyramidal structures, however, from the proximity of the nucleus to the septum and from the predominance of the connections to limbic structures the accumbens nucleus should be considered as part of the septal region.

(Supported by NSF Grant GB32170)

542 SURFACE ELECTRIC ASYMMETRY AND HEMISPHERIC DOMINANCE. Juan de Dios Pozo-Olano. Dept. Neurol., Mt. Sinai Sch. Med., N. Y. C.

The EEG record of alpha waves in normal subjects shows a consistent phase relationship between simultaneous alpha rhythms in homotopic hemispheric areas. There is also a high correlation of alpha amplitude and stability among interareas recorded. The mechanisms underlying interhemispheric alpha synchrony appear to be highly reproducible in normal subjects, consistently showing positive and negative maximal values in posterior cerebral regions, as shown by equipotential field maps (Pozo-Olano, 1967 & 1969). Dyslexic children present very little and an asynchronous alpha rhythm, the main spatio-temporal feature of which is the asymmetry existing between the two hemispheres. These children are not likely to enhance their alpha activity and bilateral synchrony due to acoustic stimuli requiring discriminatory attention (Martinius,1972). The alpha rhythm is related not only to visual performance or attentional level, but also to several sensory and motor modalities. These in turn embody interhemispheric communication and interactions, the physiological rule of which follows some kind of functional asymmetry. In dyslexic children the poor reading is secondary to primary sensory and perceptual dysfunctions. There are also strong motor and psychomotor components to those deficits. The EEG patterns relate to these shortcomings, which in some cases also involve language deficiency and laterality problems. All of these components may indicate interhemispheric transfer conflict producing learning interference.

543 EFFECT OF INTRACEREBRAL HERPES VIRUS INJECTION IN CATS. R. S. Pozos, R. J. Ziegler*, M. Hartmann*, J. Lyons*. Dept. of Phys. and Micbiol., Sch. Med., University of Minnesota-Duluth, Minnesota, 55812.

Herpes Simplex Virus I grown in Hep-2 cells, (pfu of 10^7) was injected intracerebrally into anesthetized adult cats. An injection of lcc in the mesencephalon in the region of the superior colliculus produced an initial transitory (1 wk) period of lethargy. At the end of that time, all animals recovered and no noticable effects of the injections were seen. Approximately 1.5 months after the day of injection, 65% of experimental animals demonstrated hindlimb ataxia. Initially the animals would use their tail to balance while they walked. As the ataxia became more pronounced, animals walked in a crouched position. There was no hypotonia. Experimental animals were able to right themselves and the forelimbs demonstrated no abnormal position. A study of the brain for viral inclusion bodies showed that the initial sites of viral infectivity were primarily the Purkinje cells and dorsal root ganglion. Forty-eight hrs after injection of the same virus into neonatal kittens (12 hrs old) produced 90% fatality. Before death, kittens demonstrated forelimb extensor rigidity and head clonus. The animal was able to right itself. Herpes virus was isolated from these experimental kittens. In both studies, no control died or demonstrated any abnormality in gait. These initial results indicate that the cat can be used as a model to study latent viral infections of the central nervous system. (This study was funded in part by a grant from the Sloan Foundation.)

544 A NEUROPHYSIOLOGICAL ANALYSIS OF ANTEROLATERAL QUADRANT (ALQ) NEURONS SUBSERVING PAIN IN M. MULATTA. Donald D. Price and David J. Mayer. Dept. Physiol., Med. Col. of Va., Richmond, Va. 23298, USA.

An electrophysiological analysis was made of 85 L-7 dorsal horn neurons antidromically activated from the contralateral C-1 ALQ of unanesthetized rhesus monkeys (bilateral carotid ligation). This analysis was made to compare refractory periods, thresholds, and nociceptive responses of classes of dorsal horn cells optimally responsive to nociceptive stimuli with these same parameters of ALQ stimulation required to produce pain in conscious humans (Mayer, Price and Becker, Soc. Neurosci. 1974). Refractory periods of layer IV-VI nociceptive cells (0.8 - 2.1 msec; $\bar{m}$ = 1.5 msec) were briefer than those of layer I cells (1.1 - 10 msec; $\bar{m}$ = 4.7 msec). Electrical thresholds of layer IV-VI cells ($\bar{m}$ = 404 μA) were, in general, much lower than those of layer I cells ($\bar{m}$ = 1527 μA). Unlike lamina I cells, refractory periods and electrical thresholds of layer IV-VI nociceptive neurons closely parallel those of ALQ-evoked pain in man. However, both layer I and layers IV-VI neurons usually responded to nociceptive skin temperatures (> 43°C). Although firing frequencies elicited by these temperatures varied considerably among these units, the mean firing frequency of all responding units was a linear function of skin temperature. This mean frequency ranged between 5 and 25 Hz over a temperature range (43 - 45°C) which contains most human pain thresholds. This frequency range is the same as that observed for the relationshop between ALQ stimulation frequency and percent pain reports in man (cf. Mayer et al. Soc. Neurosci, 1974). This analysis indicates that pain may be signaled by the combined output of dorsal horn laminae I, IV-VI but that output from only laminae IV-VI neurons is sufficient to produce pain. Supported in part by grants NS10251-02 and DA00576-01.

545 A COMPUTER SYSTEM FOR USE WITH THE AUTORADIOGRAPHIC METHOD FOR TRACING AXONAL CONNECTIONS. J. L. Price, D. F. Wann*, and W. M. Cowan. Dept. Anat., Washington Univ. Sch. Med., St. Louis, 63110.

A computer system for the automated analysis of autoradiographs has been developed, specifically for use in axonal tracing experiments. The system consists of a research microscope (the stage and focusing mechanisms of which are controlled by stepping motors), a television camera, and a small digital computer. The principal feature of the system is its ability to count silver grains rapidly and accurately over a wide range of grain densities. In addition automatic focusing procedures, and automatic stage movements, allow large areas to be scanned and counted with little or no operator intervention. The boundaries of the area to be counted can be easily specified, and the location of morphological landmarks within, or around, this area can be identified and related to the grain counts, so that the spatial distribution of grains over a wide area can be easily determined. Within the range of 0-300 grains/1000μ^2 the counts obtained using this computer system have been found to agree within 10% with visual counts made over the same area. A single field of 1000μ^2 can be counted in less than 10 seconds and an area of 1 mm^2 in less than three hours. In practice an area which may take several days to count visually can be done in a single afternoon with the computer. Further modifications may substantially increase the speed of the system, and adapt it to other applications of autoradiography.

546 AGE-RELATED CHANGES IN BRAIN FUNCTIONING: RELATIONSHIP OF SLEEP VARIABLES TO LONGITUDINAL CHANGES IN INTELLECTUAL FUNCTION. Patricia N. Prinz,* Gail R. Marsh and Larry W. Thompson.* Ctr. for the Study of Aging & Hum. Dev., Duke Univ., Durham, N.C. 27710

When 12 health elderly subjects (aged 78 to 95) are studied to determine the circadian levels of sleep variables, individual differences emerge which are positively related to intellectual functioning. The time spent in REM sleep is known to be positively related to Wechsler Adult Intelligence Scale (WAIS) performance scores (Feinberg, Sci. 159, 1256). Our study included an additional sleep variable: the total time spent with slow wave (delta) activity in the sleeping EEG (delta time). This measure, like REM time, correlated positively with contemporaneous WAIS performance scores, unlike the more conventionally measured delta sleep--stage 4. Both REM and delta time correlated ($r \geq .796$) even more strongly with longitudinal change in WAIS performance scores obtained over the preceding 18 year period. The results may reflect an aging process in the brain which is detectable not only in measures of intellectual function, but also in measurements of REM sleep and delta wave activity in the sleep EEG. We also have indications that these sleep measures relate positively with other variables reflecting age-related change in functional integrity of the brain, such as slowing of rhythms in the waking EEG and (in 8 of 9 cases) lowered cerebral blood flow as estimated by the Xe inhalation method (Obrist, Circ. Res. 20, 124).
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547 LATERALLY CONDUCTED SIGNAL AND INTERACTIONS OCCURRING AT LIGHT OFFSET IN THE PROXIMAL RETINA OF NECTURUS.
Luis M. Proenza. Vision Research Laboratory, Department of Psychology, University of Georgia, Athens, Georgia 30602.

A laterally conducted signal produced by light offset in the proximal retina has been isolated, and its effects on a centrally located test flash determined via extracellular microelectrode recordings of the proximal negative response (PNR)--a potential believed to be generated largely by amacrine cells (Proenza & Burkhardt, J. Neurophysiol, 1973, 36: 502-518). The laterally conducted signal is itself a negative transient, occurs with a delay of @ 200 msec relative to the off response evoked by a central test flash of equal intensity, and is evoked by a spot of small diameter (100 μm) located between 150-270 μm eccentric from the central test flash. It may occasionally reach an almost equal amplitude to that produced by the offset of the central flash. With two microelectrodes and two-spot stimulation, the PNR and the laterally conducted signal have been observed simultaneously and lateral interactions between them studied. A central test flash preceding the eccentric spot facilitates the conduction of the lateral signal, whereas preceding the central test flash by the eccentric spot can enhance the PNR. These effects may last several seconds, and resemble the transient Westheimer effect recently reported by D. R. Peeples (ARVO, Sarasota, Fla., April, 1974). It is suggested that these lateral effects in response to transient stimuli are mediated by amacrine cell channels. (Supported by NIH Grant EY 00973-02.)

548 FORMATION OF COCKROACH INTERGANGLIONIC CONNECTIVES: AN IN VITRO ANALYSIS.
Robert R. Provine, Luigi Aloe* and K. R. Seshan*. Dept. Biol., Washington Univ., St. Louis, Mo. 63130.

Individual ganglia of the cockroach (Periplaneta americana) embryonic CNS were explanted on clean glass coverslips immersed in a chemically defined liquid medium and incubated for 3-6 weeks. Substantial, straight interganglionic connections were formed between:

1) Rows of ganglia arranged in the normal in vivo configuration;
2) Rows of ganglia placed in abnormal orders;
3) Rows of ganglia which never form connections in vivo because they occur singly in the embryo; and
4) Rows of ganglia in natural sequences but which have had their rostrocaudal axes rotated 90° in relation to the line of the row.

Therefore fascicles and interganglionic connectives were formed without regard to normal in vivo relationships.

Daily observations with a Nomarski microscope indicated that several processes were involved in connective formation:

1) Initial outgrowth was in a random, radial pattern.
2) Intersecting fibers from adjacent ganglia are deflected toward each others' perikarya.
3) Fibers are shortened, which results in a straightening of interganglionic connectives and a pulling in of fibers which do not form strong terminal adhesions.
4) Outgrowing fibers follow already established fiber pathways.

Striking geometric patterns of nerve fibers emerge as the result of the fiber interactions and shortening described above. (Supported by NIH Grant NS-03777 and NSF Grant GB-16330X to Prof. Rita Levi-Montalcini)

549 RESPONSE OF PRIMARY SOMATIC SENSORY NEOCORTICAL NEURONS TO PAIRED MECHANICAL PULSES APPLIED TO THE RACCOON'S FOREPAW. Lillian M. Pubols, Robert F. Leroy*, and Benjamin H. Pubols, Jr. Dept. of Anatomy, Hershey Medical Center, Pennsylvania State University, Hershey, Pennsylvania 17033

The responses of single neurons in the forepaw region of the raccoon's primary somatic sensory neocortex were recorded extracellularly in six animals anesthetized with methoxyflurane. Only units responding to light mechanical stimulation of the glabrous skin were examined in detail. Six displayed an initially positive action potential (presumed axons), and 18, an initially negative action potential (presumed cell bodies). Single and double mechanical pulses (200 or 500 μ, 4 msec rise and fall times) were applied to the center of the cutaneous receptive field of each unit with a 1 mm diameter probe. Two positive units and three negative units continued to respond for at least 500 msec to a sustained mechanical displacement of the skin. The remainder gave only "on" or "on/off" discharges with latencies of 10-20 msec. Following a response to mechanical stimulation spontaneous activity was often depressed for periods of up to 200 msec, sometimes followed by a second burst of activity. For the negative units the probability of a response to the second of a pair of mechanical pulses (10 msec duration each) was directly related to the size of the interpulse interval, for intervals less than 100 msec. For the positive units the probability was 1.0, or nearly 1.0, for interpulse intervals as small as 5 msec. In the raccoon's somatic sensory neocortex it has been shown that following punctiform mechanical stimulation of the skin there is a depression of spontaneous activity and a lowered probability of a response to a second stimulus applied to the same locus on the skin. These results suggest that following stimulation of the skin there are characteristic changes in excitability of neocortical neurons, possibly resulting from the temporal pattern of afferent input. (Supported by USPHS grant NS-06371)

550 SYNAPTIC REORGANIZATION OF THE RAT CEREBELLUM DEGRANULATED BY POSTNATAL X-IRRADIATION. Donald G. Puro and Donald J. Woodward. University of Rochester, School of Medicine, Rochester, N.Y. 14642

Purkinje cell recordings were obtained from ataxic adult rats subjected to a nearly complete elimination of the granule, basket and stellate cells of the cerebellum by means of repeated doses of low level (150-200r) X-irradiation during the first two postnatal weeks. Needle electrodes were inserted into limb muscles to provide an activation of mossy and climbing fibers projecting to the degranulated cerebellum of rats anesthetized with 0.5% halothane. Groups of spikes with variable inactivation occurred at 15-30 msec latencies and followed at frequencies no greater than 10/sec. These characteristics are comparable to transmission in the normal climbing fiber system. Intracellular studies indicated the frequent presence of multiple climbing fiber inputs to one Purkinje cell. Normally one Purkinje cell is innervated by only one climbing fiber. Limb muscle stimulation also elicited simple spike responses with 4-7 msec latencies that followed best when stimulation was faster than 1/sec, and could respond up to 50/sec, similar to normal mossy fiber input. Most responsive cells were found in paravermal zones comparable to effective areas in normal cerebellum, indicating that main topographical projections are unaltered. Stimulation of the ipsilateral medulla resulted in simple spike responses in Purkinje cells with a 2 msec latency, which is 1 msec faster than normal. We conclude that mossy fibers may synapse with Purkinje cells directly in the absence of interneurons. We also found short latency pure inhibitory responses (9 msec) to limb stimulation. This inhibition may be mediated by recurrent collaterals of Purkinje cells. In addition, many Purkinje cells showed an entrainment of their spontaneous oscillatory activity by limb or medulla stimulation. This oscillatory activity is not observed in normal cerebella. These results demonstrate the significant reorganization of the cerebellum in the absence of interneurons. (Supported in part by USPHS grants TF AM 1004-08, NS 09820, NSF GB 28873X, NINDS IF11NS 11,030).

551 MANGANESE CAN BLOCK LATERAL AND SELF-INHIBITION IN THE LIMULUS EYE. Richard L. Purple and Jane P. Eagles*. Lab. of Neurophysiology, Dept. of Physiology, Univ. of Minnesota Med. School, Minneapolis, Minnesota 55455.

According to a general hypothesis, excitatory, chemical synaptic transmission requires an inward calcium current for the release of the transmitter agent, and relatively small amounts of Manganese will block this current and therefore prevent transmitter secretion. We tested the two synaptic processes (lateral and self-inhibition) of the lateral compound eye in Limulus to see if the hypothesis might generalize also to inhibitory synapses. Antidromic stimulation of the optic nerve was used to produce lateral inhibition. Current injected through an impaling micropipette was used to produce a train of impulses thereby generating self-inhibition. The methods avoided possible complexities in interpreting the data obtained because of the effect of Manganese on light-initiated activity. When 20 mM Manganese was added to the normal perfusate of the excised lateral eye, both lateral and self-inhibition appeared to be completely suppressed. The effect registered within 30 seconds to 5 minutes, and it was completely reversible with a 5-10 minute washout using normal perfusate. Lesser amounts of Manganese appeared to suppress the inhibitory processes in a graded manner. We interpret the results to be consistent with the general hypothesis stated above, and to extend the coverage of that hypothesis to at least some chemical, inhibitory synapses. (Supported in part by USPHS grants EY00293 and GM00572, and USAF grant AFSC-1221.)

552 ACTION OF DIPHENYLHYDANTOIN ON CORTICAL POSTSYNAPTIC INHIBITION. W. Raabe and G.F. Ayala. Depts. of Neurology, St. Paul-Ramsey Hospital and University of Minnesota, St. Paul, Minnesota 55101.

The action of Diphenylhydantoin (Dilantin^{R}) on postsynaptic inhibition was investigated in cat motor cortex by extracellular recording from pyramidal tract (PT) cells. Recurrent postsynaptic inhibition of PT cells elicited by a brief train of stimuli normally suppressed antidromic action potentials for a period of time ranging from 34 to 78 msec. Intravenous administration of Diphenylhydantoin (10-20mg/kg) increased the duration of the suppression of antidromic action potentials. This observation suggests a prolongation of recurrent intracellular hyperpolarizing IPSPs which are responsible for the suppression of action potentials. To explain an increased duration of hyperpolarizing IPSPs Diphenylhydantoin has either to prolong the action of inhibitory transmitter on the postsynaptic membrane or to increase the gradient between resting membrane potential and E_{IPSP}.

553 BEHAVIORAL STUDY OF DESCENDING PATHWAYS FROM THE DEEP LAYERS OF SUPERIOR COLLICULUS IN TUPAIA GLIS. D. Raczkowski*, I. T. Diamond, and V. A. Casagrande, Departments of Anatomy, Physiology and Psychology, Duke University Durham, North Carolina 27706, and Department of Anatomy, University of Wisconsin, Madison, Wisconsin 53706.

Total ablation of the superior colliculus in the tree shrew leads to a striking deficit in visual attention as manifested by a loss of visual tracking and a failure to withdraw from threatening stimuli (Casagrande, V. A. and I. T. Diamond, J. Comp. Neurol., 1974, in press). Yet these animals are capable of learning habits based on discriminating patterns and can orient toward apertures when running through a maze. Since the deficit is not produced by a lesion confined to the superficial superior colliculus, the question is raised whether a lesion confined to the deep layers of the superior colliculus would produce the behavioral change. To answer the question, we took advantage of an earlier finding (see Harting et al., J. Comp. Neurol., 148: 361-386, 1973), that a major portion of the descending fibers from the deep superior colliculus cross in the predorsal bundle. At this time, four cases have survived surgery aimed at transection of the crossed descending fibers. Histological results show that the predorsal bundle was transected in all four cases without concomittant damage to the nuclei of the third, fourth, sixth, or seventh cranial nerves. All of the symptoms of visual neglect previously reported were conspicuous in all of the present cases. None of these animals showed motor symptoms. At the same time, these animals were as good or better than the earlier ones in pattern discrimination. We conclude that the profound deficit in visual attention can be attributed to damage to the deep layers of the superior colliculus and does not depend on the superficial three layers. (Supported by NIMH Grant MH-4849).

554 NEUROCHEMICAL EXAMINATION OF A LEUKODYSTROPHY WITH ACCOMPANYING ADRENAL INSUFFICIENCY. R.B. Ramsey*, N.L. Banik*, and A.N. Davison*. (Spon: S. Horenstein). Saint Louis University, Saint Louis, Missouri 63104 and Institute of Neurology, London, England.

This report deals with the chemical composition of a patient with adrenal insufficiency and diffuse cerebral sclerosis. Five other cases which have undergone biochemical examination have been reported in the literature. The tissue examined here was edematous. The white matter had 26.3% of its cholesterol esterified, the gray matter 14.1%. Large amounts of free fatty acid were present in both tissue types. Galactolipids and phospholipids were depleted by at least 50% in the white matter. Cholesterol was the only sterol found in the brain. Examination of the fatty acid profiles of various tissue lipids indicated that, compared to a control, gray matter ethanolamine phospholipid had elevated levels of saturated fatty acids. White matter ethanolamine phospholipid also was reduced in long chain fatty acids, while the saturated fatty acid content was comparable to normal. Phosphatidyl choline fatty acids in the diseased tissue were more saturated than the control tissue phosphatidyl choline. Fractionation of the tissue for myelin resulted not only in the isolation of myelin, but also in a ubiquitous amount of very fatty material. This has been referred to by others as a floating fraction. Further water shocking of this floating material resulted in a pellet which bore some morphological similarity to myelin plus a fatty fraction which had no demonstrable ordered structure. The myelin and related fractions all contained 2',3'-cyclic nucleotide phosphohydrolase activity, a marker enzyme for myelin. The activity of this enzyme for the diseased myelin and the other abnormal fractions combined was only about 3% of that of the control tissue. The neural damage in cases of leukodystrophy with adrenal insufficiency appears to involve demyelination of a general and sometimes severe nature. The mechanism of this demyelination remains unknown.

555 CHEMOSENSITIVITY OF MOUSE SPINAL CORD NEURONS IN CELL CULTURE. B. Ransom*, E. Giller and P. Nelson. Behavioral Biology Branch, NICHD, NIH, Bethesda, Md. 20014.

Glutamate, γ-aminobutyric acid (GABA) and glycine produced conductance changes in the cell membranes of cultured mouse spinal cord neurons when applied iontophoretically. The dissociated cell cultures studied allowed high visual resolution of neuronal morphology so that spatial variations in sensitivity could be assessed. In several innervated cells, restricted areas of relatively high glutamate sensitivity were found. Other cells, in which no innervation could be demonstrated, exhibited a spatially uniform, relatively low glutamate sensitivity. In cells in which both excitatory post-synaptic potentials (EPSPs) and glutamate were concurrently studied we found that the reversal potential for glutamate was substantially more negative than that for the EPSP. In some other cells, however, the glutamate reversal potential was over 30 mV inside positive, which is more positive than many EPSP reversal potentials. GABA produced a marked increase in membrane conductance in many cells with the equilibrium potential for the GABA response lying between -20 and -60 mV in different cells. Glycine did not produce any responses when tested in complete medium (which contains 0.4 mM glycine) but glycine responses were readily obtained in glycine free medium. Dorsal root ganglion cells were tested for chemosensitivity, but failed to give responses to any of the compounds used. The effects of innervation and medium constituents on receptor synthesis, distribution in the cell membrane and activity will be discussed.

556 **NEURONAL LOCALIZATION OF S-100 IN NEONATAL AND ADULT RAT BRAIN.** **M. M. Rapport, H. Laev*, S. Mahadik*, and L. Graf*. Div. Neuroscience, N. Y. State Psychiatric Inst., New York, N. Y., 10032.**

As part of a program to correlate morphological development with biochemical processes, we have studied the appearance and distribution in neonatal rat brain of a specific nerve protein, S-100, by immunohistological methods. It is generally agreed that S-100 is found predominantly in glial cell cytoplasm of adult brain, but its presence in neuronal cells has been controversial. We find that S-100 is present at birth in a number of different areas of rat brain and is found in neuronal cells. These areas include the lateral recess of the fourth ventricle (neuroepithelium), cerebellum (external germinating layer), lateral ventricle (subependymal layer), hippocampus (pyramidal cells of Ammon's Horn, granular cells of dentate gyrus), cerebral cortex, and brain stem. Initial staining (stem cells and neuroblasts) in a narrow perinuclear region spreads into the nucleus, leaving nucleoli unstained. Cerebellar Purkinje cell nuclei begin to stain on the second postnatal day and eventually stain very intensely. Nuclei of many types of neuronal cells stain intensely in adult brain, with the exception of granule cells of the cerebellum. Glial cell cytoplasm stains at 5 days, and rapidly increases in intensity. Staining for S-100 has also been detected in the late embryonic stage. These studies are carried out on Sprague-Dawley rats using fresh frozen sections (10 μ) and cold chloroform-methanol fixation (Hartman, et al. 1972). The perinuclear localization of S-100 and the presence of this protein in neonatal rat brain has not been described before. The results suggest that S-100 may play a role in signalling nuclear processes related to proliferation and differentiation. (Supported in part by a grant from the National Multiple Sclerosis Society.)

557 EFFECTS OF AMPHETAMINE ISOMERS ON SPONTANEOUS NEURONAL ACTIVITY IN THE CAUDATE NUCLEUS AND RETICULAR FORMATION. George V. Rebec* and Philip M. Groves. Dept. Psych., Univ. Colo., Boulder, Co. 80302

Spontaneous neuronal activity in the caudate nucleus and mesencephalic reticular formation of male Sprague-Dawley rats was recorded following intraperitoneal injection of d-amphetamine sulphate (2.0 mg/kg) or l-amphetamine sulphate (2.0 mg/kg). The dextrorotatory form of the drug generally produced a brief increase of firing rate in the caudate nucleus that began approximately 8 to 10 minutes after injection and a subsequent prolonged depression that persisted for a period of time of from 70 to 120 minutes. The levorotatory isomer produced only a less marked depression of caudate neuronal activity of shorter duration. Mephentermine sulphate (6.0 mg/kg), a peripheral sympathomimetic, failed to produce these effects. In the mesencephalic reticular formation, d-amphetamine sulphate generally produced a prolonged increase of firing rate that was more pronounced and of longer duration than that produced by the levorotatory isomer. Mephentermine sulphate elicited only a slight increase in reticular formation activity not unlike that produced by l-amphetamine sulphate. When neuronal activity was monitored for extended periods of time following drug injection, an apparent rebound increase in firing rate was observed in the caudate nucleus following the amphetamine-induced depression, while a rebound depression of activity was apparent in the reticular formation subsequent to the initial increase in firing rate. These results are consistent with the known biochemical and behavioral effects of the stereoisomers of amphetamine.

558 INTERRELATIONS OF STIMULUS SECRETION COUPLING AND TRANSPORT OF γ-AMINOBUTYRIC ACID IN ISOLATED SYNAPTOSOMES. Dianna A. Redburn and Carl W. Cotman. Dept. Psychobiol., Sch. Biol. Sci., UCI, Irvine, 92664.

Isolated synaptosomes provide a suitable system to examine stimulus secretion coupling processes in vitro under defined conditions and over short time periods. In the CNS it is a generally held contention that after γ-aminobutyric acid (GABA) is released, it is removed and perhaps restored to the releaseable pool by a Na-dependent, high affinity transport system. We directly tested this hypothesis in isolated synaptic endings. Synaptosomes loaded with GABA in the presence of Na accumulate and can release radioactive GABA when stimulated by Ca in the presence of high K concentrations. The newly accumulated GABA can be immediately released since loading from 1 min to 20 min results in the release of a similar percent of the total accumulated GABA. The GABA analogue, diaminobutyric acid (DABA), pre-loaded in the presence of Na is accumulated and released with Ca stimulation. Thus GABA and DABA accumulated via the Na dependent transport process is rapidly accessible to the Ca dependent secretory process. Pre-loading of synaptosomal fractions in the absence of Na, so that the low affinity transport process prevails, and subsequent stimulation by Ca does not result in the release of as large quantities of GABA expressed as percent of the total. Thus the release process is linked specifically to a pool served by a Na-dependent uptake process.

559 FURTHER IN VITRO STUDIES OF SKELETAL MUSCLE SARCOLEMMA: PHOSPHORYLATION OF MEMBRANE PROTEIN. N. B. Reddy*, R. Tsukui*, W. K. Engel, and B. W. Festoff. NIH, Bethesda, Md. 20014.

Phosphorylation of membrane protein components may be involved in the overall function of excitable membranes. We thought it of value to study the properties of phosphorylation in purified sarcolemmal membranes (SL) prepared as previously described (Festoff & Engel, PNAS June '74). These SL incorporate ^{32}P from [γ-^{32}P] ATP. This acid-precipitable, covalent incorporation occurs quite rapidly (10 secs) on ice. The SL-protein labelling requires Mg^{++}. Other ionic conditions are extremely important, both qualitatively and quantitatively. Na^{+} (100mM) stimulated total ^{32}P-incorporation 2-fold. K^{+} (20mM), on the other hand, reduced total SL-protein labelling about 25%. In the presence of Ca^{++} (5mM), total ^{32}P-incorporation was inhibited as much as 80%. SDS-polyacrylamide gel electrophoresis was used to characterize the subspecies labelled under the above conditions. Preferential labelling of a high M.W. protein (about 100,000 daltons) occurred in the presence of Mg^{++}, Mg^{++} + Na^{+}, or Mg^{++} + K^{+}, the difference being quantitative. ^{32}P incorporation also occurred in a smaller 20,000 M.W. peptide but was very low. Ca^{++} however, practically eliminated the high M.W. ^{32}P peak and selectively labelled the 20,000 M.W. peptide. Cyclic AMP or cyclic GMP had no significant effect on SL phosphorylation. These studies suggest that the phosphorylation of SL proteins is profoundly influenced by cations, consistent with the known properties of the phosphorylated intermediate of NaKATPase in other membrane systems. The 20,000 M.W. peptide, phosphorylated in the presence of Ca^{++}, may be similar to the protein species found in the sarcotubular system of skeletal muscle (Masoro & Yu, BBRC 34:656, 1969). This may be indicative of a Ca^{++}-transport system inherent in SL, possibly representing the sarcotubular invagination of the SL.

560 *STRUCTURE OF CEREBELLAR CORTEX PREPARED FOR FREEZE-FRACTURING BY RAPID FREEZING.* T. S. Reese and D. M. D. Landis. *Lab. Neuropath. Neuroanat. Sci.*, NINDS, NIH, Bethesda, MD 20014

In order to examine the structure of membranes unaltered by fixatives or cryoprotective agents, a rapid freezing procedure (Van Harreveld et al., J. Cell Biol., 1965) was adapted to prepare excised mouse cerebellar cortex for freeze-fracturing within 45 seconds of decapitation. Membranes in the superficial molecular layer had a smooth contour, cross-fractured cytoplasm had a finely particulate appearance, and mitochondria and other organelles were readily identified. No structure was apparent in the intercellular spaces, which were wider than in fixed tissue. Distortion from ice crystal formation became progressively evident deeper in the cortex. In regions free of discernible ice crystals, single intramembranous particles were found randomly distributed on each half of fractured membranes and were more numerous on the cytoplasmic than the external half. Particles in astrocytic membranes were large and irregular, permitting these membranes to be distinguished from neuronal membranes. Elongate particles, never seen in fixed tissue, were randomly distributed on the outer halves of both astrocytic and neuronal plasma membranes. The single particles clustered at gap junctions and at synapses, and the astrocytic assemblies were similar to those in fixed tissue. However, the ridges at tight junctions adhered to the external rather than the cytoplasmic half of the plasma membrane. Coated pits in the presynaptic plasma membrane were infrequent and no clear sites of synaptic vesicle fusion were found, probably because of the low level of synaptic activity in the excised slab and the extreme rapidity of the freezing. It appears that this fresh freezing procedure can reveal new aspects of membrane structure, allow identification of artifacts created by other methods, and "fix" labile structures extremely rapidly.

561 SINGLE UNIT RESPONSE DECREMENTS IN THE INFERIOR COLLICULUS OF DECEREBRATE CATS DURING REPEATED ACOUSTIC STIMULATION. D.E. Regan* and J. Buchwald. Dept. Physiol., UCLA, Los Angeles, CA 90024

Previous multiunit studies of acoustic habituation demonstrated habituation at the level of the inferior colliculus. This study investigated the single unit responses that underlie the multiunit activity. Responses were recorded extracellularly with glass micropipetts from 62 single cells in the inferior colliculus. Low frequency monaural tones and white noise of one second duration were presented repeatedly to paralyzed decerebrate adult cats. Rates of presentation varied from one tone per ten seconds to continuous tones. The response to a single tone presentation consisted of one or several phases including ON, OFF, STIMULUS, and AFTER responses. During repetitive stimulation the response phases varied independently. Phase decrements up to 100 percent of control magnitudes were observed which subsequently showed spontaneous recovery after cessation of the stimulus. 29% of the cells showed phase sensitization to repeated stimulation. Both excitatory and inhibitory response phases exhibited habituation or sensitization. The percent of habituation was greater at faster stimulation rates and at lower sound pressure levels. Correlation of initial firing rate and percent habituation showed a significant negative correlation of -.619. The long lasting STIMULUS responses were more likely to habituate and habituated to a greater degree than the shorter duration ON and OFF responses. STIMULUS responses also showed a significant correlation of .875 between latency and percent habituation. Using a cutaneous shock to the outer canthus of the eye, an average dishabituation of 66 percent was produced. The results suggest that the decrements at the level of the inferior colliculus represent a form of CNS temporal coding which is highly dependent on the specific connectivity of the individual cells. (Supported by USPHS Grant #NS 05437)

562 A FAMILY OF SIMPLE MODELS RELATING REFLEX AMPLITUDE, VARIABILITY, AND INTERCORRELATION TO STIMULUS INTENSITY. Kenneth H. Reid. Dept. Physiol. and Biophys., Sch. Med., U. of Louisville, Louisville, Ky. 40201.

A family of statistical models is developed, based on the description of reflex variability as due to the activity of a neuronal pool in which individual neurons have differing excitabilities. The models are based on two curves, one defining the distribution of excitabilities within the pool and the other defining the probability of firing of an individual neuron. The pool output, in response to a stable, repeated, stimulus, is assumed to be influenced by the uncorrelated fluctuations of activity of its individual neurons, and also by fluctuations due to influences from other neural systems which affect the pool as a whole, in effect modulating the input from the stimulus. Measurable properties of the system are strikingly unaffected by substantial alterations in the shapes of the curves defining it; i.e. this is a robust model. From the model it is possible to derive expressions and inequalities permitting numerical estimations of scale factors, pool sizes, and variance ratios from experimental data. Numerical examples will be given using data from studies on the digastric (jaw-opening) reflex of the cat. (Supported by grant DE-03644 from NIDR).

563 MYELIN DEFICIENCY IN THE CNS OF DWARF (SNELL'S) MICE. Paul J. Reier, Jean-Marie Matthieu*, and Kenneth S. Brown*. National Institutes of Health, Bethesda, Maryland 20014.

As a result of a single gene mutation, dwarf mice lack pituitary Thyroid Stimulating Hormone, Growth Hormone, and Prolactin. The degree of myelination in 19 day-old dwarf mice and their normal littermates was examined morphologically and biochemically in order to determine how these genetically-regulated, multiple pituitary deficits affect this process. A 40% reduction in body weight with only a 14% decrease in brain weight was seen at this age. In transverse 2 μm sections, the area of the pyramidal tract in the dwarf brain was reduced by 30%. The distribution of myelinated fibers, based upon the number of lamellae, was normal; however, the density of myelinated fibers in the dwarf was approximately 40% less. No concomitant reduction in total fiber density was seen. Myelin fractions were purified from brains of dwarf mice and normal littermates. The yield of myelin in dwarfs was decreased by 45%. The specific activity of the myelin marker enzyme, 2', 3'-cyclic nucleotide 3'-phosphohydrolase, was similar to control myelin. Myelin proteins and glycoproteins in the isolated fraction were extracted with SDS, separated by polyacrylamide gel electrophoresis and stained with fast green or with PAS reagents. No significant differences could be found for myelin basic proteins, proteolipid proteins, the high molecular weight fraction and myelin-associated glycoproteins. The lipid composition and concentration in myelin from dwarfs was normal. These results showed that in dwarf mice there was an important reduction in the amount of myelin but that its composition was normal. These biochemical data together with the morphological observations suggest that, at least during the early phase of myelin deposition, the hormonal deficits do not affect the degree of myelin maturation but instead reduce the number of fibers which start to myelinate.

564 THE NATURE OF THE SLOW DECLINE OF DOPAMINE-β-HYDROXYLASE ACTIVITY DURING ANTEROGRADE DEGENERATION OF CENTRAL NORADRENERGIC NEURONS. D. J. Reis, R. A. Ross, T. H. Joh and P. M. Field. Dept. Neurol., Lab. Neurobiology, Cornell U. Med. Coll., New York, 10021

Lesions transecting axons of central noradrenergic (NE) neurons result in a gradual decline of dopamine-β-hydroxylase (DBH) activity in degenerating NE terminals. The slow rate of decline of DBH activity contrasts with the rapid fall in transected peripheral sympathetic axons. We sought to determine if the slow decline in brain DBH was a characteristic of the whole NE neuron, if the fall was due to reduced accumulation of specific enzyme protein, and if degeneration products are retained in glia. Electrolytic lesions of lateral hypothalamus (axons) or of locus coeruleus (cells) resulted in a comparable rate of decline of DBH in frontal cortex reaching a nadir at 12-14 days at 10-15% of control. Immunotitration with a specific antibody to DBH demonstrated that the decline was entirely attributable to decreased enzyme protein. Electron microscopy of terminals revealed the presence of electron dense orthograde degeneration at 12-48 hours. After 7-14 days degenerating fragments, including dense core vesicles, were observed engulfed in astrocytic processes. We conclude that the loss of DBH activity during the anterograde degeneration in central NE neurons is a consequence of axonal degeneration initiated by lesions at any site within the cell and that the fall of DBH activity is due to reduced accumulation of specific enzyme protein. The slow decline of DBH probably reflects a gradual destruction of terminals and vesicles containing this enzyme in glia rather than a delayed process of disruption of a axonal processes. (Supported by NIH Grants and Harris Foundation).

565 Antidromic and orthodromic activation of basomedial and periventricular hypothalamic neurons. L.P. Renaud and J.B. Martin, Div. Neurology, Montreal General Hospital, McGill University, Montreal, Quebec, Canada.

Hypothalamic regulation of adenohypophyseal secretion can be modified by several extrahypothalamic structures. In an attempt to define their functional role, we have initiated a systematic electrophysiological investigation of the influence of single shock stimuli delivered to the amygdala or stria terminalis pathway, preoptic region, dorsal hippocampus and thalamic N. medialis dorsalis on hypothalamic unit activity. Extracellular action potentials were recorded from more than 400 basomedial or periventricular neurons in male rats anaesthetized with pentobarbital or urethane. Fifty-five neurons were classified as tuberoinfundibular (TI) cells; these were located mainly in the arcuate n. and periventricular region and displayed antidromic invasion (latency range 1.6 - 18.5 msec) to median eminence shocks. Eighteen TI neurons were otherwise electrically silent. Twenty-one of the 37 spontaneously active TI neurons were unaffected by any of the stimuli. Six TI neurons displayed a pause of 40-75 msec in their discharge activity following the antidromic spike. Stria terminalis stimuli evoked short latency excitation (N=3) or inhibition (N=2) but was usually without effect (N=15). TI cells tested with preoptic (N=3) or dorsal hippocampus (N=4) stimuli showed no response. N. medialis dorsalis excited (N=4), inhibited (N=2) or did not affect (N=1) the activity of TI neurons. Only one stimulation site appeared to influence the activity of any individual TI neuron. The general lack of response of TI neurons to these stimulation sites contrasted sharply with prominent response patterns of other non-TI ventromedial hypothalamic neurons. These results suggest that extrahypothalamic structures influence certain TI neurons indirectly, possibly via local non-TI neurons.

(Supported by the MRC).

566 ^{3}H-3-O-METHYL-D-GLUCOSE UPTAKE IN ORGANOTYPIC CULTURES OF CEREBELLUM AND MENINGES. K. Renkawek*, M. Spatz, M. R. Murray, and Igor Klatzo. NIH, Bethesda, Maryland 20014.

In a project directed toward studying glucose transport in the brain, organotypic cultures of newborn rat cerebellum and pia arachnoid are utilized. Employing the Maximow culture assembly, glucose uptake is followed in separate explants of brain and meninges after 14 days in vitro. The non-metabolizable hexose ^{3}H-3-O-methyl-D-glucose is used in concentrations of 1 uc/1 ml of nutrient media with and without 1 mM of unlabeled (cold) 3-O-methyl-D-glucose. The amount of radioactive hexose incorporation per mg of wet tissue is determined after various periods of incubation by liquid scintillation counting. Preliminary studies revealed a 30-50% uptake of ^{3}H-3-O-methyl-D-glucose from the nutrient media irrespective of the incubation time (30, 60, and 180 min.). The uptake of ^{3}H-3-O-methyl-D-glucose was inhibited to a variable degree (30-90%) in cerebellar explants incubated with the labeled and cold 3-O-methyl-D-glucose for 60 min. The meningeal explants took up 96% of the introduced ^{3}H-3-O-methyl-D-glucose in the media at 60 min. of incubation. Furthermore, two-thirds of this uptake was reduced when the nutrient media contained both the labeled and unlabeled tracer. The results of this preliminary investigation suggest clear differences between the behavior of the brain and meningeal tissue under the organotypic culture conditions, and that the performance by the meninges is more uniform than that of the brain tissue with its varied cellular elements.

567 ANALGESIA PRODUCED BY ELECTRICAL STIMULATION OF MIDLINE STRUCTURES OF THE ROSTRAL MESENCEPHALON AND CAUDAL DIENCEPHALON IN THE RAT. Dell L. Rhodes* and John C. Liebeskind. Dept. Psychol., UCLA, Los Angeles, Ca. 90024.

Our previous demonstrations of analgesia produced by electrical stimulation of the brain (ESB) have been primarily from sites in the caudal portion of the mesencephalic periaqueductal gray matter (PAG). Since both more rostral PAG and several medial diencephalic structures have been implicated in morphine analgesia, this study extends the use of ESB to these areas. Male albino rats were each implanted with 2 bipolar electrodes. Animals were screened for their responses to noxious heat using tail flick and hot plate tests, and to noxious pinch using small pliers and mouse-toothed forceps. In the tail flick test, average baseline latencies were 3.8 sec, and analgesia was defined as an increase in latency to above 6.0 sec after 15 sec - 1 min ESB during each of 3 test sessions. Hot plate analgesia was defined as an increase in latency to hind-paw licking of at least 50% over the average of 3 baseline trials (overall average baseline latency = 12 sec). In the pinch test, a 4-point rating scale ranging from 1 (no response) to 4 (normal response) was used. Analgesia was defined as a rating of 1 or 2 following ESB or a rating of 1 during ESB. Analgesia on all 3 tests was obtained from all sites in PAG from the caudal end of posterior commissure to the posterior hypothalamic nucleus(PH). A placement in PH and another in the posterior nucleus of the thalamus also produced good analgesia. Also in thalamus, stimulation of paraventricular nucleus yielded good analgesia; however, stimulation of rhomboid nucleus, nucleus reuniens, and dorsomedial nucleus did not. Stimulation of these latter areas often produced motor seizures without any increase in tail flick latency. These results extend the anatomical boundaries of the midline brain stem analgesia system into the caudal diencephalon. (Supported by NIH Grant NS-07628)

568 AN ULTRASTRUCTURAL STUDY OF THE RAT MEDIAL HABENULAR (MH) NUCLEUS. Jorge L. Ribas and Cyril P. Wingfield*. Department of Neurophysiology, Walter Reed Army Institute of Research, and Neuropathology Branch, Armed Forces Institute of Pathology, Washington D.C. 20012.

As part of a project aimed at understanding the possible role(s) of MH nucleus in neuroendocrine and visceromotor functions, a descriptive scanning (SEM) and transmission (TEM) electron microscopic study was undertaken. By SEM, the ependymal surface contained regularly spaced cilial tufts interspersed with microvilli and a network of cylindrical processes with varicosities. Correlative TEM showed that these processes were unmyelinated nerve fibers making synaptoid contacts with ependymal cells. The sub-ependymal region contained: 1) capillaries and fine neuropil surrounded by glial processes; 2) MH neurons in direct apposition with ependyma; and 3) occasional cisternae with homogeneous electron dense centers. Large and small neurons were found. Their cell bodies were arranged in glomeruli with a central neuropil. Neighboring cell bodies were either in direct apposition or separated by glial processes. This glomerular arrangement was more evident in myelin free areas. The neuronal nuclei had polar invaginations facing the origin of the dendrite. Each nucleus contained a prominent nucleoulus and a homogeneously dispersed karyoplasm. An extensive Golgi apparatus faced the region of nuclear infolding. Numerous smooth and coated vesicles were associated with Golgi cisternae. Lysosomes and multivesicular bodies were common. Large neurons had moderate stacks of rough endoplasmic reticulum (RER). In small neurons, the RER was dispersed in the perikarya. The neuropil consisted of oligodendroglial, fibrous astrocytic and neuronal cell processes with axo-dendritic, dendro-dendritic and axo-somatic synapses. The sub-junctional dense bodies reported in the cat MH nucleus (M. Milhaud and G. Pappas, Brain Res. 3[1966] 158-173) were not observed.

569 REINFORCEMENT CONTINGENCIES AFFECTING AMPHETAMINE, PENTOBARBITAL DISCRIMINATIVE CONTROL AND THE DEVELOPMENT OF RESPONSE-SPECIFIC BEHAVIORAL TOLERANCE. Daniel W. Richards, III*, Carol Meyer*, and Brenda Connelly* (SPON: Mary K. Roach). Texas Research Institute of Mental Sciences, Houston, Texas 77025.

Rats were trained in operant chambers under either a multiple variable interval (MULT VI VI) or differential reinforcement of low (MULT DRL DRL) rate schedule to discriminate between the 2-response levers on the basis of the drug injection preceding (15 min) each session. Schedule effects were evaluated by comparing the drug discriminative control of S's trained with injections of saline and either 1 mg/kg d-amphetamine (A vs S), or 15 mg/kg pentobarbital (P vs S), or both drugs together (A vs P) as the discriminative stimulus conditions differentially designating the reinforcing lever under each schedule condition. Acquisition gradients demonstrated that all groups trained with DRL contingencies developed drug-lever control more readily with greater values (% of drug-appropriate lever choices) at asymptotic levels than attained by the same treatments under VI contingencies. Testing with novel dosages of both A and P resulted in dose-related generalization gradients for all groups. Differences in shape and incidence of errors of over inclusiveness reflected schedule effects across groups. Together these results suggest that DRL responding is more amenable to influences by drug stimuli than responding under VI schedules. A treatments to A vs S VI S's always produced a significant increase in responding which had no effect upon schedule performance. DRL S's schedule performance was disrupted by the initial A treatments, but this effect was overcome with subsequent training. These observations indicate that drug-induced responses which disrupt schedule performance are more likely to develop behavioral tolerance than responses with no alterations to schedule performance.

570 RECURRENT RECOGNITION MEASURES DETECT AN EARLY LABILE PHASE IN HUMAN MEMORY. Walter H. Riege. VA Hospital Sepulveda, CA 91343 and Dept. Psychiat., Sch. Med., UCLA, Los Angeles, CA 90024

Minute-by-minute analyses of recognition memory by measures derived from signal detection theory (Green & Swets, 1966) sensitively reflect changes in information retained over time. Human subjects asked to remember and recognize 6 ambiguous nonverbal stimuli when these are presented intermingled with 14 novel stimuli in long recurrent recognition series, made many recognition errors during the first 3 min of the test series. A subject's correct recognition and incorrect guesses yield a measure of recognition memory (d') relatively unaffected by response bias. We tested two matched groups of psychiatric patients with or without known memory disturbances. Phasic fluctuations of d' occurred early in each of three similar but modality-specific nonverbal tasks. Recognition in the auditory task (naturalistic sounds; $d'=5.74$) was considerably better than in the visual (graphic patterns; $d'=4.14$) or the tactual task (nonsense wire figures; $d'=1.54$). Memory-impaired patients had significantly lower d' measures in auditory or visual tasks. In both groups, recognition memory did not stabilize until 5 min after presentation of to-be-remembered stimuli. The short-term changes seemed to trace an initial decline in recognition memory, followed by a slow rise of decreasing slope. Since the recurrent recognition procedure maximizes interference and inhibits rehearsal, such time-dependent changes suggest the occurrence of an early labile phase in human memory processing.

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571 CONVERSION OF CROSS-REINNERVATED SKELETAL MUSCLES. D.A. Riley*, (SPON: H.J. Ralston). Univ. Calif., San Francisco, Calif., 94143.

All of the fibers of normal guinea pig soleus muscles stain lightly for the histochemical myofibrillar ATPase reaction, but following 6 mo of cross-reinnervation the muscles were reported to contain 5-40% moderately and darkly staining fibers. Finding 60% unchanged warrants the study of factors affecting conversion. Local freezing of muscle fibers causes dedifferentiation of the injured portions into myoblasts. These cells fuse to form myotubes that unite with the non-injured portions and in 1 mo attain full differentiation. Using injury as a tool, the present study was designed to determine whether dedifferentiation of preexisting fibers in a cross-reinnervated muscle is important in the conversion of ATPase staining. Left soleus muscles of 10 guinea pigs (320-470 g) were denervated and the peroneal nerve implanted proximally. The right soleus nerves were crushed to provide self-reinnervated controls. One mo after surgery, 5 cross-reinnervated and 2 self-reinnervated muscles were frozen distally by a copper rod cooled to -195 C. All of the experimental and 5 normal muscles were biopsied and processed for ATPase histochemistry 4 mo after nerve surgery. Cross-sections of normal and self-reinnervated muscles contained only lightly staining fibers at the previous site of injury, demonstrating that self-reinnervation plus injury did not alter staining. However, cross-reinnervated muscles had moderately and darkly staining fibers in addition to lightly staining fibers. The injured group contained an average of 61% (range 39-74%) moderate and dark fibers, while the non-injured group averaged only 23% (range 14-41%) of these fibers. Thus, the magnitude of conversion can be greatly increased by causing dedifferentiation and redifferentiation of preexisting muscle fibers in the presence of a "new" nerve. This work was done during the tenure of a Research Fellowship of Muscular Dystrophy Associations of America.

572 ELECTROPHYSIOLOGICAL PROPERTIES OF THE MEMBRANE AND CHOLINERGIC RECEPTOR IN DEVELOPING RAT MYOTUBES. Aileen K. Ritchie* and Douglas M. Fambrough. Dept. Embryology, Carnegie Institution of Washington, Baltimore, Maryland 21210.

Electrophysiological properties of the membrane and cholinergic receptor have been studied in developing rat myotubes. After 2 days in culture, myoblasts and myotubes have a mean resting potential (Em) near -10mV which increases progressively to a mean of -58mV after 7 days in culture. Measurements of ion content indicate internal Na^+ and K^+ concentrations of 16 mM and 158 mM, respectively, which are independent of cell age. The relative permeability of the membrane to Na^+ and K^+ ions (pNa/pK), estimated by generating curves of Em vs log external K^+ concentration and applying the Goldman equation, is 0.4 in young myotubes compared to 0.05 in mature myotubes. The increase in Em with age can thus be attributed to a gradual change in the relative permeability of the membrane to Na^+ and K^+ ions and not to differences in ion distribution. On the other hand, electrophysiological studies of the cholinergic receptor of rat myotubes between 3 and 10 days of age reveal a mean reversal potential near zero which does not change during cell differentiation. The calculated ratio of Na^+ to K^+ conductance changes ($\Delta gNa/\Delta gK$) was 1.46. This is similar to the value of 1.29 found by Takeuchi and Takeuchi (J. Physiol. 154:52, 1960) for frog endplate receptors. The reversal potential is unaffected by variations in pH between 6.4 and 9.0. The reversal potential is a linear function of the log of the external Na^+ concentration, but not of the external K^+ concentration. Only the former observation is in agreement with results obtained by Takeuchi and Takeuchi for frog endplate. The response to external K^+ is best described by the Goldman equation. The implications of these results will be discussed.

573 PROLONGED CHANGES IN CORTICAL UNIT ACTIVITY FOLLOWING REINFORCING BRAIN STIMULATION. Pablo I. Rivera-Díaz* and James J. Keene. (SPON: B. Martin). Dept. Physiol., Sch. Med., Univ. Puerto Rico, San Juan, P. R. 00936.

Rewarding medial forebrain bundle (MFB) and aversive midbrain reticular (RET) stimuli elicit opposite single cell responses in the thalamic dorsal medial n. (Exp. Neurol., 39: 19-35, 1973) and inhibition lasting up to 10 seconds in cortical units (Brain Res., 64: 211-224, 1973). Since frontal cortex and dorsal medial n. are reciprocally connected and have been implicated in emotion, frontal cortical units were tested in 15 unanesthetized cerveau isolé rats, to see if stimuli of opposite motivational valence would be coded in opposite neural effects. To date, the mean changes (compared to control) in firing rate (spikes/10 sec) following MFB and RET stimuli (0.2 sec, 100 Hz, 0.5 msec, 600 uA cathodal pulses) show opposite effects in frontal, but not in parietal cortex:

Structure	No. Units	MFB Stimuli	No. Units	RET Stimuli
Frontal Cortex	17	+ 4.2	44	- 2.0
Parietal Cortex	22	- 2.4	77	- 2.2

The longlasting inhibition of unit discharge was also elicited with zona incerta (- 10.8 spikes/10 sec; 68 units), mammillothalamic tract (- 10.8; 28 units), intralaminar thalamic (- 8.4; 13 units), central gray (- 6.4; 37 units), and medial hypothalamic (- 3.8; 104 units) stimuli. The laminar distribution of this prolonged inhibition was plotted for these units. Significant inhibition (X^2, $p < 0.01$) occurred in all laminae (28% overall) with greatest incidence in layers III, IV, and VI. Significant prolonged excitation occurred in only 7% of the cortical units. Since the stimuli used are known to elicit behavioral arousal and EEG desynchronization, decrease in cortical unit spontaneous activity lasting seconds may be basic to these activation processes.

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Abstract withdrawn

575 ACTIVITY IN CAT CEREBELLAR PURKINJE CELLS EVOKED BY PASSIVE FOREPAW MOVEMENTS. William J. Roberts, Donald S. Rushmer, Lab. of Neurophysiology, Good Samaritan Hospital & Medical Center, Portland, Oregon.

Small, controlled movements of a forepaw were made with a computer driven solenoid in Nembutalized or decerebrate cats. A saggital strip of Purkinje cells 0.7 x 9 mm was found in the intermediate cortex of the anterior lobe V in which brief forepaw movements evoked synchronous climbing fiber responses (CFRs). The location of the saggital strip corresponds to the lateral projection of the Dorsal Lateral Funiculus Spino Olive Cerebellar Pathway described by Oscarsson (J. Physiol., 200: 129-149, 1969). The latency of the CFR and its probability of occurrence are related to the stimulus amplitude for very small movements (< 1mm) but independent of it for larger movements. The CFR was evoked almost equally well by plantar- or dorsiflexion and was relatively independent of the initial ankle joint angle. The responses are similar in anesthetized and unanesthetized preparations. A pronounced decrease in simple spike activity generally followed the CFR. No change in simple spike activity was noted preceeding the CFR.

576 DENTATE FOLLOWER NEURONS. Lee T. Robertson and Robert J. Grimm, Lab. of Neurophysiol., Good Samaritan Hospital & Med. Ctr., Portland, Oregon.

The dentate nucleus has been implicated in the initiation and control of skilled movements. Our current studies examine whether a dentate neuron that is time-locked with a complex, stereotype motor pattern might also be related to other patterns. In the present study, the task was held constant whereas the animal's joint angles and deployment of muscle groups were varied. Squirrel monkeys were overtrained to touch, in a left to right sequence, three buttons, which were mounted in a row on a panel that could be rotated 360°. During training the buttons were played only in the horizontal plane. During extracellular recording sessions the monkey played initially with the panel in the horizontal plane, then the panel was shifted 45° to the right, then 45° to the left, and then to the horizontal position (control). Panel rotation required the monkey to use different joint angles as well as different levels of muscle activity at the various positions. Changes in the panel position caused no increase in errors but resulted in variations in the timing of play. In particular, the monkey's interbutton flight time with the panel at 45° to the right was highly variable. The output of dentate neurons did correlate with the performance of this sequencial task at different positions but the alterations in discharge did not appear to be related to joint angles or muscle arrays. Instead, dentate neurons involved in performance appear related to the timing properties of the sequence i.e., how much time spent in each epoch of the pattern. These units, regardless of panel position, had similar discharge patterns whenever the flight time was about the same. These data are suggestive that participating dentate units are following or tracking the movement, rather than preceeding the movement as reported by Thach (1970) for brief alternating flexion and extension wrist movements.

577 CEREBELLAR ADAPTATION OF THE VESTIBULOOCULAR REFLEX TO MODIFIED VISUAL INPUT. David A. Robinson. Dept. Ophthal., The Johns Hopkins Univ., Baltimore, Md. 21205

These experiments support M. Ito's theory (Brain Res. 40: 81, 1972) that one function of visual input to the vestibulocerebellum is to maintain the proper operation of the vestibuloocular reflex. The gain of the reflex (eye velocity/head velocity) was measured during brief rotations in the dark. Eye position was measured electromagnetically with a sensitivity of 7 min arc, a bandwidth of 1 kHz and a calibration reproduceability of better than 5%. Cats were loosely restrained in a box, their heads fixed by skull bolts, and rotated with velocity steps or sine waves in the range 0-80 deg/sec and 0.03-1.2 Hz.

When cats, living in a normal indoor environment, wear left-right reversing prisms, the gain of the reflex (tested daily) decreased from about 0.85 (range 0.6-1.1, 10 cats) to about 0.47 (down by 45%, 5 cats tested) in about 2-5 days. The gain returned to normal (3 cats followed) with the same time course on prism removal. When subjected to forced rotations at 0.05 Hz with prisms, the gain dropped 45% in 4 hrs (4 cats tested). Gain decreased at all frequencies, not just the adapting frequency. Gain did not decrease if prisms were not used. This provides an animal model for the results of A. Gonshor and G.M. Jones (J. Physiol. 234: 102P, 1973).

Four cats were cerebellectomized. For forced rotation the gain decreased only 17% in 4 hrs. Three recovered adequate locomotor activity. When they wore prisms for 4-10 days there was no decrease in gain. Two cats with lesions confined to the vestibulocerebellum behaved similarly. The results suggest that the vestibulocerebellum is the site of the adaptation process and that when motor systems become dysmetric, the cerebellum corrects them and maintains them appropriate to the sensory stimuli. Adaptation could occur by modifiable synapses on Purkinje cells.

578 CHLORPROMAZINE INDUCED HYPERPHAGIA. R. G. Robinson*, B. J. Hoffer* and F. E. Bloom. Lab. of Neuropharmacology, SMR, IRP, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032.

Chronic administration of chlorpromazine has been noted to cause elevation of appetite, increased food intake and weight gain in humans. Animal studies however have been inconclusive. Twenty rats were treated over a 5 month period with subcutaneous injections of either chlorpromazine (CPZ) or saline. Weight gain for the 5 month period was less in CPZ-treated animals than controls. Daily food intake and weight gain were elevated in CPZ-treated animals only on the first day of treatment. The average 24 hr food intake after CPZ (8 mg/kg) was 61 gm/kg body wt (controls = 46 gm/kg body wt) with a weight gain of 8 gms (controls = 0.5 gm) ($p < .001$). With successive days of treatment food intake and weight gain were less than controls. The phenomenon of first day hyperphagia, however, could be repeatedly elicited by CPZ when treatment is interrupted for at least 2 days. Doses of CPZ greater than 8 mg/kg however, did not further increase weight gain or food intake. Twenty-four hr activity as measured by photocell was reduced by 50% in CPZ-treated animals at a dose of 4 mg/kg. This sedation was reflected in the hourly pattern of food intake which showed that treated animals did not eat for 6-10 hr after injection of CPZ and then ate markedly increased amounts. However, the hyperphagic effect of CPZ was not due to sedation alone since an equally sedative dose of chloral hydrate did not cause overeating. Finally, in studies designed to investigate the motivational state associated with CPZ-induced hyperphagia, it was found that treated animals will eat more than controls even when they are required to work for their food by bar pressing.

579 The Connections of the Pulvinar Nucleus in the Grey Squirrel (*Sciurus carolinensis*). J. A. Robson*, E. C. Marsh* and W. C. Hall. Departments of Anatomy and Psychology, Duke University, Durham, N. C. 27710.

The pulvinar nucleus in the grey squirrel receives projections from the superficial layers of the superior colliculus and projects to an extensive cortical zone which includes occipital areas 18 and 19 and at least two cytoarchitectonically distinct temporal areas. Also a number of lines of evidence suggest that the squirrel's pulvinar n. can be subdivided. First, small lesions in the superior colliculus result in two types of degeneration in the pulvinar n. which can be seen in material prepared with the Fink-Heimer technique: a small fiber system which terminates widely in the caudal one-third of the pulvinar n. and a larger fiber system which terminates in a more localized fashion in the rostral two-thirds. Second, small lesions or injections of tritiated amino acids in the pulvinar n. which cross the boundary between these two zones result in two separate cortical projection areas, one in occipital cortex and one in temporal cortex. Finally, whereas all areas of the pulvinar n. receive reciprocal connections from the cortex, both lesions and injections of labeled amino acids show that the rostral part of the pulvinar n. receives an additional non-reciprocal projection from striate cortex. This projection is located ventrally and complements the projection from the superior colliculus which primarily terminates dorsally in the rostral part of the pulvinar n.
(Supported by NIH grant NS-09623).

580 OXIDATION OF REDUCED NICOTINAMIDE ADENINE DINUCLEOTIDE IN DORSAL ROOT GANGLION NEURONS AFTER TOPICAL APPLICATION OF ADENINE NUCLEOTIDE. Carlos Rodríguez-Estrada. Cátedra de Fisiología, I.M.E., Facultad de Medicina, Universidad Central de Venezuela, Caracas, Venezuela.

Chance and Williams (J Biol Chem 217:409-427) have shown that mitochondrial respiration did increase after addition of adenosine diphosphate in the suspension media of isolated mitochondrial preparation. In this work adenosine diphosphate (ADP) was applied on the surface of dorsal root ganglion (Rana palmipes spix) in an attempt to increase respiration of intraneuronal mitochondria. Fluorometric determinations were made of the level of reduced nicotinamide adenine dinucleotide (NADH) as indicator of mitochondrial respiration. Oxidation of NADH was observed after topical application of ADP (200 µM/ml) diluted in Ringer's solution. But after ATP (200 µM/ml) no change was observed in the NADH level. These results indicated that ADP reached the intracellular mitochondria and acelerated the rate of respiration as it does in isolated mitochondrial preparation, and ATP did not produce any change (by itself) in isolated mitochondrial preparation.

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581 ACETYLCHOLINE LEVELS AFTER ELECTRICAL STIMULATION OF THE CHOLINERGIC SEPTAL-HIPPOCAMPAL PATHWAY. Hans Rommelspacher* and Michael J. Kuhar. Dept. Pharmacol., Johns Hopkins Univ. Sch. Med., Baltimore, Md. 21205

Electrical stimulation of the medial septal area was performed under various conditions with concentric, bipolar electrodes. Acetylcholine (Ach) levels were subsequently measured in the hippocampal formation with a sensitive enzymatic-isotopic assay. Stimulation of the septum at 40 Hz for time periods up to 1 hr did not result in any change in hippocampal Ach levels as compared to untreated controls. However, after pretreatment with 10 μg of hemicholinium-3 (HC-3) administered intraventricularly, stimulation under the same conditions caused a maximal 50% decline in Ach levels in 7.5 min. There was no significant depletion after a 3 or 5 min stimulation period after 10 μg HC-3, and also no depletion at any time up to 30 min using only 1 μg HC-3. Higher doses of HC-3, 15 or 20 μg, did not cause a further depletion of Ach when the septum was stimulated at 40 Hz for 7.5 min. In other experiments, we varied the frequency of stimulation (7.5 min duration) after 20 μg HC-3. There was no significant reduction in Ach levels after 0.4 or 1.0 Hz. However, after 10, 20, 30, 40, 50, 75, or 100 Hz, there was a similar and maximal depletion. In some experiments, rats were stimulated for 30 min after 10 μg HC-3, and sacrificed at varying times after the cessation of stimulation. At 30 min or 1 hr after stimulation, there was still the maximal depletion of Ach levels. However, at 3 days post-stimulation, Ach levels had returned to that of untreated controls. To determine the anatomical specificity of the stimulus-induced depletions, Ach levels were measured in the striatum after septal stimulation and in the hippocampus after striatal stimulation. There are no major cholinergic pathways between these structures and, as expected, there was no stimulus-induced depletion of Ach.

582 ASCENDING PROJECTIONS OF BRAINSTEM GENITAL SENSORY NEURONS IN THE FEMALE CAT. James D. Rose. Dept. of Psychol., Dartmouth Coll., Hanover, N.H. 03755

In a recent series of investigations, the brainstem distribution of neurons responding to vaginal stimulation in the cat has been determined. The objective of the present work was to seek evidence of ascending projections from these neurons by recording antidromic single-unit responses to electrical stimulation of rostral brain sites. Unit responses were considered to be antidromic if they displayed a short, fixed latency, and followed stimulation frequencies of at least 100/sec. The collision technique was also used in some instances. Medullary genital sensory neurons could be driven antidromically by stimulation of the pontine reticular formation dorsomedial to the superior olive, but not by stimulation of medial pontine or more rostral loci. The pontine cells were antidromically driven by stimulation of midbrain sites, including the central gray, the region around the central tegmental tract, and the red nucleus. Midbrain neurons responded antidromically to stimulation of sites in the posterior hypothalamus, lateral hypothalamus and medial thalamus. The units for which antidromic driving could be demonstrated constituted a minority of the sample of genital sensory neurons tested, but were sufficiently common to warrant the conclusion that neurons at all levels of the brainstem contribute to an ascending system of genital sensory activity. (Supported by NIH Grant NS10420-01).

583 PREFRONTAL ELECTROCORTICAL CORRELATES OF CUE POSITION DURING PERFORMANCE OF DELAYED RESPONSE TASKS BY MONKEYS. Steven C. Rosen, Alcides Gadotti* and John S. Stamm. Psych. Dept., SUNY at Stony Brook, New York, 11790

Four monkeys with transcortical nonpolarizable electrodes chronically implanted in prefrontal (bilateral), precentral, and occipital cortex, and also subcutaneously about the eyes, were trained to perform a spatial delayed response task requiring transient memory of the left-right position of a visual cue. During 120 trial testing sessions in which the cue was presented an equal number of times in the left and right position, according to a random sequence, electrocorticograms and horizontal electrooculograms (EOGs) were recorded with DC amplifiers. The data were stored on FM magnetic tape and averaged off-line with a PDP-12A computer programmed to separate left-cue from right-cue trials. The results indicate that only the amplitude of a surface positive evoked potential (PEP) of .5-1.0 sec duration recorded in prefrontal cortex and time-locked to cue onset was related to cue position. The amplitudes of averaged PEPs recorded in left prefrontal cortex were consistently greater for right-cue than left-cue presentations, and conversely, right prefrontal PEPs were greater for the left- than right-cued trials. No systematic differences in averaged cue evoked potentials were observed in precentral or occipital cortex. Averaged EOG recordings revealed lateral eye movements associated with cue presentations in only one or the other cue position and these movements were coincidental with the PEP. The results are consistent with reports of contralateral visual receptive fields for prefrontal neurons and prefrontal neuronal discharge during saccadic eye movements. Our data suggest that prefrontal neural mechanisms involved in oculomotor control may subserve transient spatial memory functions. (Supported by NSF Grant GB-35735X.)

584 EVIDENCE FOR EFFERENT ACTIVITY IN THE FISH OPTIC NERVE AND ITS EFFECT ON RETINAL GANGLION CELLS. N. Paul Rosenthal and David E. Sandeman*. Depts. Physiology and Neurology, Sch. Med., UCLA, Los Angeles, 90024 and School Biol. Res., Australian Nat'l Univ., Canberra, A.C.T., Australia.

Efferent and afferent unitary activity was recorded in the optic nerve of the coral reef trigger fish, Hemibalistes chrysopterus. Experiments were performed on board the R/VAlpha Helix off the North Queensland Coast of Australia. The fish were usually immobilized with gallamine, but anesthesia was not used after the initial surgical procedure. The intra orbital section of optic nerve was exposed, and recordings were made from small bundle cut at either the proximal or distal end of the nerve, which was then wrapped over a single wire hook electrode. Efferent activity is excited by light, rotation, vibration, and touch. In addition, retinal ganglion cell activity is influenced by rotational, vibratory and tactile stimulation, and this effect is invariably excitatory. In any ganglion cell axon the effect is progressively reduced by division of surrounding optic nerve fibers. Section of about 1/4 of the optic nerve in the region of the ganglion cell axon entirely abolishes the excitatory effect. By ablating various areas of the brain, it appears that the source of the efferent activity is in the general region of the contra lateral tectum. The functional significance of the efferent activity is unclear but it may act as an alerting influence on the retina.

585 IMMUNOLOGICAL ENHANCEMENT OF CHEMOTHERAPY FOR BRAIN TUMORS. Samuel Rosner. Department of Anatomy, CMDNJ - Rutgers Medical School, Piscataway, New Jersey 08854.

The principle of increasing the Immunological response, by the injection of bacterial polysaccharide, in brain tumors is set forth. This method results in an increased antigen-antibody reaction between the cancer and the bacterial polysaccharide. If the chemotherepeutic substance, organic arsenic in this method, is combined with the bacterial polysaccharide, the affinity between the cancer and the therepeutic substance is greatly increased. The organic arsenic is lodged in the malignancy in greatly enhanced quantities. (Organic.) Arsenic has been demonstrated to have an affinity for malignant tissue, cancerous tissue is destroyed when organic arsenic combines with the sulfhydryl portion of the cell thus destroying the oxygenating mechanism. This method has been shown to be efficacious in varying degrees in 34 patients, the longest follow up being 24 years. Both primary and secondary malignancies were treated. In C_3H mice, this method also showed a prophylactic effect on the growth of cancerous tissue. Animal work supported by the Anatomy Department of Rutgers Medical School. A grant from the United True Sisters supported the Clinical portion of this project which was carried out through the sponsorship of Stuyvesant Polyclinic.

586 DEPLETION OF REGIONAL BRAIN CALCIUM BY ETHANOL AND SALSOLINOL: SELECTIVE ANTAGONISM BY NALOXONE. David H. Ross, (Spon.: Leslie Felpel) Depts. of Pharmacology and Psychiatry, University of Texas Health Science Center, San Antonio, Texas 78284

The administration of ethanol in a range of 1.0-3.0 gm/kg (i.p.) produced a significant depletion of regional brain calcium in rats. This dose level produced decreases of 15-60%. The observed decrease is linear, dose dependent and effectively abolished by the stereospecific opiate antagonist, naloxone. Salsolinol, the dopamine-acetaldehyde conjugate, produced a similar depletion of regional brain calcium which was also blocked by naloxone. Naloxone alone was without calcium depleting effects. The ethanol and salsolinol induced calcium depletion effect is significantly potentiated with pyrogallol pretreatment. Morphine sulfate (25 mg/kg) also produces a decrease in brain calcium levels and this effect is antagonized by naloxone. When this dose of morphine sulfate was given concurrently with an equi-active dose of salsolinol there was no additive depletion of regional calcium observed. Reserpine (5 mg/kg) induced calcium decrease was not antagonized by naloxone. Pentobarbital sodium (40 mg/kg) had no effects on regional calcium levels and at 20 mg/kg did not block the decrease in calcium seen after either morphine or ethanol. The decrease in regional brain calcium appears a specific and somewhat stereoselective effect of ethanol and salsolinol. Based on this data, it would appear that ethanol and the tetrahydroisoquinoline alkaloid salsolinol, recently implicated as a possible mediator of some of the pharmacological actions of ethanol, may have a common biochemical action in the displacement of membrane bound calcium. Supported by NIH General Research Grant R-5-501-RRO-5654-05.

587 TONOTOPIC ORGANIZATION OF NEURONS IN NUCLEUS MAGNOCELLULARIS AND NUCLEUS LAMINARIS OF THE CHICKEN: E. W Rubel and Thomas Parks (SPON: J.P. Flynn). Dept. Psychol., Yale Univ., New Haven, Ct. 06510.

The cochlear portion of the avian eighth cranial nerve terminates in nuc. angularis (NA) and nuc. magnocellularis (NM), considered homologous to the mammalian dorsal and ventral cochlear nuclei respectively. Third-order neurons of nucleus laminaris (NL) receive spatially-segregated inputs to their dorsal and ventral dendritic processes from the ipsilateral and contralateral NM respectively. The present study sought to determine the tonotopic organization of neurons in NM and NL of the hatchling chicken. Standard microelectrode recording techniques were used to monitor extracellular responses to tonal stimuli presented to either ear and the "characteristic frequency" was determined for each unit encountered in NM or NL. Histological identification of electrode tracks allowed a three-dimensional "map" of each nucleus to be established. The cells of NM are arranged in dorsal-ventral frequency-specific columns with neurons responding to high frequencies (to 5 kHz) situated at the antero-medial pole of the nucleus. Progressively lower-frequency tones activate columns of cells at successively postero-lateral positions. Cells at the postero-lateral tip of NM, which receive innervation from the macula lagena, appear unresponsive to acoustic stimuli. The binaurally-innervated cells of NL exhibit similar tonal receptive fields to stimulation of either ear and a spatial organization which matches that found in NM; high frequencies are represented anterior and lower frequencies activate progressively more posterior positions. These data suggest that the ipsilateral connections of NM to NL may be established simply by the ventral outgrowth of NM axons to the closest site, while contralateral connections may be based on some type of "afferent matching" process. (Supported by NSF grant GB31934).

588 A FUNCTIONAL INTERPRETATION OF THE CLIMBING FIBER RESPONSES EVOKED BY FOREPAW MOVEMENTS IN THE CAT. Donald S. Rushmer and William J. Roberts, Lab. of Neurophysiology, Good Samaritan Hospital & Medical Center, Portland, Oregon.

The studies described in the preceeding abstract (W. J. Roberts and D. S. Rushmer) were extended to show that the CFRs evoked by paw movement are produced by exteroceptors in the foot. The adequate input for the response is the applied force produced either by passive movement or active contraction. The CFR will respond with a high probability only to events occurring at least 150 msec apart. A hypothesis will be proposed that the CFR acts as an "event marker" during a task such as locomotion t reset the Purkinje cell activity in preparation for subsequent inputs. This hypothesis follows from the observations that a) the response threshold is extremely low, b) stimulus intensity is not coded in the response except for very weak stimuli, c) the response is essentially independent of paw position and the direction of the stimulus force, and d) the CFR will follow repetitive inputs for rates found during locomotion but fails at higher rates.

589 **VISUAL RECOGNITION AND REACTION TIME: LATERALITY DIFFERENCES IN RESPONSE TO VERBAL STIMULI.** Ruth Rutschmann, Larry Weeks*, and Cynthia Berry*. Queens College of The City University of New York.

Measurement of response to verbal stimuli visually presented to each of the two cerebral hemispheres in right handed split brain patients has shown that the right hemisphere has the partial language capability of response to concrete nouns. In the normal subject verbal stimuli might also produce differences in response of the same kind. Using normal subjects, high imagery words that refer to concrete visual images and low imagery words referring to concepts were tachistoscopically presented via the contralateral visual field to the temporal retina of each eye, with a center point presented for fixation and response. Recognition duration was determined using the method of limits and response to stimulus presentations was measured by reaction time (RT). Results showed that presentation of stimuli in the right visual field produced a lesser RT than presentation in the left visual field. High imagery words presented in the left visual field produced a lesser RT than low imagery words. Comparison to experimental presentations at subthreshold duration show that the effects of the stimulus content were not produced below recognition duration. Differences in the speed of response produced by the stimulus words indicate that the hemispheres function independently during verbal information processing in the normal subject.

590 IMMUNOCYTOCHEMICAL LOCALIZATION OF DOPAMINE-β-HYDROXYLASE IN PERIPHERAL ADRENERGIC NEURONS AT THE ULTRASTRUCTURAL LEVEL. K.E. Rybarczyk*, J.A. Redick*, and L.S. Van Orden III. (SPON: W.W. Kaelber) Dept. of Pharmacology, Univ. of Iowa, Iowa City, IA 52242

Localization of Dopamine-β-Hydroxylase (DBH) in peripheral adrenergic neurons was determined immunocytochemically by means of a peroxidase-anti-peroxidase (PAP) technique employing heterologous antibodies. Cat spleens were fixed by perfusion with 1.5% formaldehyde plus 0.5% glutaraldehyde and two approaches were employed to localize DBH. The first involved pre-embedment immunocytochemical staining of Vibratome or polyethylene glycol-embedded thick sections. Rabbit antiserum to bovine DBH was used for incubation of sections and the antigen-antibody complex was visualized by incubation with sheep anti-rabbit γ-globulin followed by soluble rabbit PAP complex. Peroxidase was localized histochemically and the reaction product stabilized by treatment with OsO_4. Sections thus reacted were embedded in Epon and ultrathin sections prepared. The second approach involved post-embedment staining of ultrathin sections of tissue embedded in either 30% bovine serum albumin or glycol methacrylate and immunocytochemically reacted as described above. All ultrathin sections were examined without counterstaining. Substitution of normal rabbit serum for rabbit anti-DBH produced no specific staining at both light and electron microscopic levels. At the light microscopic level reaction product appeared to be in nerves and paralleled catecholamine fluorescent histochemical distribution patterns. Electron microscopic examination revealed the presence of reaction product deposited over structures of synaptic vesicle dimensions. Preliminary data suggest the presence of DBH in small as well as large vesicles. Further refinements in ultrastructural immunocytochemical techniques should define more precisely the intracellular localization of DBH. Supported by USPHS Grants HD-06380 and GM-12,675.

591 EFFECTS OF SLOW MUSCLE STRETCH ON GROUP I EPSP's IN CAT EXTENSOR MOTONEURONS. W.Z.Rymer and J.V.Walsh,Lab., of Neural Control, NIH, Bethesda, Md, 20014.

Recent experiments in which muscle stretch and tendon vibration were combined have produced evidence supporting an excitatory effect of secondary muscle spindle afferents on extensor motoneurons of the cat (Matthews,P.B.C.,J.Physiol., 1969,204,365-393; Westbury,D. J.Physiol., 1972,226,37-56). However, vibratory activation of primary afferents leaves open the possibility that some primary endings fail to maintain consistent discharge at shorter muscle lengths, because of spindle unloading. The generation of group I EPSP's by electrical means avoids this pitfall. In our experiments , the nerve to lateral gastrocnemius and soleus muscles (LGS) was stimulated electrically at group I strength, while the medial gastrocnemius muscle (MG) was subjected to slow sinusoidal stretch (0.25 Hz., 1.0 mm. amplitude) combined with longitudinal tendon vibration (175 Hz., 110 micron amplitude). The average amplitude of the electrically induced LGS EPSP's was measured at different points of the slow stretch cycle, using intracellular recordings from MG motoneurons. The EPSP amplitude at the peak of the slow stretch was consistently greater than that in the trough, and for most motoneurons this difference reached statistical significance ($p < 0.05$). These observations provide further support for the hypothesis of an excitatory effect of secondary spindle afferent fibers, and taken together with previous evidence,(Rymer,W.Z.& Walsh,J.V., 1973, Symposium on the Control of Posture and Locomotion, ed. Stein,R.B.,Plenum) suggest that this may be mediated via presynaptic disinhibition.

592 The Differential Telencephalic Projections of the Subdivisions of the Medial Geniculate of the Rat. David K. Ryugo* and Herbert P. Killackey, Dept. of Psychobiol., Univ. of Calif. at Irvine, Irvine, Calif. 92664.

The medial geniculate of the rat can be subdivided into three major cytoarchitectonic subdivisions: Dorsal (MGd), ventral (MGv) and medial (Mgm)(K. Morest, J. Anat., 1964). For the present study discrete lesions were placed in each of these subdivisions and the resultant axonal degeneration was traced with the Fink-Heimer technique. Each subdivision of the medial geniculate was found to project to the telencephalon in a unique fashion. MGv was found to project in a dense restricted fashion to layers III and IV of the dorsal and rostral portions of auditory cortex. MGd was found to project chiefly to layers III and IV of the caudal and ventral portions of auditory cortex. The projections of MGd were consistently less dense than those of MGv. Finally, MGm was found to project densely to restricted portions of the basal telencephalic nuclei and in a diffuse fashion to all layers of the entire auditory cortex. The cytoarchitectonic differences and the differences in projections reported here suggest that each subdivision of the medial geniculate may perform unique physiological operations and exert an effect on different populations of telencephalic neurons.

Supported by NSF Grant GB 41294

593 SELECTIVE DRUG EFFECTS ON MOTOR & SENSORY NERVES: A "DALE'S PRINCIPLE" FOR RECEPTORS. H.C. Sabelli, J. DeFoe-May*, and M. Bulat*. Dept. Pharmacol., Chgo. Med. Sch. and Dept. Anesthesiol., Mt. Sinai Hosp., Chicago,Ill. 60612

We propose that a neuron contains the same type of chemosensitive receptors (for neurotransmitters and exogenous drugs) over its entire membrane, including the conducting membrane of axonal processes, as well as synaptic areas. This postulate is drawn by analogy to Dale's principle regarding neurotransmitters, and it is based upon the metabolic unity of the neuron (Ramon y Cajal's neuronal theory). In support of this new postulate, cholinergic, adrenergic and other neurotransmitter receptors have been demonstrated in isolated peripheral nerves (Sabelli and Gorosito, 1969) and on CNS fibers in vivo (Vazquez and Sabelli, this meeting). We have now recorded separately the compound action potentials of the isolated ventral root motor fibers and of the dorsal root sensory fibers of the bullfrog (R. catesbeiana). Stimuli (30/sec) were delivered to the isolated sciatic nerve. Drugs were applied in Ringer's (pH 7) to the site of stimulation. The muscarinic agent arecoline (0.1 mM) selectively increased ventral root action potential; it did not affect sensory axons of similar diameter (estimated by threshold and conduction velocity measurements), and it depressed conduction of slower sensory fibers. GABA (5 mM) selectively blocked conduction on sensory fibers without affecting conduction on motor axons. These results are compatible with the proposed postulate because they suggest a selective location of cholinergic receptors on motor fibers (as expected from their existence on motor nerve terminals) and of GABA receptors on sensory axons (as expected from their presence on primary afferent terminals in the spinal cord). A qualitative difference in drug sensitivity between motor and sensory fibers of the same diameter opens the possibility for developing selective "local analgesics" without local anesthetic stabilizing actions. (Supported by NIMH grant #MH-14110 and by Abbott Laboratories.)

594 CHANGES IN THE DEVELOPMENT OF CENTRAL MONOAMINE NEURONS FOLLOWING TREATMENT WITH 6-HYDROXYDOPAMINE (6-OH-DA) AND 5,7-DIHYDROXYTRYPTAMINE (5,7-HT) AT BIRTH. Charlotte Sachs* and Gösta Jonsson* (SPON: V. G. Carson). Dept. of Histology, Karolinska Inst., S-104 01 Stockholm, Sweden.

Systemic injection of 6-OH-DA (3X100 mg/kg s.c.) to newborn rats produces a selective and permanent reduction of endogenous noradrenaline (NA), ^{3}H-NA uptake in vitro, and dopamine-β-hydroxylase (DBH) in the cerebral cortex. This treatment concomitantly leads to a considerable increase, almost a doubling, in these parameters in the pons and medulla oblongata. The changes in the cerebral cortex are related to a 6-OH-DA induced degeneration of the NA nerve terminals, whereas the effects in the pons-medulla in all probability are related to both an increased outgrowth of NA terminals and an increased intraneuronal NA concentration. The 6-OH-DA induced changes are probably associated with a direct action of this compound on the NA neurons, since the effects could be completely counteracted by the 'membrane pump' blocker, desipramine. Administration of 5,7-HT (2X50 mg/kg s.c.) to newborn rats caused marked reductions of both ^{3}H-NA and ^{3}H-5-hydroxytryptamine (5-HT) uptake in the cerebral cortex, while in the pons-medulla the uptake of both compounds was markedly enhanced. Both the 6-OH-DA and the 5,7-HT induced changes were observed very early (days 5-7 postnatally) during the development. It is suggested that central NA and 5-HT neurons show similar responses following administration of a specific neurotoxic compound at the neonate stage.

595 INTENSITY DEPENDENT RESPONSE PATTERNS OF OPTIC TRACT UNITS DURING THE SUPPRESSION-RECOVERY EFFECT IN THE CAT. Walter L. Salinger and Dawn L. Brown. Department of Psychology, University of N. Carolina at Greensboro, 27412

When the eye is stimulated with a train of flashes the gross evoked potential (EP) in optic tract (OT) shows a transient depression beginning with the response to the second flash. This phenomemon is known as the suppression-recovery effect (S-R effect). Using stimulus parameters found to be optimal for producing the S-R effect, three different response patterns were observed in single units. Forty per cent of the OT units exhibited a dynamic response pattern of activity which paralleled the gross EP. The remaining two classes of cells appeared to make little contribution to the S-R effect. The purpose of this paper is to investigate the basis of the three different response patterns of OT units, and to determine if these patterns result from differences in physiology or receptive field organization. Using acute, anesthetized preparations, OT units were examined with respect to threshold, spectral sensitivity, critical fusion frequency, receptive field size and location, and the sustained-transient classification. None of these characteristics seemed to account for the different response patterns which were obtained. However, all three activity patterns could be generated in a single unit by carefully manipulating stimulus intensity.

596 ORIGIN AND DEVELOPMENT OF SENSORY NEURONS IN AN INSECT ANTENNA. Joshua R. Sanes* and John G. Hildebrand, Dept. of Neurobiology, Harvard Medical School, Boston, Mass. 02115

Antennae, bearing thousands of primary sensory neurons, develop from the undifferentiated cells of imaginal discs during the pupal-adult metamorphosis of the moth, Manduca sexta. At pupation each disc everts to form a pupal antenna, an elongated epithelial tube closed at the tip. The sensory neurons differentiate synchronously in this epithelium; histological examination of the tip, center, and base of the antennal flagellum on each of the 18 days of metamorphosis did not reveal significant differences between these regions. Thus any wave of development that might pass along the flagellum must have a period of less than one day. Autoradiography following administration of [^{3}H]thymidine showed that cell divisions giving rise to neurons occur soon after pupation. Axons grow out of the immature neurons on day 3 of metamorphosis and form two nerves in the lumen of the antenna. Further steps in neuronal maturation, studied by light and electron microscopy, will be described. Even before day 3, two small nerves (each with ca. 150 axons) are present in the lumen; they arise from pupal peripheral neurons of unknown function, not from a precocious subpopulation of developing neurons. The synchrony of neuronal development and the apparent absence of interneurons, synapses, and muscles from the flagellum favor our correlative biochemical, physiological, and anatomical studies of neurogenesis. In view of the possibility that insect sensory neurons are cholinergic, we have shown that antennae can synthesize and accumulate acetylcholine in vitro, and have studied the development of choline acetyltransferase and acetylcholinesterase. Electrophysiological studies of the developing neurons are in progress. (Supported by USPHS Grant R01NS 11010-01, the Milton Fund of Harvard, an Alfred P. Sloan Foundation Fellowship, and an Established Investigatorship of the American Heart Association to JGH.)

597 A HISTOCHEMICAL STUDY OF CERVICAL MOTOR NEURONS AND THE POSTERIOR LATISSIMUS DORSI MUSCLE IN NORMAL AND DYSTROPHIC CHICKENS. F.M. Sansone[1] and F.J. Lebeda*[2] Dept. Anat. Sci.[1] and Dept. Pharm.[2], SUNY at Buffalo, Buffalo, N.Y. 14214.

Since it has been shown that neural alterations occur in the Posterior latissimus dorsi (PLD) muscle of dystrophic chickens, a study of the spinal cord representation of the nerve supplying this muscle was undertaken. Five mm of the PLD branch of the dorsal thoracic nerve were removed from normal (line 200) and dystrophic (line 304) chickens. Animals were sacrificed 14 to 21 days after denervation. Chromatolysis appeared in the ventrolateral cell column between segments 14 and 15. To characterize cervical neurons not undergoing chromatolysis, histochemical studies were done on additional animals. Staining reactions for cholinesterase, succinic dehydrogenase (SDH), beta-hydroxybutyrate dehydrogenase (HBD) and glycogen, (periodic acid Schiff; PAS) did not reveal any qualitative differences between motor neurons in cervical segments 14 and 15 of normal and dystrophic birds. These neurons gave a definite true cholinesterase reaction and were negative for pseudocholinesterase. Several PAS positive neurons as well as a mixed staining intensity for SDH and HBD were encountered in the normal and dystrophic cords. Innervated normal and dystrophic PLD muscle fibers gave a mixed response to the PAS, SDH and HBD reactions. The dystrophic PLD, however, had many more SDH and HBD positive fibers than the normal muscle. On the other hand, the normal muscle had more PAS positive fibers than the dystrophic muscle. The motor endplate in normal and dystrophic muscles contained only true cholinesterase. These variant staining patterns suggest that there is no histochemical correlation between the PLD muscle and cervical motor neurons of normal and dystrophic chickens. (Supported by USPH grants GM-00107 and NS-08233 and the UB Foundation.)

598 THE PATTERN OF VENTROBASAL NEURON PROJECTIONS TO RAT SOMATOSENSORY CORTEX STUDIED BY RETROGRADE AXONAL TRANSPORT OF HORSERADISH PEROXIDASE. Samuel Saporta* and Lawrence Kruger. Dept. Anat. and Brain Res. Inst., UCLA, Los Angeles, 90024

The organization of cells in the ventrobasal complex (VB) which project to somatosensory cortex (SmI) was studied in rats using retrograde transport of horseradish peroxidase (HRP). Injections of HRP ranging from 0.01 µl to 1.5µl were made in electrophysiologically defined areas of somatosensory cortex either bilaterally or unilaterally. The pattern of labelled cells restricted to the ipsilateral VB was distinctive in that each zone of cortex, independent of receptive field position, was represented by a hollow hemispherical "shell" of labelled cells rostrally which condensed caudally into a "column" of cells curving along the rostrocaudal axis of VB. The largest aggregate of labelled cells was at the rostral "shell" of each "column". At its caudal portion the labelled neuronal "column" tapered ventrally and medially. Preliminary results also indicate that there is a non-isomorphic density of projection from VB to different areas of SmI cortex. In addition to retrograde labelling of VB from supragranular layers, labelling of infragranular neurons (probably via dendrites) and their axonal trajectory was seen in a majority of experiments.

(Supported by USPHS Grant NS-5685.)

599 ATTEMPTED TRANSFER OF HABITUATION TO THE VISUAL CLIFF BY CHEMICAL MEANS. Merrill Sarty, Ph.D., University of Southern California School of Medicine, Los Angeles, 90033.

(I) The effect of rearing condition on habituation to the visual cliff was investigated using a new measure: latency of approach to hatch-mates across the optically deep side. Domestic chicks age 4 days raised since hatching over the deep side had significantly shorter response latencies than chicks reared over the shallow side. (II) Using a 2 x 2 (donor x recipient) design, an attempt was made to transfer experience-differentiated response tendencies to 120 deep-reared and 120 shallow-reared recipients by chemical means. During days 1 - 3 post-hatch, 0.8 - 2.5 gm unhomogenized brain tissue was fed to recipients immediately upon its removal from hatch-mate donors. On day 4, Ss were tested on the deep side. No significant transfer tendencies were noted, though analyses by sub-group according to type of brain tissue used (optic lobes, cerebrum, cerebellum or basal brain) have yet to be done.

600 EFFECTS OF LONG-TERM CHRONIC EXPOSURE TO DELTA-9-TETRAHYDROCANNABINOL (THC) IN THE RHESUS MONKEY. E.N. Sassenrath, Gail P. Goo*, Jo D. Cowen* and Loring F. Chapman. Dept. Behav. Biol., Sch. Med., U.C. Davis and Calif. Primate Res. Cntr., Davis, 95616

The effects of chronic daily oral drugging with THC (at 2.4 mg/kg/day) on social behavior and stress-related neuroendocrine measures in group-caged rhesus and fascicularis macaques have been studied. During the first few weeks drugging of single members of cage groups of 3 to 6 sub-adult or young adult rhesus monkeys, the treated subjects showed paradoxical combinations of behaviors characteristic of withdrawal, sleepiness, hyperactivity, and anxiety, with a wide range of inter-individual differences. After 6 to 9 months of drugging, a high level of behavioral tolerance had developed to the immediate effects (1 to 5 hours post drug) of THC in all subjects. In two peer groups of 3 males and 3 females each, the one drugged female in each group showed increased aggressiveness, resulting in marked rise in dominance rank for each. These females also showed a 3-months delay in pregnancy compared to 4 non-drugged female cagemates. After nine-months drugging of single members of 6 other 3 or 4-membered cage groups, there were no observed changes in basal excretion levels of epinephrine, norepinephrine, MHPG or cortisol or in ACTH-response levels of cortisol which specifically differentiated the 6 drugged subjects from their 16 non-drugged cagemates. These data suggest that the observed behavioral effects of THC are not mediated via direct action on the stress response systems monitored, but via a central action which can also affect reproductive function. (Supported by USPHS grant DA00135, RR00169 and MH21366.)

601 Selective blockade of the inhibitory postsynaptic response by mercurial compounds, observed in Aplysia ganglion cells. Makoto Sato and Masashi Sawada*. Neuroscience Lab., Div. Neurosurgery, Univ. Oregon Med. School, Portland, Oregon 97201.

Acetylcholine (ACh)-induced excitatory (D-type) and inhibitory (H-type) responses of Aplysia ganglion cells were evaluated by the ionic conductance increase (ΔG) of each receptor membrane. The effects of various mercurial compounds were compared on the dose (ACh)-response (ΔG) curves obtained from D- and H-type membranes. Each compound was dissolved in Aplysia Ringer and the pH was adjusted to be 7.4 - 7.6.

p-Hydroxymercuri benzoate (PMB): The ACh-induced ΔG of the H-type membrane was depressed to 50% of the control after a 1 min. exposure to 1 mM PMB. A subsequent 3 min. exposure reduced it further to less than 10% of the control. The ΔG of the D-type membrane was depressed only to 90% of the control after 10 min. exposure to 1 mM.

Na-Salyrganic acid (Mersalyl): The ACh-induced ΔG of the H-type membrane was markedly depressed to 20% of the control after 5 min. exposure to 1 mM Mersalyl. The ΔG of the D-type membrane was not appreciably altered by a 5-10 min. exposure to 1 mM Mersalyl.

Mercury dichloride ($HgCl_2$): The ACh-induced ΔG of the H-type membrane was depressed to 10-20% of the control after a 5 min. exposure to 0.1 mM $HgCl_2$. The ΔG of the D-type membrane was depressed only to 80-90% of the control after a 5 min. exposure to 0.1 mM $HgCl_2$.

All the above mercurial compounds decreased the slope of the dose-response curves obtained from the H-type receptor membranes, suggesting that the mode of inhibition is non-competitive. It was postulated that the H-type receptor complex includes more specific dithiol groups which may be controlling the mobility of cationic Cl^--carrier residues.
(Supported by NIH Grant USPHS GRANT NS-01687-16)

602 DOES THE NUCLEUS RAPHE PONTIS HAVE CHEMOSENSOR OR NEUROENDOCRINE FUNCTIONS? Madge E. Scheibel* and Arnold B. Scheibel. Depts. Anat. and Psychiat., UCLA, Los Angeles, Cal. 90024

Raphe neurons of the brainstem reticular core may be involved in the initiation of slow wave sleep through mediation of serotonin. Modifications of the Golgi methods have been used to study the organization of the raphe complex in several hundred young and neurally mature cats and mice. While each of the 8 or 9 commonly described raphe nuclei show idiosyncratic variations in dendrite domains and axonal paths, cells of n. raphe pontis (B.5?) are of particular interest. Somata and dendrites are arrayed in two dorso-ventrally directed rows along midline. Many dendrites appear to encircle the large raphe blood vessels, often terminating in small enlargements, rounded or brush-like. While most of these elements are clearly neuronal in nature with obvious axons, many of the small round cells possess 2 or 3 very long dendrites but are apparently without axons. Several types of neuroglia are also seen. We suggest that n. raphe pontis may differ from other raphe elements in serving a chemosensor, or neuroendocrine function.

603 CODING OF SPECIES SPECIFIC VOCALIZATION IN THE AUDITORY MIDBRAIN NUCLEUS OF THE GUINEA FOWL. H. Scheich*, R. Koch* and G. Langner* (SPON: J. S. O'Brien)
Max Planck Institut für Biophysikalische Chemie, Göttingen, F.R.Germany

Brown (Science 149: 1002, 1965) showed that normal vocalization can be elicited by electrical stimulation in the torus semicircularis (inferior colliculus) of a bird. Sensory areas of this structure might therefore be involved in the analysis of vocalization patterns of the species. Specificity for vocal input has so far been suggested only for the auditory forebrain. Single unit recording has been done in chronic preparations of awake guinea fowl. The birds were presented with tone stimuli and tape recordings of a number of their own stereotyped calls, which show different orders of complexity. In a large proportion of neurons pure tone stimuli were less effective than calls, or good responses to simple stimuli failed to provide adequate predictions for the response to calls. Most units preferred a few calls, some were selective to one. In order to define their specificity a spectrum of modifications of natural calls were introduced. Most powerful for demonstrating specificity proved to be methods of generating synthetic calls, allowing independent combination of spectral and temporal parameters. Among specific units were those requiring adequate combinations of several frequency bands or a particular harmonic spectrum, sometimes in connection to sharp onsets or frequency modulations as found in calls. Adjacent neurons often showed similar properties. Clusters of more specific units were embedded in areas of weak tonotopical organization. The recording sites were marked and identified in the nucleus mesencephalicus lateralis dorsalis (MLD). These findings give support to the idea that neuronal networks in the midbrain participate in the analysis of vocalization.

604 PHYSICO-CHEMICAL PARAMETERS RELATED TO OLFACTORY QUALITY. S. S. Schiffman. Dept. Psy., Duke Univ., Durham, N.C. 27706.

At the present time, a model does not exist which can be used to accurately predict the odor of a substance from its physico-chemical properties. Two recent attempts have met with some success toward the solution of this problem. S. S. Schiffman (N. Y. Academy of Sciences, October, 1973) proposed a methodology which successfully weighted a series of physico-chemical properties including functional group and Raman spectra, accounting for 84% of the variance in predicting olfactory quality in humans. Dravnieks and Laffort (Olfaction and Taste IV., D. Schneider, Ed., Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart, 1972) have related four factors concerned with intermolecular interaction (an apolar factor, a proton receptor factor, an electron factor, and a proton donor factor) to odor discrimination in humans. This paper will describe the ability of both of these models to predict the olfactory quality of twenty-one molecular stimuli not previously tested by psychophysical methods.

605 EFFECTS OF LASER IRRADIATION ON THE SPONTANEOUS ELECTRICAL ACTIVITY OF UNSTAINED CEREBELLAR CELLS IN CULTURE. Walter Schimmerling*, James Olson*, Abdel M. Mamoon, Cornelius A. Tobias*, and Beat Gahwiler*. Donner Laboratory, University of California, Berkeley, CA 94720 and Biomedical Research Laboratories, SANDOZ A.G., CH-4002, Basel, Switzerland.

This work is part of a continuing study of the bioelectric activity of Purkinje and Golgi type cells (25-35 μm diam) in culture, with the aim of obtaining an adequate biological endpoint for the effect of very low doses of radiation on cell function. The cells are grown as explants from the cerebellum of 2-4-day-old rats in a plasma clot. The electrical activity is recorded extracellularly. Stimulation of action potentials by standard microelectrodes cannot easily be confined to a single cell. We have designed an instrumentation system that incorporates a commercial ruby laser (6943 Å) for our studies. The laser light is focused (to ~4 μm diam) on a single cell through the microscope. The cells are not stained. The energy of each laser pulse is measured with an integrating photodiode monitoring the light reflected from the culture chamber. Reproducibility of the laser is ~20%. The laser can be triggered by a single action potential, or by a sequence of spikes falling within a predetermined time interval. The pulse can further be delayed to ensure that it occurs during, or after an action potential. Time interval histograms (TIH) are obtained. The spike amplitude and instantaneous firing rate are also monitored on-line. Our preliminary results are: 1. The TIH can be modified by a single, 20 mJ laser pulse. In quasi-periodic cells the mean firing rate is slowed down, and the TIH is sharpened by a significant reduction in dispersion about this mean. 2. "Quiet" cells can be stimulated with a single pulse. 3. The effect of the laser seems to depend on the delay between the onset of an action potential and the laser pulse.

606 ABRUPT TRANSITION IN THE DURATION OF POST-TETANIC POTENTIATION AS A FUNCTION OF TEMPERATURE IN APLYSIA CALIFORNICA. Werner T. Schlapfer, Gary A. Smith*, Paul B.J. Woodson*, Jacques P. Tremblay,* and Samuel H. Barondes, Dept. Psychi., UCSD and VA Hospital, San Diego, Ca. 92161

After a train of stimuli (100 pulses at 2/sec) the monosynaptic and unitary EPSP recorded in cell R15 of the abdominal ganglion of Aplysia californica displays post-tetanic potentiation (PTP). The duration of the PTP was studied as a function of temperature. In preparations from animals which had been kept at 20°C for 48 hrs prior to the experiment, the PTP measured at 15°C lasted about 20 min; measured at 12°C it lasted 30 min. However, when the temperature of the ganglion was reduced to 10°C the PTP lasted 3-4 hrs. After the preparation had been kept at 10°C for 3 to 4 hrs, a further decrease of the temperature to 7.5°C resulted in a shortening of the duration of the PTP (average 70 min). By contrast, if the temperature was lowered directly from 12°C to 7.5°C, the duration of the PTP was increased from 30 min at 12°C to 5-6 hrs at 7.5°C. The temperature at which the animal was maintained prior to removal of the ganglion influenced the temperature range in which this sudden transition occurred. Thus, animals maintained at 12°C rather than 20°C before the experiments, showed an abrupt transition in the duration of the PTP between 8°C and 6°C.

The magnitude of the PTP was unaffected by temperature, while the frequency facilitation of the size of the EPSP (the ratio of the 100th EPSP to the first EPSP of a train of 100 pulses at 2/sec) decreased with decreasing temperature but did not show any abrupt transitions.

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607 CATECHOLAMINE SYNTHETIC ENZYME CHANGES ASSOCIATED WITH NEURONAL ACTIVITY. Cameron J. Schlehuber, David S. Segal and Charles E. Spooner, Depts. Neuroscience and Psychiatry, Sch. Med., UCSD, La Jolla, CA 92037.

Tyrosine hydroxylase activity was determined in striata obtained from freely moving rats receiving continuous and intermittent electrical stimulation in the region of the dopaminergic cell bodies in the substantia nigra. Behavioral concomitants of such stimulation included increased chewing, sniffing and suppression of locomotion. Electrical stimuli (two reciprocal pulses each 0.1 mA for 0.5 msec at 100 Hz) were delivered bilaterally for 24 hours through bipolar stainless steel electrodes. Continuous stimuli resulted in habituation of behavioral responses within 4-6 hours. No habituation was observed with intermittent stimulation, i.e. every 60 seconds for 30-second intervals during the 24-hour period. In the intermittent stimulated rats, total tyrosine hydroxylase activity was increased by 13%. Soluble tyrosine hydroxylase activity was increased by 32% compared to control animals, membrane bound enzyme activity showed no change. Continuous stimulation at the same parameters did not produce a significant alteration in enzyme activity. The increased tyrosine hydroxylase activity with intermittent stimuli indicates a direct relationship between catecholamine biosynthetic capacity and neuronal activity. (This research was supported by NIMH Grant No. DA-00265-02.)

608 BEHAVIORAL EVIDENCE OF A CNS NEUROTRANSMITTER BALANCE USING PRIMATE SOCIAL COLONIES. R. Francis Schlemmer, Jr.*, David L. Garver, John M. Davis, and John P. Bederka, Jr.*. Illinois State Psychiatric Institute and University of Illinois, Medical Center, Chicago 60612.

Recently, numerous experimental and clinical reports have indicated an intimate relationship between brain catecholamines (CA) and acetylcholine (ACh). To further explore this concept, the cholinesterase inhibitor, physostigmine (P), and d-amphetamine (d-Amp) were administered both alone and concomitantly to selected members of a stable Macaca speciosa social colony following peripheral cholinergic blockade with methscopolamine. Several important behavioral parameters showed changes from baseline levels when P and d-Amp were administered alone, but returned back toward normal when P and d-Amp were given concomitantly (film documentation). *d-Amp induced stereotypies and hypervigilance were reduced when P was co-administered. Both P and d-Amp decreased social grooming when administered alone; but, in combination (P + d-Amp), this normal affiliative behavior returned in quality and quantity.* P decreased, while d-Amp increased activity scores, but P + Amp showed no change from baseline level. In one animal, d-Amp induced chronic, intense scratching was greatly diminished by the co-administration of P. The results of this experiment, therefore, support the theory of an ACh-CA balance in the CNS. Furthermore, since the behavioral effects of chronic human amphetamine ingestion have been closely correlated to the symptomatology exhibited by schizophrenics, these results suggest that the CNS cholinergic system may modulate some of the behavioral disorders associated with schizophrenia, and indicate a need to explore cholinomimetic agents for possible antipsychotic properties.

609 CORTICAL CELL DISCHARGE PATTERNS DURING DIFFERENT LOADING CONDITIONS. Edward M. Schmidt, R. Gilbert Jost* and Kathleen K. Davis*. Laboratory of Neural Control, NINDS, NIH, Bethesda, Md. 20014.

Monkeys (Macaca mulatta) were trained to move a handle by alternate flexion-extension of the wrist for a liquid reward. Two target zones were electrically established into which the handle had to be positioned for a minimum of 500 msec. Loads opposing muscular activity were provided by a torque motor.

Single unit extracellular recordings were obtained from 103 precentral cortical cells whose activity was related to the alternate wrist flexion-extension task. Although the task was carried out under different loads only a weak relationship between cortical cell firing rates and static force levels was observed for force in one direction. A large change in firing rate occured however, when the required direction of force was changed causing the predominant activity to shift between extensor and flexor muscles.

The firing patterns of the observed cortical cells suggest that the motor cortex is involved in specifying the muscles to be activated for a given movement and not the level of force to be produced by those muscles.

610 REORGANIZATION OF THE RETINO-TECTAL PROJECTION IN GOLDFISH. John T. Schmidt*, Carol M. Cicerone* and Stephen S. Easter,Jr. Biophys. Res. Div., Dept. Psych. and Dept. Zool., Univ. of Michigan, Ann Arbor,MI 48104

The retino-tectal projection was electrophysiologically mapped in 12-18 cm goldfish (tip to tip) after surgical removal of half of the tectum, half of the contralateral retina, or both. 1) 150 days following removal of the caudal half tectum (contralateral retina intact), the retinal projection was found to have compressed onto the remaining rostral half tectum. Computation of the magnification factor (MF), the number of microns of tectum per degree of visual field, showed that the compression was strictly along the rostro-caudal axis; the medio-lateral MF was unchanged from normal. This same observation has been reported in 5-10 cm goldfish (Gaze and Sharma, Exp. Brain Res. 10, 171, 1970); we conclude that the plasticity is retained in the older, larger fish. 2) 150 days following the removal of the nasal half retina (contralateral tectum intact), the remaining retinal projection expanded onto the caudal half of the tectum previously denervated by the retinal ablation. Only the rostro-caudal MF increased. This same procedure has been carried out on smaller fish by Horder (J. Physiol. 216, 53P, 1971) and Yoon (Am. Zool. 12, 106, 1972). Their reports conflict; ours support Yoon. 3) 150 days following the removal of the nasal half retina and the contralateral caudal half tectum (to which it normally projects), the MF was unchanged. We conclude that changes in the MF do not result from decreases in either retina or tectum alone, but from a mismatch in the sizes of the two surfaces. (This work was supported by PHS grant EY-00168.)

611 RESPONSES OF FIRST AND SECOND ORDER VESTIBULAR NEURONS IN GERBIL. L.W. Schneider* and D.J. Anderson. Kresge Hearing Research Institute, The University of Michigan, Ann Arbor, Michigan, 48104

Discharge patterns of first and second order vestibular neurons responding to angular acceleration were studied in gerbil. The resting discharge activity of each cell was used to characterize the neuron by measuring the coefficient of variation and coefficient of skewness of the inter-spike interval distributions. Sinusoidal angular oscillations ranging in frequency from .0125 to 5.0 Hertz were delivered by a velocity controlled rate-table. A PDP-12 minicomputer system was used on-line to display period and post-stimulus histograms of discriminated single unit activity. Off-line Fourier analysis of the period histograms was used to determine the phase of cell response to sinusoidal accelerations, while the average level and amplitude were determined by a least squares fitting algorithm applied over the fraction of the stimulus period where the cell discharged. First order neurons were found to have high discharge rates (avg.=61.7 impulses/sec.) and bi-directional responses to rotation, and were of two groups called regular and irregular according to their resting discharge patterns. Second order neurons, located mainly in the medial and lateral vestibular nuclei, had low or even zero resting discharge rates (avg.=17.8) resulting in more uni-directional responses and were of a single population. The Bode plots of the regular first order cells are similar to that of a first order system with a time constant of about 2 seconds as predicted by the torsion pendulum theory for cupula movement. The irregular first order cells show an increasing gain above .5 Hertz and a large phase lead re velocity above 1.0 Hertz suggestive of a fractional power transfer function. The second order cells show the phase and gain characteristics of the regular first order cells and thus transmit a unidirectional coding of head angular velocity for frequency components of head movement above 1.0 Hertz. Supported in part by a grant from the John A. Hartford Foundation.

612 PHASE-SHIFT THEORY OF NEURAL INFORMATION PROCESSING IN THE CORTEX: THEORETICAL CONSIDERATIONS AND PHYSIOLOGICAL EVIDENCE. Walter Schneider, Psychology Department, Bloomington, Indiana 47401.

This theory proposes that information is stored and transferred via phase relationships within neural populations. The general characteristics and advantages of phase encoding are described. Two systems are proposed by the theory. The first, Functional Group (FG), consists of a population of Information Cells which receive inputs from other FG cells, have no excitatory interconnections, and can be inhibited as a unit by the Supervisor. The second, the Supervisor, controls all the information flow in the system by altering the time of spiking of neurons which can inhibit FGs. Information Cells have the following properties: 1) they undergo postinhibitory rebound; 2) they are connected to inhibitory interneurons which greatly inhibit the cell which fired them while partially inhibiting neighboring cells; and 3) after they receive a consolidation command, they increase the effectiveness of the excitatory synaptic dendritic connections which recently depolarized the cell.

By sequencing inhibitory spikes the Supervisor can perform the following operations: 1) phase-lock a FG to allow information input; 2) gate information between FGs via shifting their respective phase relationships; 3) maintain information for relatively long periods of time (seconds); 4) bias a FG to allow an alternate output; 5) accomplish hierarchical information transfer; and 6) recognize an input into a FG as causing short or long term memory match.

Physiological evidence supports all the postulates of the model except those defining plastic changes at the synaptic dendritic sites. Cortical pyramidal cells are shown to have similar properties to theoretical Information Cells, cortical columns to FGs, and the thalamus to the Supervisor. Microelectrode recordings provide evidence consistent with most of the Supervisor operations stated above.

613 PHARMACOLOGIC CHANGES IN PERFORMANCE OF NORMAL AND BRAIN DAMAGED RATS. B. Schneiderman* and R. L. Isaacson. Dept. of Psychology, Univ. of Florida, Gainesville, Fla. 32611.

Animals with bilateral damage to the hippocampus are deficient in the performance of an operant DRL (differential reinforcement for low rates of responding) task. The major tranquilizer chlorpromazine has been found to effectively improve the DRL performance of the brain damaged rats (Van Hartesveldt, in preparation). In an attempt to extend these observations drugs which affect specific neurochemical systems (i.e., physostigmine, alpha-methyl-para-tyrosine, and para-chlorophenylalanine) in addition to the more generally acting drug, chlorpromazine, were administered (i.p.) to rats with bilateral hippocampal damage, with neocortical lesions, and intact rats acquiring a DRL-20 schedule of reinforcement. Chlorpromazine improved the performance of animals with hippocampal damage and there was a small improvement subsequent to the alpha-methyl-para-tyrosine injection, but the other drugs were relatively ineffective. Normal and neocortically lesioned rats were positively influenced by all of the drugs administered but the effects of catecholamine depletion and cholinergic increase were of the greatest magnitude. In normal animals improvements in task performance were attributed to actions upon response rate or timing mechanisms which can be differentially affected by the pharmacological agents.

614 A ROLE FOR THE DORSAL COLUMNS OF MONKEY IN TACTILE DISCRIMINATION. Arthur S. Schwartz and Alan Azulay*. Div. Neurobiol., Barrow Neurological Inst., Phoenix, 85013.

The bulk of behavioral evidence has failed to support a role in tactile discrimination for the dorsal column system commensurate with its anatomical and neurophysiological characteristics. Recent observations by Vierck, and an analysis of the types of somatosensory tasks used by us and others in testing dorsal column function, suggested that this pathway may be important for the discrimination of patterns requiring the spatiotemporal integration of tactile stimulation. Accordingly, we designed plastic disks with excavated patterns which could be discriminated only if the monkey traced or explored the contours with the fingers. Six stump-tail macaques suffered severe impairment in the pattern discrimination after section of the dorsal column at the C_2-C_3 level, imposed either before or after original learning. Rarely were any of the patterns discriminated postoperatively after prolonged testing. Interposed tactile quality tasks (roughness, hardness, form) requiring similar response typology were discriminated easily. Tests for motor performance and finger dexterity, plus the above tactile quality tasks, implied that motor deficits were not a factor in the pattern agnosia. Preliminary data indicates that spinothalamic section at the midbrain level is ineffective in disrupting the pattern discrimination. We conclude that the dorsal column fibers from the primate forelimb are necessary for tactile discriminations involving the integration of spatiotemporal stimuli on the skin surface.

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615 UNIT ACTIVITY AND EVOKED POTENTIALS DURING READOUT FROM MEMORY. E. Schwartz*, A. Ramos* and E. R. John. Brain Res. Labs., Dept. of Psychiatry, New York Medical College, New York, New York, 10029

Cats were trained to respond for food at a work panel, exhibiting CR_1 for flicker at one frequency (V_1), and CR_2 when a second frequency (V_2) occurred. Occasionally, a meaningless test stimulus was presented at frequency V_3, midway between V_1 and V_2. In such differential generalization tests with V_3, occurrence of CR_1 (V_3CR_1) causes the average evoked potential (AEP) to resemble the usual response to V_1; while if V_3CR_2 occurs, the AEP is as if V_2 had been presented. Using computer pattern recognition, the individual evoked potentials (EP) caused by V_3 in a series of trials can be separated into several classes. Occurrence of EPs in a particular class predicts the subsequent behavioral performance. Multiple unit and EP data from the same chronically implanted microelectrodes were tape recorded and then separated by electronic filters. EP waveshapes were classified individually. The multiple unit activity occurring during each class of EP was analyzed. The same neuronal population was found to display different firing patterns corresponding to each class of EP and the related behavioral responses. These findings suggest that the same neurons participate in different memories, but in different firing combinations and sequences.

616 VESTIBULAR INPUT TO SOMATOSENSORY THALAMIC NUCLEI IN THE SQUIRREL MONKEY. D.W.F. Schwarz, C. Liedgren*, J.H. Young*, A. Rubin*, R.D. Tomlinson*, A.C. Milne*. Deptartments of Otolaryngology and Physiology, University of Toronto.

In order to define the thalamic relay of the vestibulo-cortical projection pathway ca.2000 units were studied by extracellular recording from the postero-lateral quarter of the thalamus in locally anesthetized monkeys. All units were submitted to electrical stimuli of the contralateral vestibular, auditory and facial nerves and to manual somato-sensory and natural auditory and visual stimuli. Within the VB complex a large population of cells responded to vestibular stimulation with short latencies (2-10 msec). Most of these neurons had somatosensory receptive fields within deep subcutaneous tissue of the trunc or proximal limbs and were located posteroventrally in the VPL and rostrodorsally in the VPLo (nucl. ventralis intermedius of Vogt). The central part of the VPL, receiving skin afferents from distal parts of the limbs, receives little vestibular input. Few units could be antidromically invaded by stimulation of the pre and postcentral gyrus. Occasionally one cell could be invaded with different latencies from both gyri indicating axon collaterals. Corticothalamic monosynaptic connections were as frequently observed as thalamo-cortical projections. Vestibular responses, some of them converging with afferents from large somatosensory receptive fields, were also found in MGmc and the supra-geniculate nucleus.

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617 FUNCTIONAL CHANGES FOLLOWING MOTONEURON AXOTOMY. I.G. Scott*, I. B. Munson and L. M. Mendell. Dept. Physiology, Duke Medical Center Durham, N. C. 27710

Medial gastrocnemius (MG) motoneurons of adult cats were axotomized by dividing one half of the MG muscle nerve in the popliteal fossa. Averaged EPSP's produced by activation of uncut single MG Ia afferent fibers were examined in both axotomized and intact homonymous motoneurons 29 to 60 days following axotomy. Ia afferent fibers elicited EPSP's in 69% of the axotomized MG motoneurons compared to 95% of the MG motoneurons with intact axons. These differences were significant ($p<.01$). The rise times of EPSP's in axotomized motoneurons were significantly longer than in normal motoneurons (1.08 msec vs. 0.78 msec; $p<.03$). These facts indicate a partial loss of synaptic terminations from Ia fibers onto axotomized α-motoneurons, and that these terminals were selectively removed from the soma and proximal dendrites. The conduction velocities of the axons proximal to the transection were lower than normal and progressively diminished with time following the initial procedure. Axotomized motoneurons with fast rising EPSP's had larger conduction velocities than axotomized motoneurons with no EPSP's suggesting that the reduction in conduction velocity and the loss of somatic Ia terminals are different aspects of the same process. The amplitudes of the EPSP's were slightly though not significantly smaller in axotomized motoneurons. These changes have a slower onset and are less severe than those reported by Kuno and Llinas (J. Physiol., 1970) following ventral root transection. The results of these 2 experimental procedures are qualitatively similar with the exception of our failure to observe "partial responses". (Supported by NIH).

618 EFFECT OF SUCROSE APPLICATION ON LATERAL HYPOTHALAMIC SELF-STIMULATION IN RATS. Thomas R. Scott and Michele Lemaistre* Dept. Psychol., Univ. of Delaware, Newark, Delaware 19711

Appetitive gustatory stimuli (sweet, salt) activate neurons in the medial forebrain bundle at the level of the hypothalamus. Aversive stimuli (sour, bitter) evoke responses from hypothalamic cells outside this area. If gustatory afferents impinge on neurons which mediate lateral hypothalamic self-stimulation (LHSS), then administration of appetitive taste stimuli might augment the reinforcement of LHSS, causing an increase in response rate. This could be analogous to increasing hypothalamic activity by raising the reinforcing current level. Nine male albino rats were implanted unilaterally with bipolar stimulating electrodes in the lateral hypothalamus, and with cannulas which allowed small quantities of solution to be applied directly to the tongue without disrupting behavior. LHSS sessions were 20 minutes, including five minutes of warmup. When response rates had stablized within a 5% range, 1.5 cc of 1.0 M sucrose was applied to the tongue at a constant rate over a five minute period (0.3 cc/min). Bar-pressing increased steadily over 1-3 minutes, and remained elevated for the remainder of the sucrose period. Distilled water and other taste stimuli (salt, sour, bitter) caused no change, nor did non-gustatory control stimuli (alterations of sound and light levels) calculated to increase general activity. Thermal reinforcement, presumably affecting other hypothalamic nuclei, had no effect. It was concluded that lateral hypothalamic neurons mediating self-stimulation also respond to appetitive gustatory stimuli. Conversely taste sensations may provide a measure of the reinforcing effect of LHSS.

619 REGENERATION OF AXONAL FIBERS AFTER NEONATAL CORPUS CALLOSUM SECTION IN RATS. Jeri A. Sechzer. E. W. Bourne Behavioral Res. Lab., Dept. of Psychiatry, N.Y. Hosp.-Cornell Med. Ctr., Westchester Div., White Plains, N.Y. 10605.

Twenty-five rats, subjected to corpus callosum section on the day of birth (gestation day 22), were permitted to survive for 140 days. Their brains, embedded in celloidin, were serially stained with thionine and by Weil's method. In five animals, in which either callosal section was complete or nearly complete a group of callosal fibers, as they approached the midline gap, splayed out and coursed ventrally toward the anterior commissure. This pattern of axonal growth was only evident in one hemisphere and was never observed to occur bilaterally. Other fibers were seen across the midline, forming whorls in the interhemispheric space. Most of these fibers were myelinated, although incompletely. Since the bulk of the fibers of the corpus callosum in the rat are formed by gestation day 22, these findings are suggestive of axonal regeneration.

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620 TRANQUILIZER-BLOCKADE OF DOPAMINE RELEASE FROM STIMULATED STRIATAL SLICES. Philip Seeman and Tyrone Lee*. Pharmacol. Dep't., Univ. of Toronto, Canada.

The blockade of dopaminergic transmission by neuroleptics can be explained either by a block of the post-synaptic dopamine receptor, or by a pre-synaptic anesthetic blockade of nerve impulses and an inhibition of impulse-triggered release of neurotransmitter (Seeman et al., Fed. Proc. 33: 246, 1974). In order to determine the pre-synaptic sensitivity of the striatum to neuroleptic blockade, the effects of neuroleptics were studied on electrically-stimulated release of dopamine from rat caudate slices. The slices were pre-loaded with ^{3}H-dopamine and superfused in the presence of neuroleptics. Biphasic pulses (0.6 msec; 15 V; 25/sec) were applied for 60 secs and the stimulated efflux of ^{3}H-dopamine measured. All neuroleptics inhibited the impulse-triggered release of dopamine; 50% inhibition occurred at 40 nM trifluperidol, 50 nM pimozide, 54 nM fluphenazine, 70 nM reserpine, 95 nM haloperidol, 320 nM prochlorperazine, 430 nM perazine, 440 nM clozapine, 550 nM trifluperazine, 700 nM chlorpromazine, 800 nM thioridazine, 6 uM promazine, and 16 uM promethazine. Tetrodotoxin (10^{-6}M) completely blocked release. The impulse-triggered release of ^{3}H-acetylcholine was also inhibited by haloperidol (starting at 160 nM), as was ^{3}H-GABA release (starting at 400 nM haloperidol). It is concluded that neuroleptics can act pre-synaptically by blocking impulses or impulse-triggered release of neurotransmitter, that the dopaminergic neurones are the most sensitive to the neuroleptics, and that the impulse-blocking potencies correlate with the anti-psychotic potencies of the neuroleptics.

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621 EFFECTS OF LOCUS COERULEUS STIMULATION ON HIPPOCAMPAL UNIT ACTIVITY AND ON BEHAVIOR IN UNRESTRAINED RATS. M. Segal and F. E. Bloom. Lab of Neuropharmacology, SMR, IRP, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032.

The behavioral and neuronal effects of electrical stimulation in the nucleus locus coeruleus (LC) were studied chronically in freely moving rats. Bipolar stimulating electrodes were implanted in the region of LC. For unit recording in the hippocampus semi-microelectrodes or a pedastel base for a mechanically advanced steel microelectrode were implanted. Experiments were conducted at least three days after implantation, and consisted of three phases. First, the rat was tested for intracranial self-stimulation through the LC electrode and the "rewardability" of the stimulating electrode position was assessed. Simultaneously, the responses of hippocampal cells to LC stimulation were noted. Second, the rat was trained in a classical conditioning paradigm in which a tone was associated with milk. Subsequently, the effects of LC stimulation on the generation and performance of the conditioned response were assessed. Finally, the effects of adrenergic drugs were studied on self-stimulation and evoked hippocampal activity. We observed that rats will self-stimulate their LC at a high rate. Cells in the hippocampus are inhibited by LC stimulation under these conditions as they were in acute experiments reported earlier. LC stimulation potentiates unitary conditioned responses in the hippocampus. Both self-stimulation behavior and hippocampal unit inhibitions are antagonized by alpha-methyltyrosine and potentiated by amphetamine, supporting the adrenergic character of this inhibitory projection.

622 EFFECT OF SEPTAL LESIONS ON STRESS RESPONSE PATTERNS OF PLASMA GROWTH HORMONE AND PROLACTIN AS COMPARED WITH ADRENAL STRESS RESPONSES. Jo A. Seggie and G.M. Brown. Neuroendocrine Research Section, Clarke Institute of Psychiatry, Toronto.

In order to evaluate the effects of a septal lesion on stress responses, plasma levels of growth hormone (GH) and prolactin were measured 0, 5, 15, 30 or 60 minutes after 5 seconds of handling or 3 minutes exposure to a novel environment at crest or trough of the diurnal adrenal rhythm in normal, sham operated and septally lesioned rats. Hormone levels were compared with corticosterone stress responses which were previously reported (Soc. for Neuroscience Prog., #76.5: 406, 1973). In support of a previous study (Psychosomatic Med., 1973, 35: 447) all three hormones responded to stress, however, the stress response patterns were influenced very differently by the type of stimulation and the time of observation in the diurnal cycle. A septal lesion, previously shown to potentiate adrenal stress responses, caused delay of return to baseline GH levels following stress suggesting that the GH response to stress, like the adrenal response, is potentiated. In contrast, a septal lesion potentiated the prolactin stress response following the 3 min stimulus but attenuated the prolactin response to the 5 sec stimulus. It is concluded that limbic control of these hormonal stress responses differs. It appears that corticosterone and GH share some common elements of control as they are both potentiated by a septal lesion. In contrast, prolactin responses are differentially affected by a septal lesion. (Dr. J. Seggie is an Ontario Mental Health Foundation (O.M.H.F.) Research Scholar while Dr. G.M. Brown is an O.M.H.F. Research Associate).

623 PATHWAYS MEDIATING TWO TYPES OF VISUAL RESPONSE IN THE CEREBELLUM OF THE FROG. Farhad Shafa and William B. Marks. Biology Dept., Johns Hopkins Univ., Baltimore 21218 and Lab. of Neural Control, NIH, Bethesda 20014.

In an extracellular microelectrode examination in curarized frogs, cerebellar Purkinje cells of both the auricular lobe and the corpus cerebelli responded with complex and simple spikes to 1/min on, and especially off, stimulation by a flash of light. Also moving targets subtending 20 deg. of arc or larger could elicit this response, and the receptive fields covered the entire binocular field. When the cerebellum was cut in half along the midsaggital line and one optic tectum (OT) was removed, both cerebellar halves still responded to visual stimulation, but removal of the eye ipsilateral to the lesioned OT abolished the response to 1/min flash stimulation and to fast moving large objects. This suggests that the OT is a necessary way-station for this response. However, a very weak response triggered by a 1 deg. vertical bar entering the visual field with a speed of 1-6 deg./sec was detected which persisted even when the diencephalic structures were removed bilaterally in addition. This implicates the accessory optic system, the only remaining site of optic nerve terminals, as a way-station for the latter response. The contribution of each tectal efferent pathway to the tectally mediated cerebellar response was studied using 1/min off-stimulation and lesions which selectively severed different tectal projection routes. The crossed and uncrossed tecto-bulbar tracts of one OT could each mediate simple and complex spikes in both cerebellar halves, while the rostral projections crossing at the commissura transversa had a very weak effect which was mediated through the opposite OT. Thus the two visual responses of the cerebellum are mediated by descending tectal efferents and the accessory optic system, respectively. Supported by NIH Grant 08385, and Biology Dept. funds, JHU.

624 EFFECT OF GLUTAMATE ANALOGS ON NEUROMUSCULAR EXCITATION IN THE WALKING LIMB OF THE LOBSTER. Richard P. Shank and Alan R. Freeman. The Institute of Psychiatric Research, Indiana University Medical Center, Indianapolis, Indiana 46202 and Department of Physiology, Temple University School of Medicine, Phila., Pa. 19140.

Compounds with structural similarities to L-glutamate were tested for pharmacological activity on the neuromuscular preparation of the lobster walking leg. The compounds were examined for effects on the membrane potential and input resistance of muscle fibers, the amplitude of neurally evoked EPSPs and IPSPs, and for effects on the excitatory action of applied L-glutamate on the muscle fibers. Of the 41 compounds studied 14 had no apparent action at concentrations up to 10 mM. Thirteen compounds possessed activity qualitatively similar to that of L-glutamate but none was as potent. Among the thirteen, L-aspartate, β-N-oxalyl-L-α,β-diaminopropionate, 2,4-dinitrophenyl-L-glutamate and α-tert-butyl-L-glutamate were the most active. Seven compounds antagonized both neurally evoked excitation and the action of applied L-glutamate without altering neurally evoked inhibition. Four compounds showed mixed agonistic and antagonistic activity, and 3 demonstrated presumed non-synaptic actions. Of the seven antagonists kainic acid was the most potent, but a concentration of 1 mM was required for minimal activity. D-aspartate and D-glutamate also exhibited marked antagonistic activity at a concentration of 10 mM. L-glutamate diethyl ester and L-glutamate γ-methyl ester, which respectively exert antagonistic effects on L-glutamate induced excitation in the cat CNS and neurally evoked excitation on the crayfish abdominal muscle, mimicked the action of L-glutamate in our studies. Thus the L-glutamate receptor at this lobster neuromuscular excitatory synapse appears to be pharmacologically distinct from those in the cat CNS and crayfish abdominal muscles.

625 TROPHIC RELATIONSHIPS OF NERVE AND MUSCLE IN REGENERATING LEGS OF AN INSECT. Eli Shapiro* and Melvin J. Cohen. Department of Biology, Yale University, New Haven, Connecticut, 06520.

In the nymph of the cockroach Periplaneta americana, amputation of a limb at the trochanter leads to regeneration of the lost segments within the remaining coxal stump. The regeneration occurs during the 20-25 days of a single intermolt period. Regeneration is accompanied by a loss of some of the muscle in the coxal stump and the retention of other muscle. The "saved" muscle is incorporated into the coxa of the regenerated leg. We have examined regressing and "saved" coxal muscle in the regenerating leg to gain information on the systemic and neural events involved in maintaining muscle viability. During limb regeneration, the levator and depressor coxal muscles each loose about 40% of their wet weight. The muscle regression proceeds in an orderly manner starting at the distal end of the coxa and moving proximally until the apodemes at the distal ends of the muscles are bared. The regenerating limb segments grow in the space formed by the lysis of the muscle. The proximal 2/3 of the coxal muscle mass remains healthy as judged by histological and electrophysiological examination. If the distal limb segments are amputated and the muscles of the coxal stump denervated, then all the muscles of the coxal stump break down completely within 10 days. In contrast, denervated muscles in legs that have not had any segments amputated remain viable for months. Amputation of limb segments appears to initiate a systemic process that tends to break down muscle. Intact innervation to muscle in the distal region of the coxa is not sufficient to protect it from this systemic lytic effect. The presence of innervation to some of the muscle in the proximal region of the coxal stump exerts a trophic "saving" effect on that muscle.

626 THE RETINOTECTAL PROJECTION IN XENOPUS LAEVIS FOLLOWING LEFT-RIGHT EXCHANGES OF THE EYE RUDIMENT. S.C.Sharma and Joe Hollyfield* (Spon: E. Roy John). Depts. Ophthal., N.Y. Medical College and Columbia Univ., New York, N.Y.

The specification of central retinal connections in Xenopus occurs first in A-P axis at developmental stage 30 followed by D-V axis at stage 31 (Jacobson, Dev. Biol., 17:202,1968). The rotation of the eye primordium before stage 30 resulted in a normal visual map and a rotated map if the eye was rotated after stage 30. In the present series of experiments in Xenopus, we transplanted the right eye analag to its left orbit and vice versa at embryonic stages 26-31. The transplants were with 0^{o} and 180^{o} rotations. After metamorphosis, the visual projection from the right eye (original left eye) to the left optic tectum was mapped electrophysiologically. In all cases the visual projection map corresponded to a normal left eye map, i.e. the left eye transplant retained its original axis. Furthermore, the degree of rotation of the map corresponded to the position of the choroidal fissure of that eye. These results show that a left eye transplant between stages 26-31 never became a right eye. The results also suggest a reconsideration of the prevailing hypothesis of the development of neural specificities in retinal ganglion cells.

627 ACTIVITY RELATED 2-DEOXY-D-GLUCOSE UPTAKE IN THE CENTRAL NERVOUS SYSTEM OF THE RAT. Frank R. Sharp* (SPON: E. V. Evarts). NIH, Bethesda, Md. 20014.

Tracer amounts of ^{14}C 2-deoxy-d-glucose have been shown to be a quantitative indicator of localized cerebral glucose uptake using X-ray film autoradiography.[1] Using a modification of this technique (with no correction for an estimated 10-20% exchangeable pool at 45 min after injection), an increase in the deoxyglucose uptake was seen in one dorsal horn of the spinal cord in anesthetized rats following electrical stimulation of ipsilateral sciatic nerve. Experiments in unanesthetized rats revealed a significant increase in the deoxyglucose uptake of much of the gray matter in the brain and spinal cord of three swimming compared to three resting rats. The increase ranged from minimal changes in parts of the cerebellar hemispheres to a four-fold change in parts of the vermis of the cerebellum. Autoradiography, utilizing a technique for the diffusible ^{3}H 2-deoxy-d-glucose on NTB 2 and 3 emulsions, was employed in three swimming and three resting rats. The distribution of grains in these experiments indicated that in the resting and swimming states much of the deoxyglucose uptake occurs outside of cellular perikaryons. This suggests cell processes and synapses utilize the bulk of the glucose available, a view compatible with large enzyme activities in dendritic layers of Ammon's horn[2] and high affinity transport of deoxyglucose in synaptosomes.[3]

1. Kennedy, C., et al. Local cerebral glucose consumption in conscious lab animals, Proc. 5th Mtg. Amer. Soc. Neurochem., 86, 1974.
2. Lowry, O.H., et al. The quantitative histochemistry of brain, Ammon's horn, J. Biol. Chem. 207: 39-49, 1954.
3. Diamond, I., et al. High affinity transport and phosphorylation of 2-deoxy-d-glucose in synaptosomes. J. Neurochem. 20: 1533-42, 1973.

628 COLOUR AND ORIENTATION SPECIFICITY OF SPATIAL PATTERN DETECTORS IN THE HUMAN VISUAL SYSTEM. C.R. Sharpe* and G. Mandl. Aviation Medical Research Unit, McGill University, Montreal, P.Q., Canada.

Results obtained from psychophysical experiments have shown: (1) Colour specificity. Superimposing a uniform background of one colour upon a sinusoidal grating (4c/deg) of another colour has no effect upon a subject's contrast threshold (detection threshold) for that grating, if the luminance of the uniform background is kept within a limited range. This is taken as evidence that the spatial pattern detectors responsible for detecting the test grating are to some extent colour specific. (2) Cross-colour adaptation. Adapting to a stationary sinusoidal grating of one given angular orientation and one colour (say red), can elevate a subject's contrast threshold for detecting a test grating of the same angular orientation but of a different colour (say blue). This occurs even when the luminance of the adapting (red) pattern is too low to directly excite the subject's specific colour channel responsible for detecting the (blue) test pattern. (3) Orientation specificity. For cross-colour adaptation, the contrast threshold for a test grating of one colour, and one given angular orientation, is elevated by adapting with a grating of another colour only if the adapting grating has an angular orientation that is sufficiently close to that of the test grating. As these experiments were so arranged that cross-colour spatial adaptation could not be the result of direct test channel excitation, it is suggested that such adaptation may be the after-effect of prolonged lateral inhibition between spatial pattern detectors. This lateral inhibition may sharpen the tuning curves of pattern detectors in both the chromatic and spatial domains.

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629 THERMAL RESPONSES FOLLOWING INTRACRANIAL MICROINJECTIONS OF ANGIOTENSIN II, CARBACHOL AND PUTATIVE NEUROTRANSMITTERS IN THE BRAIN STEM OF RABBITS. Lawrence G. Sharpe, Janie E. Garnett* and Nancy S. Olsen*. Dept. Psychiatry, Washington Univ. Sch. Med., St. Louis, Mo. 63110.

Over 1100 injections (1.0 µl) of various compounds were made via chronic indwelling cannulae implanted into several brain stem regions of 31 New Zealand rabbits under restrained and non-restrained conditions. When microinjected into the anterior-preoptic region of the hypothalamus and the central gray matter of the lower brain stem, carbamylcholine chloride (carbachol, 0.3-6.0 µg) produced a significant dose-dependent rise whereas angiotensin II (AII, 0.05-1.5 µg) caused a significant dose-dependent fall in brain and body (colonic) temperature lasting about 1 h. Other carbachol-hyperthermic sites were located in the dorsal and lateral hypothalamus and other AII-hypothermic sites included the ventromedial nucleus of the hypothalamus and the massa intermedia. The hyperthermia following microinjections of carbachol was almost always related to the occurrence of behavioral excitation, whereas the hypothermia induced by AII was not related to any behavior observed, including drinking and drowsiness. Microinjections of acetytcholine mixed with equal amounts of physostigmine (3-50 µg) caused hyperthermia and hyperactivity similar to that produced by carbachol. The biogenic amines, norepinephrine, epinephrine, dopamine and 5-hydroxytryptamine caused little or inconsistent thermal changes when microinjected into several brain stem regions in the normothermic rabbit. These data suggest that, in the rabbit, cholinergic mechanisms play a significant role in the central regulation of body temperature and behavioral activation. At present, the mechanisms involved in the AII-induced hypothermia is unknown. (Supported by grants, AA00209, MH07081, NS09156, DA00259).

630 STUDIES OF THE SYNTHESIS OF PROTEINS IN GOLDFISH BRAIN FOLLOWING THE ACQUISITION OF NEW BEHAVIOR PATTERNS. Victor E. Shashoua. McLean Hospital, Biological Research Laboratory,Harvard Medical School, Belmont, MA 02178.

The search for biochemical correlates of the information recording and storage process of the nervous system has implicated a role for RNA and protein synthesis. Experiments in a number of laboratories have demonstrated that protein synthesis is required for establishing long-term memory. In previous studies with goldfish, as the experimental animal, we found that specific RNA changes occurred when the animals acquired a new swimming skill. The possibility that these RNA molecules are templates for the synthesis of specific proteins was therefore investigated. The pattern of synthesis of goldfish brain proteins and the time course of their distribution in brain subcellular fractions was determined. In preliminary experiments the suitability of using a double labelling method was first established. These brains from groups of seven animals, labelled with valine 3H and seven animals labelled intracerebrally with valine ^{14}C were pooled, homogenized and fractionated into their nuclear, cytoplasmic soluble, microsomal, myelin, synaptosomal, and mitochondrial components. The polyacrylamide gel electrophoretic patterns of labelled proteins were determined. The ratio of $^{3}H/^{14}C$ for each of the labelled proteins was then measured. Methods were developed to give constant ratios of $^{3}H/^{14}C$ for each protein. The results for use of these methods in the search for the formation of specific proteins following training, after exhaustive physical exercise, after stress and during the performance of well-known tasks will be described.

631 SIAMESE CAT: RECEPTIVE FIELD POSITION AND ANATOMICAL DISTRIBUTION OF FIBERS IN THE CORPUS CALLOSUM. Carla Shatz* (SPON: S. W. Kuffler). Department of Neurobiology, Harvard Medical School, Boston, Mass. 02115

In the "Boston" Siamese cat, an abnormal representation of part of the ipsilateral visual field is inserted between the usual contralateral representations in cortical areas 17 and 18. The anatomical 17-18 border remains in approximately the same position as usual, but now represents a region in the ipsilateral visual field roughly 20 degrees from the vertical meridian (VM). The representation of the VM is thus displaced from the 17-18 border to regions within areas 17 and 18 proper. Do visual fibers in the "Boston" Siamese cat corpus callosum originate, as in ordinary cats, from the 17-18 border even though the VM is no longer represented there? Single units were recorded from the callosum of 5 normal and 11 Siamese cats. In normal cats, 53/57 receptive fields (RF's) had their nearest edge within 2.5 degrees of the VM. In Siamese cats, only 49/130 RF's fell within this range; the remainder decreased uniformly in number over a region extending up to 25 degrees away from the VM. The absence of a peak in RF distribution 20 degrees away from the midline suggests that the origin of callosal fibers in the "Boston" Siamese cat is not restricted to the anatomical 17-18 border. The Fink-Heimer technique was used to show the distribution of terminal degeneration after cutting the posterior 1/3 of the callosum in both normal and Siamese cats. In the normal cat, dense fiber and terminal degeneration in area 17 was confined to a region close to the 17-18 border. The medial bank of the lateral gyrus was entirely free of degeneration. In the Siamese cat, rather diffuse degeneration extended beyond the 17-18 border well into area 17 proper, and stopped abruptly halfway down the medial bank (near the suprasplenial sulcus) at a region representing contralateral visual fields roughly 5-10 degrees from the midline. Thus, in "Boston" Siamese cats, both the origin and termination of callosal fibers are more widespread than normal. (NIH: TO1-EY0082)

632 INTERRELATED PROPERTIES OF MULTIPLE FORMS OF BRAIN MONOAMINE OXIDASE. Jean C. Shih and Samuel Eiduson. Dept. Psychiat. and Biol. Chem., NPI, UCLA, Los Angeles, Calif. 90024.

Several forms of rat brain mitochondrial monoamine oxidase (MAO) were solubilized by Triton X-100, followed by ammonium sulfate fractionation, and calcium phosphate treatment. They were further separated and isolated by agarose (Bio-Gel A 1.5m). (J. Neurochem., 21:41-49, 1973.) When the column was equilibrated with 0.05 M phosphate buffer, pH 7.4, depending on the concentration of the protein applied to the columns, two fractions (A and B or C) were obtained. At high concentrations fractions A and B were obtained. The approximate molecular weight of A was 1.5×10^6 daltons or greater. B was 400,000 daltons, while C was less than 30,000. If the column was equilibrated with 8 M urea or 6 M guanidine-HCl in 0.05 M phosphate buffer pH 7.4, A and C were obtained, and therefore B is thought to be an aggregate of C. By rechromatographing B, the results indicated that B and C were interconvertable. Fraction A, B and C had different substrate specificities. "C" had the highest specific activity among the three forms when tryptamine, serotonin, phenylethylamine or benzylamine was used as substrate. Similar results as above were obtained with Tris-HCl buffer, pH 8.2. These results suggest that the interconvertible property between B and C was not caused by ionic or pH effects. If the partially purified sample was treated with sodium perchlorate first, and a column was equilibrated with sodium deoxycholate in Tris-HCl buffer, pH 8.2, it was observed that again three fractions A, B or C were obtained. Based on these results, we suggest that the concentration of the protein might be an important factor in determining whether A, B or C are present in certain preparations or even in certain areas of the central nervous system.

633 CHOLINERGIC EFFECTS OF METHYLPHENIDATE HYDROCHLORIDE ON SELECTIVE SENSORY INFORMATION PROCESSING. Tsung-Ming Shih*, Zaven S. Khachaturian, Kurt L. Reisler*, and Israel Hanin. Dept. Pharmacology, School of Pharmacy and Dept. Psychiatry, School of Medicine, University of Pittsburgh, Pittsburgh, Pa. 15261

We have investigated the effects of Methylphenidate HCl (MPH) on selective sensory information processing in both acute and chronic preparations (rats and cats). Evoked potentials (EP) and multiple unit activity (MU) elicited by both relevant (conditional) stimuli and irrelevant (repetitive background) stimuli were recorded during habituation and conditioning phases of a classical conditioning experiment. Data were recorded from the mesencephalic reticular formation (MRF), pulvinar (PUL), lateral geniculate nucleus (LGN) and medial geniculate nucleus (MGN). Intravenous (1 mg/Kg) injection of MPH attenuated both EP amplitude and MU rate recorded from the MRF and the PUL, whereas the activity in the LGN and the MGN were not affected. In order to determine whether the cholinergic system may be involved in mediating these results oxotremorine (0.5 and 1 mg/Kg; a muscarinic agonist) and nicotine (0.125 and 0.25 mg/Kg; a nicotinic agonist) were administered intravenously. These drugs mimicked the effects of MPH. Mecamylamine (4 mg/Kg; a nicotinic blocker) blocked the effects of MPH, where as atropine sulfate (4 mg/Kg; a muscarinic blocker) had no effect on the electrographic activity induced by either MPH or oxotremorine. These results suggest that the apparent effect of MPH in improving specific attentive processes in hyperactice children may conceivably be mediated via the cholinergic system.

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634 PRIMARY EXPLANT CULTURES OF RAT BRAIN REGIONS: CATECHOLAMINE PRODUCTION IN BRAIN STEM CULTURES. Wm. J. Shoemaker, M. Schlumpf*, D. S. Forman, G. R. Siggins and F. E. Bloom. Lab of Neuropharmacology, NIMH, St. Elizabeths Hospital, Washington, D. C. 20032

Cultures of CNS catecholamine-producing neurons would be a useful preparation for the study of the development and characterization of catecholamine mediated synaptic events. Small explants of brain stem, cerebellum and cerebral cortex from 17-19 day gestation embryos were cultured alone or in combination on collagen-coated cover slips in 35 mm culture dishes. Dulbecco's media supplemented with 10% fetal calf serum, 10% horse serum and 0.6% Methocel aided initial attachment of the tissue pieces. On the 5th day of culture, media is supplemented only by 10% horse serum and by 5-Fluorodeoxyuridine for 24 hours every 5 days. This procedure yields healthy cells as judged by morphological appearance, process formation, the ability to produce spontaneous and induced action potentials, and (in brain stem cultures) the synthesis of catecholamine neurotransmitters. Catecholamines were measured by a modification of the radio-enzyme assay utilizing Catechol-O-Methyl Transferase and ^{3}H,S-Adenosyl Methionine. We could detect as little as 20 picograms (2×10^{-11}g.) norepinephrine and 40 pg of dopamine in perchloric acid extracts of cultured brain stem cells. Preliminary results indicate that dopamine is the predominant amine synthesized, that during the first 19 days in culture most of the catecholamines synthesized are released into the medium, and that the small stores remaining in the cells can be depleted by reserpine. Addition of co-factors (biopterin congeners, ascorbic acid, copper ions) and Nerve Growth Factor failed to increase the formation of norepinephrine. Co-cultures of brain stem and normal receptor tissues for catecholamine fibers of brain stem origin (cerebellum, caudate-putamen) failed to increase catecholamine formation under the conditions and time-period of our study.

635 ENTRY OF ANGIOTENSIN INTO CEREBRAL VENTRICLES AND CIRCUMVENTRICULAR STRUCTURES. E. Eileen Shrager*, A. Kim Johnson, Alan N. Epstein and Mary J. Osborne*. Inst. Neurol. Sci., University of Penn., Phila., Pa. 19174.

The cerebral ventricles and circumventricular structures, the subfornical organ in particular, have been proposed as the avenue of access into the brain for angiotensin in the elicitation of thirst. In addition, area postrema is necessary for the reflex hypertension provoked by intracranial angiotensin. The distribution within the brain of blood-borne angiotensin was therefore studied by autoradiography. Five unanesthetized adult male rats received intravenous pulses of tritiated angiotensin II (1-Asn, 5-Val, $Tyr^{3,5}$ H^3, A II) of high specific activity ($\sim$ 30 Ci/m mole) and unimpaired biological activity for the pressor response. Doses of 6µg (1 rat), 2µg (3), and 400ng (1) were given. Within minutes their brains were frozen without fixation and prepared for autoradiography. To retain CSF in situ tissues remained below -15°C during sectioning and exposure. Grain counts/mm^2 were uniformly low over parenchymal tissues throughout the brain. Ratios (regional counts/neocortical counts) were 1.0 or less for caudate, septum, preoptic area, lateral hypothalamus, hippocampus and vestibular nuclei. Radioactivity was conspicuous (ratios >2.0) in pituitary, area postrema and choroid of lateral ventricles. Ratios were between 1.7 and 2.0 for subfornical organ and over CSF of lateral ventricles, and dorsal third ventricle. Median eminence appeared cold. Supraoptic crest and subcommissural organ have not been sufficiently studied. Blood-borne angiotensin is excluded from intrinsic tissues of the brain while it reaches the choroid plexi and CSF, and the subfornical organ and area postrema both of which are vascularized circumventricular structures that have been implicated as target organs for the intracranial effects of the hormone. Supported by USPH NDS 03469.

636 PROJECTIONS OF THE HIPPOCAMPUS IN THE SQUIRREL MONKEY. Allan Siegel, Schoichiro Ohgami* and Henry M. Edinger, Dept. of Anatomy, Physiology and Neuroscience, N.J. Medical School, Newark, N.J. 07103.

In a previous study we demonstrated that in the gerbil, rat, rabbit and cat the topographical projections to the medial and lateral septum arise from the dorsal and ventral hippocampus, respectively, and not from specific CA fields (Soc. Neurosci. Abs. 1973, p.284). The purpose of the present experiment was to determine how the hippocampal projections to the septum are organized in the primate brain. Radio frequency lesions were placed in the anterior, middle, and posterior portions of the hippocampus in 16 squirrel monkeys. Following lesions of the anterior third of the hippocampus, degenerating axons (stained by the Fink-Heimer I method) were followed through the lateral margin of the fornix to the lateral septal nucleus and nucleus accumbens. Fibers from the posterior third of the hippocampus pass through the medial aspect of the fornix and terminate in the medial septal nucleus. Fibers from the middle third of the hippocampus project to an intermediolateral position within the septum. All regions of hippocampus project to the diagonal band, olfactory tubercle, anteroventral nucleus, and mammillary bodies. Very few fibers of hippocampal origin were observed to terminate directly within the lateral hypothalamus.

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637 THE CONTRIBUTION OF PREFRONTAL NEOCORTEX TO DELAYED ALTERNATION IN A PROSIMIAN PRIMATE. Carl Skeen* and Bruce Masterton. Dept. Psychol., Fla. St. Univ., Tallahassee, Fla. 32306

As part of a continuing inquiry into the evolutionary origin of the brain and behavior of primates, we have shown that there is a close correspondence between the development of the prefrontal system and the ability to perform delayed-alternation among mammals with successively more recent common ancestry with anthropoids. We have now examined prosimian primates (bush baby, Galago senegalensis) before and after ablation of one or another parts of prefrontal neocortex to determine whether the resulting degeneration and behavioral deficits resemble those seen in anthropoids. The major results show that: 1) selective prefrontal lesions result in circumscribed areas of retrograde degeneration in the thalamic nucleus medialis dorsalis (MD); 2) there is a correspondence between the locus of the lesion within the prefrontal area and the locus of the degeneration within MD; 3) lesions producing degeneration in the lateral sector of MD result in a marked deficit in the ability to perform several variations of delayed-alternation while lesions producing degeneration in the medial sector of MD result in a different deficit. Since these anatomical and behavioral results are clearly reminiscent of those seen in monkeys after similar treatment, the evolutionary continuity of the prefrontal system and at least some of its contributions to behavior can be extended back in time to the origin of true Primates. (Supported by NSF Fellowship and by NINDS 7726.)

638 THE DELETERIOUS EFFECTS OF PSYCHOLOGICAL STRESS AND BETA-ADRENERGIC BLOCKADE ON THE INCIDENCE OF VENTRICULAR FIBRILLATION FOLLOWING ACUTE CORONARY OCCLUSION IN THE CONSCIOUS PIG. James E. Skinner. Neurophysiol. Dept., Methodist Hospital, and Physiol. Dept., Baylor Coll. Med., Houston, Tex. 77025

Adaptation of naive subjects to the laboratory will prevent the occurrence ($P < .01$) of ventricular fibrillation (VF) after occlusion of the left anterior descending coronary artery (OCC). In naive animals, the injection of 0.2 mg/kg of racemic propranalol, which was sufficient to block the cardiac response to circulating catecholamines but not to nervous stimulation or psychological stress, had no effect on the time of onset of VF after OCC. A larger dose of propranalol (2.0 mg/kg), which did reduce the cardiac response to sympathetic nerve stimulation, had a deleterious effect in that VF was precipitated at 3 min after OCC instead of 11 min ($P < .01$). Adaptation of the naive subjects resulted in the larger dose of propranalol producing VF at 11 min after OCC instead of 3 ($P < .01$). Heart rate was controlled throughout the study by electric pacing in conditions where statistically significant changes were noted between the control and experimental groups. Thus, the effects of adaptation are not mediated by a change in the level of circulating catecholamines, and reduced psychological stress can compensate for the deleterious effects of more complete beta-adrenergic blockade.

639 THE DISTRIBUTION OF CATECHOLAMINE-CONTAINING PERIKARYA IN MACACA SPECIOSA. J. R. Sladek, Jr. and D. L. Garver. Dept. Anat., Sch. Med., Univ. Rochester, Rochester, N. Y., 14620, and Illinois State Psychiatric Inst., Chicago, Il., 60612.

Falck-Hillarp histofluorescence was employed to examine the distribution of catecholamine (CA)-containing perikarya in the brain stem of Macaca speciosa. Groups of such neurons were identified and designated M1 through M10; Msc; Mdr; and Mcg. The latter three represent the nucleus sub-coeruleus; nucleus raphe dorsalis and mesencephalic central gray, respectively. The former groups follow the classification (i.e., A1 - A10) defined for the rat by Dahlstrom and Fuxe ('64). Direct comparison of the above patterns seen in M. speciosa with those reported in rat, cat, and squirrel monkey revealed species-specific patterns of CA distribution. Some of the most apparent dissimilarities in contrast to the rat include the presence of M1 cells within the lateral reticular nucleus; the juxtaposition of groups M1 and M2; the absence of a group within the inferior olive (i.e., "M3"); the occurrence of M4 cells within the roof, as well as the lateral wall, of the fourth ventricle; the occurrence of M7 within the ventral nucleus of the lateral lemniscus; and the existence of CA cells within the dorsal raphe and central gray of the mesencephalon. The groups which closely parallel those seen in the rat include: M5; M6; Msc; M8; and M9. While it is unequivocally true that a certain degree of monoamine morphology, as seen in the rat is reflected in M. speciosa; it is equally apparent that marked species dissimilarities are prominent features to be considered when examining monoamine distribution and function in species other than the rat.

640 DIASCHISIS AS BILATERAL CEREBRAL DYSFUNCTION FOLLOWING LATERALIZED CEREBRAL LESIONS. Aaron Smith. Univ. Mich. Med. Sch., Ann Arbor, MI 48104.

Accumulating studies of hemispheric blood flow (HBF) and cerebral metabolism in patients with lateralized cerebral lesions have confirmed von Monakow's findings of diaschisis. Reduced HBF in both the intact and damaged hemisphere was positively correlated with the duration and severity of bilateral cerebral dysfunctions. Neuropsychological tests of 122 (mean age 49 yrs) right-handed chronic aphasics (mean duration 19 mos) with diagnoses of left hemisphere vascular lesions revealed associated left-sided motor and/or sensory defects in 70, indicating right as well as left hemisphere dysfunctions. Comparisons of language and nonlanguage functions showed significantly greater impairment by the 70 aphasics with left-sided motor and/or sensory defects than the 52 without such defects. Confirming von Monakow's and subsequent studies, bilateral dysfunction occurred more frequently in older patients, and in those with evidence of larger (hemiplegic aphasics) than smaller (non-hemiplegics) lesions. Constructional dyspraxia occurred in 34 patients. Although previous studies attributed this defect to posterior parietal left hemisphere lesions, the association of right hemiplegia in 29, advanced age (mean 56 yrs), bilateral sensory defects and/or subnormal left hand motor functions indicates that constructional dyspraxia following left-sided lesions is usually due to radiation of effects or diaschisis, disrupting right hemisphere functions. A prospective study of 99 consecutive stroke patients (mean age 66 yrs) including reexaminations of survivors at six month intervals showed similar persistence of bilateral cerebral dysfunction during a three year period in most patients with infarctions of the right as well as left hemisphere. The results indicate that persisting diaschisis following lateralized lesions is more frequent than commonly believed.

641 BEHAVIORAL AND NEUROCHEMICAL CHANGES IN PIGEONS FOLLOWING L-TRYPTOPHAN ADMINISTRATION. J.E. Smith*, J.D. Lane*, J.N. Hingtgen* and M.H. Aprison. Section of Neurobiology, Institute of Psychiatric Research, Depts. of Psychiatry and Biochemistry, Indiana Univ. Med. Center, Indianapolis, Ind. 46202.

Injections of 50 mg/kg D,L-5-hydroxytryptophan (5-HTP) into pigeons working for food on a multiple fixed-ratio 50, fixed-interval 10 schedule of reinforcement produce a period of behavioral depression (mean = 150 min) that is temporally related to increased levels of total serotonin (5-HT) in the telencephalon (T) and diencephalon plus mesencephalon (D-M) of the brain. When intramuscular injections of L-tryptophan are given to pigeons working on the same schedule, similar but shorter periods of disrupted behavior follow: 100 mg/kg - 12 min; 200 mg/kg - 45 min; 300 mg/kg - 75 min. As is also the case with 5-HTP, the period of depression following L-tryptophan is increased by pretreatment with 50 mg/kg iproniazid (a monoamine oxidase inhibitor). To determine whether L-tryptophan is acting in a manner similar to 5-HTP, trained pigeons were injected with 300 mg/kg L-tryptophan and killed by decapitation at various times after drug administration. The brains were dissected into 4 parts (T, D-M, pons plus medulla oblongata and cerebellum) and these samples were subjected to a new multiple assay and analyzed for content of tryptophan (TRY), 5-HTP, 5-HT, 5-hydroxyindoleacetic acid (5-HIAA), tyrosine, dopamine and norepinephrine. Increased content of TRY, 5-HTP, 5-HT and 5-HIAA were found in all brain parts, but increases in 5-HT were not as large as those found after 5-HTP injections. Tyrosine levels decreased in all four brain parts. (Supported in part by research grant MH-03225-15 from NIMH).

642 RELATIVE POTENCIES OF AMPHETAMINES AND METHYLPHENIDATE ON MOOD AND ACTIVATION IN MAN AND STEREOTYPED BEHAVIOR AND LOCOMOTOR ACTIVITY IN RATS. Robert C. Smith, John M. Davis, Francis Schlemmer.* Illinois State Psychiatric Institute and Dept. of Psychiatry, University of Chicago 60637

The relative potencies of d and l amphetamines (D-AMP, L-AMP) on inducing psychosis in humans and stereotyped behavior (SB) and locomotor activity (LA) in rats, have been hypothesized to indicate the predominance of dopaminergic vs noradrenergic mechanisms underlying analogous behaviors in rat and man. Davis and collaborators (PSN Abst.:3,346, 1973) reported that methylphenidate (RIT) was more potent than D-AMP or L-AMP in increasing psychosis in schizophrenics. If the euphoric and activity effects of D-AMP in man are mediated primarily through norepinephrine, one would expect that D-AMP will be about 10 times as potent as L-AMP in increasing mood and activation in man on the basis of the Snyder hypothesis (Arch. Gen. Psychiat.:27,169, 1972). We conducted quantitative, double-blind, dose-response studies with equimolar doses of D-AMP (10 & 20 mg.), L-AMP, and RIT which showed that all three drugs have approximately equal potency on increasing euphoric mood and activation in normal humans. Parallel studies on the relative potencies of these drugs on rat SB and LA were conducted--in rats with MAO (Pargyline 50 mg/kg 1 hr. prior) pretreatment (Parg. rats) and without MAO pretreatment (Non-MAO rats) in order to clarify some of the disparate results reported by other investigators. The results were: I) Relative potencies on SB in: a) Non-MAO rats--D-AMP 3-4 X L-AMP; D-AMP only about 2.5 X RIT. b) Parg. rats--D-AMP about 2.5 X L-AMP; RIT slightly less potent than L-AMP. II) Relative potency on LA in: a) Non-MAO rats--D-AMP 5-7 X L-AMP; D-AMP about 10 X RIT. b) Parg. rats--D-AMP about 3 X L-AMP. In summary, there is a complex relationship, but no clear parallel, between the potencies of the three drugs on increasing 1) psychosis in schizophrenics, 2) euphoric moods and activation in normal humans, and 3) SB and LA in rats.

643 ULTRASTRUCTURAL EVIDENCE OF IMPAIRED CEREBELLAR SYNAPTOGENESIS DUE TO EXPERIMENTALLY INDUCED HYPOTHYROIDISM. Ronald L. Smith, W. Jann Brown*, M. A. Akers* and M. A. Verity*. Dept. Path., Sch. Med., UCLA, Los Angeles, CA 90024.

Frequently irreversible mental retardation occurs with early thyroid deficiency. The nature of the abnormal morphogenesis in the brain is poorly understood, but definite ultrastructural and biochemical alterations are found in the abnormal condition. The rat cerebellum is being studied as a model of the developing mammalian brain. Neonatal rats made hypothyroid by administering propylthiouracil to the lactating mothers were sacrificed at ages 8, 14, 20 and 30 days. Normal rats of the same ages provided control tissues. After perfusion with glutaraldehyde, sagittal blocks from the nodular portion of the vermis were processed for electron microscopy according to the technique of Bloom and Aghajanian (Science 154: 1575, 1966) which selectively stains synaptic junctions with ethanolic phosphotungstic acid. Mature synapses were counted on montages of micrographs from the pial surface down to the Purkinje cell layer. Appropriate areal corrections were made for the thinner molecular layer that results from hypothyroidism. A significant decrease is apparent in the number of synapses present in experimental molecular layer as compared with normal controls. At 14 days there are 20% fewer mature synapses present in the hypothyroid animal. At 20 days there are only about half as many synapses in the hypothyroid cortical tissue as are found in controls. Although the absolute number of synaptic junctions is significantly less in hypothyroid rats at all time periods studied, the apparent doubling rate of junction formation between days 14 and 20 is similar in hypothyroid and control molecular layer. (Supported by USPHS grant HD-05615-Mental Retardation Research Unit)

644 DENDRITIC TRANSPORT OF HORSERADISH PEROXIDASE IN VIVO AND IN VITRO. Rebekah Smith, Christine Gall*, Sam Deadwyler and Gary Lynch. Department of Psychobiology, University of California, Irvine, California 92664

Horseradish peroxidase (HRP) was injected through 5 μ glass micropipettes into the apical dendrites of hippocampal pyramidal cells in urethane-anesthetized rats. After various survival times up to 1 hr, animals were perfused and the brains removed and processed according to the method of Lynch et al (Brain Res. 65: 373-380, 1974). Measurements of transport were made by projecting the sections through a Zeiss drawing tube onto calibrated drawing paper. Tissue was prepared for in vitro studies by decapitating unanesthetized rats, quickly removing the brains, and sectioning the hippocampal formation perpendicular to the septo-temporal axis at 300-600 μ. Sections were suspended on a nylon net in a chamber containing oxygenated MEM maintained at 37°C. Injections were made as in intact animals. Sections were fixed by immersion in a cold solution of formalin-glutaraldehyde-sucrose and processed as the whole brains. Measurements in intact animals revealed that HRP was taken into hippocampal dendrites and transported rapidly, extending maximally to the tips of the dendrites and to the cell layer (a total of approximately 450 μ) by the shortest survival times of 2 min. In the explants, somatofugal flow in the CA1 subfield was at least 200 μ/min, while somatopetal flow appeared somewhat slower, approximately 150 μ/min. Both the amount of uptake and the rate of transport of HRP were diminished at lower temperatures, although some transport in the main dendritic shafts was apparent even at 10°C. The addition of 0.5-50 μM colchicine to the medium 1/2 hr before injections resulted in a similar diminishing of transport at higher concentrations.

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645 MORPHINE AND ETHANOL: INTRAGASTRIC AND INTRAVENOUS SELF-ADMINISTRATION. S. G. Smith, T. E. Werner* and W. M. Davis. Dept. of Pharmacol., Sch. of Pharm., Univ. of Mississippi, University, MS. 38677.

Following the report of drug self-administration by rats via intragastric (IG) catheters (Gotestam, 1973), we have confirmed the finding of morphine self-administration by this route and have obtained self-administration also for ethanol solutions. Our procedure employs a plastic cannula reaching the stomach after surgical entry via the esophagus rather than surgical entry of the stomach as by Gotestam. Other rats bearing chronically implanted jugular cannulas also developed an intravenous (IV) self-injection response for alcohol or for morphine. Medium to high dosages of both drugs supported self-administration by both routes while low dosages supported self-administration only by the IV route. After repeated passive injections of either morphine or ethanol by either IG or IV method so as to produce physical dependence, rats showed much greater drug self-administration than did non-dependent subjects. Rats which had developed IV self-administration of morphine showed considerable ethanol self-administration during even the first session after changing from a morphine contingency to an ethanol contingency.

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646 CAUDATE AND PALLIDAL UNIT ACTIVITY DURING DELAYED INSTRUMENTAL RESPONSE PERFORMANCE IN MONKEY. S. Soltysik*, C.D. Hull and N.A. Buchwald, Depts. of Psychiatry and Anatomy, Mental Retardation Research Ctr., NPI, UCLA, Los Angeles, Calif. 90024.

Three monkeys (Macaca nemestrina) were trained to perform a task requiring a delay in response of 8 sec following the onset of a light. The required response was pulling a joy stick following the delay. Correct responses were rewarded with jets of grape juice delivered at a rate of 1/sec. Trials in which responses were made before the required delay period elapsed were not rewarded and the trial was terminated. Intertrial intervals were varied from 5 to 120 sec. Single unit recordings were made with moveable microelectrodes during the task performance. Principal recording sites were the caudate nucleus and globus pallidus. For the purpose of correlating unit activity with behavior, the task was broken into 5 epochs: viz. stimulus onset, delay, pre-response, post-response and delivery of reward. A lower proportion of caudate units (70%) showed activity correlated with at least one epoch than did the pallidal units (100%). Of these correlated units, fewer caudate units (30%) showed significant shifts in activity during 3 or more epochs than did the pallidal units (59%). Pooled analyses of these unit responses showed similarities and discrepancies in response patterns in comparing caudatal and pallidal unit responses. A convergence of caudatal and extrastriatal output neurons on the pallidal neurons may account for the discrepancies.

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647 BIOCHEMICAL ANALYSIS OF PERFUSATES TAKEN FROM THE MRF OF CONSCIOUS CATS DURING SLEEP AND WAKEFULNESS. Curt W. Spanis*, Rene R. Drucker-Colin, Carl W. Cotman and James L. McGaugh. Dept. Psychobiol., School of Biol. Sciences, Univ. of California, Irvine, 29664.

Sleep inducing perfusates from MRF of cats have been obtained by means of a push-pull cannula (Brain Res. 56:123-134, 1973). These experiments describe the attempts to carry out biochemical characterizations of such perfusates. Characterization of the perfusates centered on proteins and/or peptide content using Lowry analysis, polyacrylamide gel electrophoresis, immunoelectrophoresis, diaflo ultrafiltration separations and gas chromatography. Samples were streaked on EMB and blood agar to test for the presence of contaminating bacteria. Our data demonstrate two new findings. First, proteins are present in perfusate from brain and the concentration of these proteins (0.05-0.20 mg/ml) changes in a cyclic fashion with time. These proteins do not appear to arise from damage due to the cannula or similar artifacts. Rather, they appear to represent macromolecules actively released from neural tissue. Second, the cyclic release of proteins from the midbrain reticular formation (MRF) of cats during continual perfusion over a period of 21 hours appeared to correlate often with major bouts of REM sleep. Also, the total protein content over time from pure REM sleep perfusates was of a higher concentration than those from pure awake perfusates. These data suggest that brain protein metabolism changes in a cyclic manner in the MRF and the changes may be related to REM sleep.

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648 RECEPTIVE FIELD CHARACTERISTICS AND TOPOGRAPHIC ORGANIZATION OF SINGLE NEURONS IN THE LATERAL SUPRASYLVIAN VISUAL AREA OF THE CAT. Peter D. Spear . Dept. of Psychology, Kansas State Univ., Manhattan 66506

Receptive field properties of single cells in the lateral suprasylvian (LS, or Clare-Bishop area) cortex were studied in cats anesthetized with nitrous oxide. A small percentage of cells responded best to stationary stimuli (6%) or stimuli moving through the receptive field in any direction (8%). The remainder (86%) gave directionally selective responses to moving stimuli. A small proportion of these (6%) responded to stimulus movement in both directions along a preferred axis. The remainder (94%) had a clear preferred and null direction. Typically these cells gave no response to stimuli moved in directions greater than $\pm$67 deg from the preferred direction. Most of the cells responded over a broad range of stimulus velocities, from 15-20 deg/sec to over 100 deg/sec, with little or no response to slower moving stimuli. Many of the receptive fields had inhibitory surrounds (30%). Most of the cells (83%) showed spatial summation within the activating region of the receptive field. However, the vast majority (90%) of the LS area cells did not respond selectively to stimulus shape or orientation. Nearly all of the cells with receptive fields in the central visual field responded to stimulation of both eyes. The LS area was found to extend along the entire medial bank of the middle suprasylvian sulcus from the anterior bend of the sulcus (at about A12) to beyond the posterior bend of the sulcus (at about P4) and several mm along the posterior suprasylvian sulcus. The area contains a topographic representation of the contralateral visual hemifield, with a disproportionally large amount of tissue devoted to the central visual field. Bilateral removal of visual cortical areas 17, 18, and 19 resulted in an elimination of the directional selectivity of the LS area cells and responses to only the contralateral eye. (Supported by NIH grant EY01170).

649 EFFECT OF LIGHT DEPRIVATION ON THE ELECTRORETINOGRAM AND THE VISUAL EVOKED RESPONSE IN THE RAT. Robert F. Spencer*, John G. Parnavelas*, and Paul D. Coleman (SPON: Victor G. Laties). Dept. Anat., Sch. Med. & Dent., Univ. Rochester, Rochester, NY 14642.

Sprague-Dawley rats were raised from birth either totally in the dark or in a 12 hour light-12 hour dark cycle, the latter condition serving as the normal control. At the conclusion of the rearing period at 35 days of age, the electroretinogram (ERG) and visual evoked response (VER) were recorded with Ag-AgCl electrodes from the retina and visual cortex, respectively, under pentobarbital anaesthesia. Delivery of stroboscopic flashes was controlled by pulses from a PDP-5 computer, and responses to 50 flashes were averaged by the computer. Consistent with the results of others with regard to light deprivation from birth in other mammals, notably the cat, the b-wave of the ERG was found to be markedly depressed in the dark-reared rats. Although all components of the VER were present, the positive components were consistently reduced in the dark-reared rats when compared to the light-dark controls. These results indicate that the development of specific responses to photic stimulation in the postnatal period of the rat does occur in the absence of light stimulation.

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650 INHIBITION OF PROTEIN SYNTHESIS IMPAIRS LONG-TERM HABITUATION. Larry R. Squire and Carl Becker.* VA Hosp. San Diego, Ca. 92161 and Dept. Psychiatry, UCSD, Sch. Med., La Jolla, Ca. 92037

Thirsty mice drank water during daily 3-minute periods. After water intake had stabilized over several days, drinking was markedly suppressed during 3 brief presentations of recorded mouse shrieks. Habituation of the suppression response to mouse shrieks was demonstrated 3 days later, when the same stimulus had little effect on drinking. However, mice given anisomycin, a potent inhibitor of protein synthesis, immediately following the initial stimulus presentations exhibited no habituation 3 days later. These mice suppressed drinking during the auditory stimuli on Day 3 as markedly as they did when the stimuli were first presented. In contrast, mice given anisomycin several hours following the initial stimulus presentations behaved like normal mice, and did not suppress drinking when the stimuli were presented again on Day 3. Inhibition of protein synthesis has previously been shown to impair memory for discrimination training and passive avoidance habits. The present study extends these findings to a relatively simple and phylogenetically primitive example of behavioral plasticity.

651 DISRUPTION OF LONG TERM MEMORY IN GOLDFISH BY INHIBITION OF CEREBRAL MONOAMINE OXIDASE. Stephen M. Stahl* and E. Albert Zeller* (SPON: D.X. Freedman). Dept. Biochem., Northwestern U. Med. Sch., Chicago 60611.

Systematic study of five different monoamine oxidase (MAO) inhibitors administered either via the aquarium water for a 24-hour period, or via intracranial injections has shown that the propargylamines SU-11,739 (N-methyl-N-2-propynyl-1-indanamine) and pargyline are the most potent in production of goldfish brain MAO inhibition, iproniazid the least potent, and both tranylcypromine and Lilly 51641 (o-chloro-phenoxy-ethyl-cyclopropylamine) intermediate and about equal in potency. Pargyline was shown to produce clear-cut rises in brain serotonin, dopamine and norepinephrine, but not until 90% brain inhibition was reached. Histochemical studies support the results of biochemical assays in that increases in fluorescence of the hypothalamus and preoptic area could be observed only when brain MAO was inhibited 90% or more. Conditioned avoidance behavior of goldfish showed significant decrements in long term memory when brain MAO was inhibited 90% or more by any of the five MAO inhibitors. Therefore, the level of cerebral MAO inhibition critical to the production of significant decreases in long term memory was the same level of MAO inhibition critical to the production of significant rises in cerebral amine levels in the hypothalamus and preoptic area. Our results show that a certain "threshold" of MAO inhibition must be reached before significant biochemical or behavioral changes will result. We suggest that MAO-catalyzed monoamine turnover or elaboration of amine catabolites is necessary for optimal retrieval of stored information and that this turnover as well as the retrieval of memory is disrupted by high degrees of MAO inhibition.

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652 PHYSIOLOGICAL RESPONSIVITY SHIFTS OF DROSOPHILA VISUAL SYSTEM. William S. Stark* (SPON: E. Blass). Dept. Psychology, Johns Hopkins Univ., Baltimore, Md. 21218

Recent electrophysiological studies have shown that intense short wavelengths (500 nm and below) decrease responsivity in the Drosophila visual system while long wavelengths (525 nm and above) reinstate responsivity. Several analyses indicate that short wavelengths convert rhodopsin to a metastable intermediate which can be reconverted to rhodopsin by long wavelengths. Electroretinographic recording indicates that receptors remain depolarized subsequent to short wavelength stimulation while the second order neurons register continuous response. Action spectra of the short wavelength adapted retina show that the visible and ultraviolet sensitivity peaks are differentially affected by intense visible and ultraviolet short wavelength stimulation while the absence of a long wavelength peak shows that the intermediate does not transduce light. Relative effectiveness for the process of reinstating maximal sensitivity with long wavelengths becomes lower as wavelength decreases presumably because each wavelength establishes an equilibrium combination of rhodopsin and its intermediate. These results may help to explain differences between visual pigment absorption spectra and receptor action spectra, relative insensitivity to red, and enhanced sensitivity to ultraviolet in insects.

653 RESPONSES OF TENDON ORGANS TO RAMP CHANGES OF ACTIVE IN-SERIES MOTOR UNIT FORCE. E. K. Stauffer* and J. A. Stephens* (SPON: E. S. Creps). Dept. Physiol., Coll. of Medicine, University of Arizona, Tucson, Az. 85724.

As an extension of a previous study using whole muscle activation (Fed. Proc. 33:341, 1974), tendon organ behavior has been studied in 18 soleus muscles from 5 cats during anisometric contractions controlled in force-servo to obtain linear ramp profiles of active force development from 34 in-series motor units. Initial (1 to 10 gm) and final (12 to 35 gm) ramp forces were chosen to fit the intermediate portion of the ascending limb of each motor unit's own length:tension curve. Rates of ramp force development ($\dot{F}$) ranged from 5 to 400 gm/sec. Responses were noted to the dynamic and static components of the ramp stimulus. In qualitative agreement with preparations using whole muscle activation: (1) the plot of dynamic index (DI = peak minus steady state response in pps) versus $\dot{F}$ was best fit by a power curve ($DI = a\dot{F}^b$; X ± S.D. for b = 0.44 ± 0.18 pps/gm/sec); (2) there was no pronounced "acceleration-like" response analogous to the initial burst of the muscle spindle; (3) the apparent static sensitivity was constant on the ascending limb of each unit's length:tension curve (2.0 ± 1.2 pps/gm); and, (4) both static and dynamic sensitivities decreased when the test ramps were started at longer muscle lengths (still on the ascending portion of each unit's length:tension curve). As with similar data from medial gastrocnemius (J. Physiol., in press), the steady state response of tendon organ discharge did not reflect the force development by each motor unit as measured at the common tendon. A correlation did appear, however, when all the motor unit forces and all the tendon organ responses were summed progressively. (USPHS grants NS 07888 and He 5884).

654 MEDULLARY DISCHARGE PATTERNS AND THE CONTROL OF BREATHING. *I. Staw, S. Katz, and * A. D. Horres, Department of Physiology, Medical University of South Carolina, Charleston, S. C., 29401.

A mathematical model of respiratory control by medullary neurons has been developed. This model is capable of closely reproducing the ventilatory response of anesthesized dogs to minute pulmonary emboli and pneumothorax, as well as the neuronal activity of individual members of the inspiratory and expiratory neuron network within the medulla.

This model comprises reciprocally innervated inspiratory and expiratory centers in which neuronal activity during a respiratory cycle is influenced by accommodation and by the activity on inspiratory inhibitory internuncial system.

Using established curve-fitting and systematic parameter sensitivity techniques, the model suggests that: (1) inspiratory neuron activity is terminated primarily by the activation of the internuncial system. In both pneumothorax and pulmonary emboli the delay characteristic of this system is significantly decreased and (2) expiratory neuron activity is terminated primarily by a rise in expiratory neuron firing threshold. In pneumothorax, the rate at which this threshold rises is significantly increased.

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655 RELATION BETWEEN VISUAL AND SOMATIC ORGANIZATION IN THE CAT SUPERIOR COLLICULUS. Barry E. Stein, Braulio Magalhaes-Castro* and Lawrence Kruger. Dept. Anat., Sch. Med., UCLA, Los Angeles, 90024

The organization of visual and somatic receptive fields of neurons in the cat superior colliculus was studied with metal microelectrodes in animals paralyzed and artificially respired with a NO_2 and O_2 mixture. A somatotopic pattern was observed in lower layer neurons for the contralateral body, which was related to the retinotopic representation of the contralateral eye in more superficial cells. The correspondence was such that the area of visual space related to the temporal and nasal parafoveal area corresponded to the somatic representation of the anterior aspect of the face, the lateral portion of the temporal field corresponded to neck and shoulder, ventrolateral portion to forelimb, dorsolateral portion to hindlimb and dorsomedial portion to the crown. A wide range of receptive field sizes were observed, from those several millimeters to those encompassing a large proportion of the contralateral body surface, with the smaller fields usually confined to the head or forepaw. Some bilateral fields with approximate symmetry were also observed. The majority of somatic-responsive neurons were readily activated by gentle hair or skin displacement, although cells requiring subcutaneous stimulation with higher thresholds were also encountered. Moderate or high velocity stimuli were required for activation of most neurons, and they thus resembled F (or G)-Intermediate and F (or G)$_1$ peripheral mechanoreceptors. (Supported by USPHS Grants NS-5685 and EY-571.)

656 FAILURE TO FIND RECOVERY OF FUNCTION AFTER 2-STAGE FRONTAL LESIONS IN AGED RATS. Donald G. Stein and Arthur Firl*. Dept. Psychol., Clark Univ., Worcester, Massachusetts, 01610

Mature but young rats show considerable sparing of behavioral function after CNS lesions when such lesions are made in two, separate stages with a 30 day interval between first and second operations (2-S). In contrast, rats with the same amounts of tissue removed in a single operation (1-S), demonstrate long-standing impairments on the same battery of tests. Such findings indicate that there is plasticity of function in the adult CNS but the limits, or parameters, of such plasticity require further study. We were concerned with whether aged rats approximately 2 yrs. old at the beginning of surgery and testing would show the same degree of recovery from 2-S lesions as their younger counterparts. The animals were raised from birth in the laboratory, without special handling or testing, and then given either sham operations, bilateral 1-S lesions or 2-S lesions of the frontal cortex with a 30 or 60 day interoperative interval. When all surgery had been completed, the rats were tested on a spatial alternation task followed by training on a discriminative shock avoidance problem and then by measures of activity in an open field. The rats with 1-S operations were permitted the same postoperative recovery time as those with 2-S, 30 day surgery. In all cases, we were unable to observe any evidence of recovery of function in old rats with serial lesions. In fact, the 2-S aged rats showed greater impairments of ability to learn than agemates given simultaneous operations of the frontal cortex. Both the 1-S and the 2-S rats were significantly more impaired than the sham-operated controls. In younger rats, 2-S lesions of the frontal area result in dramatic sparing but the same damage inflicted upon old rats did not permit these animals to escape the debilitating effects of CNS lesions.

657 A LACK OF DORSAL ROOT SPROUTING FOUND AFTER SPINAL HEMISECTION IN NEONATAL OR WEANLING RATS. Dennis J. Stelzner and Eric Weber*. Dept. Anat., Upstate Med. Cntr. S.U.N.Y., Syracuse, 13210

Large differences are found in the behavior of the hindquarters of the albino rat if a mid-thoracic spinal transection is performed at birth (0-4D) rather than at the weanling stage (21-25D). In an attempt to determine whether these behavioral differences can be attributed to differences in the distribution of dorsal root connections, neonatal (N=6) and weanling (N=5) animals were mid-thoracically hemisected. After long survival times, spinal roots were cut bilaterally above the L5 dorsal root ganglia. After 3, 6, or 8 days survival the animals were perfused and the lumbosacral spinal cords were processed for Fink-Heimer staining. Differences in the density and distribution of degeneration were assessed by using a blind forced-choice paradigm and comparing the previously hemisected and control sides of the spinal cord. Comparisons were made at different spinal levels in lamina III-IV of Rexed, in the medial and lateral portions of lamina V-VI, and in the lateral motor region. No significant differences were found in comparing the 2 sides in either the neonatal or weanling group for any of the loci studied. The pattern of degeneration after the second lesion also was similar to that found after lumbosacral dorsal root lesions in the adult rat. It is concluded that the behavioral result cannot be attributed to a change in the distribution or density of dorsal root connections. (Supported by Grant NS-10579)

658 INTEGRATION OF SENSORY INFORMATION IN THE CRAYFISH OPTOMOTOR SYSTEM. Wendy B. Stern.* (SPON: R.P. Borda). Dept. Biol., Rice Univ., Houston, Texas 77001.

Activity in crayfish optomotor neurons was recorded extracellularly by penetration of the eyestalk musculature. These units are primarily sensitive to changes in body position; rotation about either the longitudinal or lateral body axis produces continuous modulation of firing frequency corresponding to varying degrees of excitation or inhibition. One type of unit responds to rotation about both orthogonal axes. With body position held constant, excitation and inhibition can also be produced by pulsing light in the appropriate receptive fields of the eye (Wiersma et al., Comp. Biochem. Physiol. 26:1, 1968). The averaged excitatory response, as displayed in a poststimulus time histogram, has both a transient "on" and a steady state component. During inhibition, the inhibitory trough is sometimes preceded by a brief increase in firing frequency consistent with a lateral inhibitory mechanism. There is some evidence, derived from simultaneously recorded data, that the visual information is channeled through sustaining fiber interneurons found in the optic nerve. The interaction between response to light and to position is striking. The size and shape of the excitatory response to light varies as a function of steady state position. In the inhibited position, when background firing rate is zero, the response to light is totally blocked. At increasingly more excitatory positions, the response to light is progressively enhanced. Further evidence suggests that this interactive effect is produced by strong inhibition on an element in the circuit which integrates information flowing through the two sensory channels. (Supported by NSF GB-33561, awarded to Dr. Raymon M. Glantz).

659 ENHANCED SEIZURE SUSCEPTIBILITY IN RATS FOLLOWING PROTEIN MALNUTRITION DURING DEVELOPMENT. Warren C. Stern, William B. Forbes, Oscar Resnick* and Peter J. Morgane. Psychopharm. & Neurophysiol. Labs., Worcester Fndn. Exp. Biol., Shrewsbury, MA., 01545.

We examined the change in seizure susceptibility in adult rats which were reared on a diet containing either normal (25% casein) or reduced (8% casein) levels of protein. A significantly greater percentage of the protein malnourished rats convulsed at low (16 mA) to moderate (25 mA) intensities of transcorneally applied electroconvulsive shock (ECS) than normals. Also, seizure duration in the malnourished subjects tended to be longer than in the normals. Switching adult rats to the opposite diet, i.e., rats reared on normal diets receive low protein diet and vice versa, had a moderating effect on seizure susceptibility, but full reversal of the effects of protein malnutrition during development was not achieved. In sum, protein malnutrition during development led to enhanced seizure susceptibility in adulthood, an effect which was only partially ameliorated by restoration of adequate dietary protein levels in adulthood.

Prior studies have shown a strong inverse relationship between brain biogenic amine levels and seizure activity. Therefore, we investigated whether changes in regional brain levels of norepinephrine and serotonin were produced by chronic protein malnutrition. Since the low protein diet contains subnormal levels of the amino acid precursors of the biogenic amines it might be expected to decrease brain amine content. Surprisingly, levels of norepinephrine and serotonin were elevated in the brains of the protein malnourished rats. Therefore, decreases in the levels of these neurochemicals cannot be the basis for the increased seizure activity seen in rats reared on inadequate amounts of protein.

(Supported by Grants NICHD 06364 and MH 10625).

660 VARIATION OF SENSITIVITY TO THERMAL STIMULATION OVER BODY SURFACE. Joseph C. Stevens and Lawrence E. Marks. John B. Pierce Foundation Laboratory and Yale U., New Haven, 06519.

Heretofore, assessment of regional sensitivity to warmth has relied on threshold measurement and "spot" mapping by punctiform stimulation. The present study examined the skin's response to warmth over a wide stimulus range in order to answer the question: how much energy does it take to arouse any given level of warmth sensation in any of ten body sites (forehead, cheek, forearm, upper arm, shoulder, chest, back, abdomen, thigh, and calf)? In an experimental session, a subject (15 in all) made magnitude estimations of the warmth produced by several levels of infra-red heating of 22 cm^2 of each site. This procedure generated a family of psychophysical power functions that can be plotted in the same axes, and horizontal cross-sections through these functions serve to specify the levels of irradiance that arouse any given level of warmth. The equal-warmth profiles thereby generated reveal very large regional differences in sensitivity near threshold, gradually diminishing differences with increasing level, and almost (but not quite) negligible differences near the pain threshold.

661 SELECTIVITY IN THE PATTERN OF NEW SYNAPSE FORMATION WITH DENERVATED DENTATE GRANULE CELLS. Oswald Steward*, Carl W. Cotman, and Gary Lynch. Dept. of Psychobiol., School Bio. Sci., U.C. Irvine, Irvine, Ca. 92664

Granule cells of the hippocampal formation, which normally receive a massive projection from the entorhinal cortex only ipsilaterally, come to receive new inputs from the contralateral entorhinal area following destruction of the ipsilateral entorhinal circuitry. The present study examines whether this post-lesion fiber growth is a random process, resulting in unpatterned reinnervation of the denervated zones, or alternatively, whether there is any selectivity in the pattern of growth and termination of the proliferating contralateral entorhinal fibers. The normal projection from the ipsilateral entorhinal cortex to the dentate gyrus is composed of two distinct fiber systems. One originates in pars medialis of the entorhinal area, and terminates selectively on the middle 1/3 of the granule cell dendrites. The second component arises in pars lateralis, and terminates selectively on the more distal 1/3 of the granule cell dendrites. Both of these components are destroyed by unilateral entorhinal lesions. By tracing the connections of the surviving entorhinal area autoradiographically, we show that the contralateral entorhinal fibers which grow in response to the lesions terminate in a selective fashion in the denervated zones. Fibers which originate in pars lateralis selectively reinnervate the most distal portions of the denervated dendrites, whereas fibers from pars medialis selectively reinnervate the middle dendritic regions. Thus, this post-lesion growth results in the recreation of a pattern of entorhinal termination which is quite reminiscent of the normal mode of innervation by the ipsilateral entorhinal cortex. These results suggest that in some situations, post-lesion axon growth may be an orderly process, culminating in patterned reinnervation of denervated cells.

662 EFFECTS OF N,N-DIMETHYLTRYPTAMINE (DMT) ON SHUTTLEBOX ESCAPE/AVOIDANCE IN RATS. D. M. Stoff*[1], D. A. Gorelick[2], T. R. Bozewicz[3], J. C. Gillin[1], and W. H. Bridger[3]. Laboratory of Clinical Psychopharmcology, NIMH, IRP, St. Elizabeths Hosp., Washington, D.C. 20032[1] and Depts. Pharmacology[2] and Psychiatry[3], Albert Einstein College of Medicine, Bronx, New York 10461

DMT is a known hallucinogenic compound in humans and enzymes capable of synthesizing it have been found in humans and animals. This suggests that DMT may be an endogenously produced hallucinogen. Single injections of DMT were given ip to male rats in three shuttlebox escape/avoidance experiments: 1) naive hooded rats during acquisition; 2) well-trained F 344 albino rats ($\geq$ 93% avoidance); 3) well-trained hooded rats who were either good ($\geq$ 90% avoidance) or poor ($\leq$ 10% avoidance) performers. Results were analyzed in terms of percentage of avoidance. DMT (2, 4, or 8 mg/kg) did not significantly effect avoidance in Experiment 1. DMT (4 mg/kg) significantly inhibited avoidance in Experiment 2. DMT (2, 4, 8, or 16 mg/kg) significantly inhibited avoidance of good performers in Experiment 3, except at the lowest dose, but did not significantly effect avoidance of poor performers. DMT's inhibitory effects in well-trained good performers (Experiments 2 and 3) is consistent with results previously reported for mescaline and LSD; however, DMT's lack of effect during acquisition or on poor performers (Experiments 1 and 3) is inconsistent with excitatory effects for mescaline and LSD previously reported in these situations.

663 A COMPARISON OF VARIOUS DOSES OF LITHIUM IN THE TREATMENT OF ACUTE MANIA. Peter E. Stokes and James H. Kocsis* Psychobiology Study Unit, Dept. of Psychiatry, Payne Whitney Clinic, New York Hospital-Cornell University Medical Center, New York 10021

Because fixed and possibly inadequate doses of lithium have been used in most previous studies evaluating the efficacy of lithium for the treatment of acute mania, and because lithium is a potentially toxic drug with a narrow therapeutic index, a double-blinded alternating dose study of 70 patients was undertaken to compare the efficacy of high (0.72 meq/kg/day), medium (0.5 meq/kg/day) and low (0.24 meq/kg/day) doses of lithium and placebo in the treatment of acute mania. High and medium doses of lithium were significantly ($P<0.01$ by chi-square) more efficacious than placebo, or low dose lithium, for improvement of mania as rated. Ratings were done daily by trained nurse observers using a 7 point global rating of mania described previously (Stokes, P. E. et al., The Lancet, June 26, 1971, pp. 1319-1325). Low dose lithium was associated with significantly ($P<0.02$ by chi-square) greater maintenance of previous rating than placebo. (i.e. prevention of increasing mania) However, low dose lithium was not significantly better than placebo regarding improvement (decrease) in manic rating. Serum lithium levels achieved within the patient group on each dose did not significantly correlate with clinical improvement in mania as rated. (This research was supported in part by MH 12464-07).

664 SEDATIVE EFFECTS ON ADRENOCORTICAL FUNCTION. Peter E. Stokes, and Peter Stoll.* We have reported the unexpected finding in depressed patients that 9 am plasma 17-hydroxycorticosteriod (17OHCS) levels are not reduced by nighttime sedation. We therefore examined the effect of oral pentobarbital (P) or flurazepam (F) on adrenocortical function in hospitalized depressed patients. One mg overnite dexamethasone (dex) suppression tests were obtained pre drug, then during a 2-3 day period of P or F. Drugs were administered to the point of minimal intoxication and definite drowsiness. Mean maximum daily dose was P 290 mg (range 200-500), F 66 mg/day (range 30-120). Striking increases in resistance to dex were noted during P. After 1 mg dex at 11 pm during pre drug period, 9 am 17OHCS levels were < 5 µg/100 ml in 8/12 cases and < 10 µg/100 ml in 12/12. During P only 2/9 patients suppressed < 10 µg/ 100 ml. Mean 9 am levels after dex in the pre drug and P periods (3.4 and 17.1 µg/ 100 ml) were significantly different ($t= 3.79$, $p < .001$). 6/9 dex tests pre F and 9/13 during F suppressed (9 am 17OHCS < 10 µg/100 ml). Mean ± S.E. of resting 9 am 17OHCS levels during pre drug ($n = 23$), P ($n = 12$) and F ($n= 11$) periods were 22.3 ± 2.1, 16.5 ± 1.6 and 19.3 ± 2.3 µg/100 ml, respectively. Mean 9 am level in 14 patients studied during a no drug period 1-3 days after cessation of P or F was 19.9 ± 2.0 µg/100 ml. P and F produced slight but significant decreases in 9 am 17OHCS from pre drug with no change in 4 or 11 pm levels. Mean levels during drug remained > normals. These data demonstrate support of our previous work showing adrenocortical function in depression and caution interpretation of dex suppression studies in patients on P. (This research was supported by MH 12464-07)

665 THE PRIMARY SOMATOSENSORY EVOKED RESPONSE AS INDICATOR OF CHANGES IN STIMULUS SUB-MODALITY AND SENSORY QUALITY. Hilton Stowell. Research Division, Central State Hospital, Milledgeville, Ga. 31062.

Primary somatosensory evoked responses (SER) summed from human scalp approximating the contralateral hand region of postcentral gyrus, in response to repetitive 3/sec, brief (1.4 ms pulse) tactile stimuli on digital and palmar tissue, demonstrated replicable differences of peak latency and waveform, attributable to changes in area and depth of indentation rather than in total force applied to the hand. The two different stimulus modes were subjectively reported as "just tapping" and "tingle/pinprick" respectively. Peripheral tissue adaptation for the latter was minimized by making the needle probe randomly vary its contact site over a surface area roughly equivalent to that contacted by the smooth tapper on the central palm. Four sequential 84 sec trials showed no significant attenuation of SER, while subjective reports indicated a periodic fading and return of sharp sensation. The flat tapping showed some adaptation during successive trials. Alternating trials of tap and needle lessened the SER differences between stimulus modes, and this primary SER blurring was matched by blurring of the subjective verbal responses. No measurable differences between finger-tip and palmar tapping showed in the SER, nor were trial-replicable differences for the two sub-modes visible in the later components up to 256 ms after stimulus onset.

This study was supported wholly by the Central State Hospital of Georgia.

666 PATTERN DISTRIBUTION AS A CUE IN VISUAL DISCRIMINATION IN STRIATE LESIONED HOODED RATS. David D. Strachan and Thomas D. Parker*. Dept. of Psychology, Loyola University of Chicago, Chicago, Ill., 60626

Animals deprived of visual cortex can discriminate between patterned stimuli which differ in contour (amount of black-white edge) though equated for luminous flux. Most of these studies have used stimuli in which the contour cues are confounded with the distribution of pattern within a stimulus (e.g., two large triangles vs. 50 small triangles of equal total area). The present study was designed to evaluate the contribution of unequal pattern distribution to contour discrimination performance of hooded rats with bilateral occipital cortical lesions. Three groups of lesioned subjects were trained. Ss in Group I were trained using typical contour stimuli (large filled circles vs. small dots). Ss in Group II were trained with stimuli differing in pattern distribution but not contour (2-ring "bull's eyes" vs. dots). Ss in Group III were trained with stimuli differing in contour but equated for distribution of pattern (4-ring "bull's eyes" vs. large filled circles). Results indicate that differences in pattern distribution yield more rapid acquisition of the task than contour alone (Mann-Whitney U=9, $p < .051$). Lesion extent was confirmed by histological examination of degeneration in the lateral geniculate nucleus. The results suggest that visually decorticate rats respond to differences in the distribution of contour within stimuli as well as differences in the absolute amounts of contour between stimuli. The finding supports and extends the conclusions of Pasik and Pasik (Vision Res. Supplement 3: 419, 1971), who state that pattern discrimination is not the "exclusive domain of the striate cortex", and emphasize the role of extrastriate structures.

667 ACTIVITY OF NEURONS IN THE VENTROLATERAL NUCLEUS OF THE THALAMUS IN RELATION TO LEARNED MOVEMENT IN THE MONKEY. Peter L. Strick, Lab. Neurophysiology, NIMH, Bethesda, Md. 20014

The activity of neurons in the ventrolateral nucleus of the thalamus (VL) was recorded in monkeys trained to maintain the handle of a manipulandum within a small zone, despite perturbations to the handle, and to perform slow and rapid arm movements triggered by a visual stimulus. VL units related to arm movement were located within a restricted mediolateral zone centered at approximately the middle of the nucleus, and most neurons in this zone discharged in relation to both slow and rapid arm movements. Units related to jaw and tongue movements associated with the juice reward were located medial to arm-related units. Concurrent anatomical studies utilizing retrograde transport of horseradish peroxidase indicate that the VL region in which units related to arm movement were recorded projects to the "arm" area of the motor cortex. In addition, micro stimulation (<25 μA) in the arm movement-related region of VL evoked contractions of shoulder and forelimb musculature. Unlike hand area motor cortex neurons, most VL neurons showed little or no change in activity in relation to passive manipulation of arm or hand. Some VL neurons, however, did show short latency (<50 msec) changes in activity following small perturbations of the manipulandum handle held by the monkey. These short latency VL responses may reflect sensory driving during task performance or short latency motor responses related to the corrective movements which followed the handle perturbation.

668 RECOVERY OF FUNCTION FOLLOWING DAMAGE TO CENTRAL CATECHOLAMINE-CONTAINING NEURONS. Edward M. Stricker, Michael J. Zigmond and Mark I. Friedman*
Psychobiology Program, Univ. Pittsburgh, Pittsburgh, Pa. 15260

Rats given two intraventricular injections of 200 μg 6-hydroxydopamine (6-HDA), like animals with small electrolytic lesions of the lateral hypothalamus, were able to maintain themselves on lab chow and water despite permanent loss of 60% of dopamine (DA) and 95% of norepinephrine in the telencephalon. However, unlike control animals, neither group increased its food intake rapidly after inhibition of cellular glucose utilization by 750 mg/kg (ip.) 2-deoxy-D-glucose (2-DG) or when animals were shaved and placed in a 5°C environment. Similar results also were obtained in rats with selective depletions of brain DA, produced by administering 50 mg/kg (ip.) desmethylimipramine prior to intraventricular 6-HDA. In contrast, all three brain-damaged groups increased their food intakes when severe glucoprivation was produced more gradually by daily injections of 2-? Units (ip.) protamine zinc insulin, or when they were housed in the cold environment for several weeks. Furthermore, all rats then increased their food intakes after 2-DG administration. We have previously observed that more extensive depletion of DA by 6-HDA (90-95%) is accompanied by an aphagia and adipsia followed by gradual recovery. These initial deficits can be temporarily reinstated by 75 mg/kg (ip.) α-methyltyrosine. We believe that the ability of each of these groups of animals to eat and drink after depletion of DA is a result of compensatory changes which occur in large part at the DA synapse. The ability of chronic stress to expand the range of stimulus conditions under which normal ingestive behaviors occur may be due to the ability of stress to promote further biochemical adaptation. (Supported, in part, by grants from the USPHS, (MH-20620), Smith Kline and French Laboratories, and Eli Lilly & Co.)

669 SELECTIVE EXPOSURE DOES NOT QUICKLY MODIFY ORIENTATION SELECTIVITY OF VISUAL CORTEX IN PARALYZED, ANESTHETIZED KITTENS. Michael P. Stryker. Department of Psychology, M.I.T., Cambridge, Mass. 02139

Blakemore and Mitchell (Nature 241: 467, 1973) have reported that when visually inexperienced kittens are exposed to contours of a single orientation, even for very brief durations, a subsequent sample of neurons from the primary visual cortex will show a strong bias toward the exposed orientation. The present experiment asked whether a similar effect could be obtained in paralyzed, anesthetized kittens.

Five paralyzed, N_2O-anesthetized visually inexperienced kittens (27, 28, 29, 30 and 35 days old) were binocularly exposed for 12 to 16 hours to a moving pattern consisting of either vertical or horizontal stripes. Following the exposure during the next 36 to 48 hours, single unit recordings in area 17 were made, using a "blind" procedure whereby the experimenter did not know to which orientation the kitten was exposed. For each unit, preferred orientation or direction, ocular dominance, and receptive field type were assessed by hand, and many units were further studied using a computer-driven optical display. After recording each unit, the microelectrode was quickly advanced 100μm in order to avoid sampling many units from a single column. In the 301 units sampled, no significant bias toward the exposed orientation was present, and no trend over the course of each experiment toward increasing preference for the exposed orientation was noted. Successively recorded units tended to show progressive changes in preferred orientation, suggesting the existence in these kittens of a columnar organization for orientation similar to that found in the adult.

These findings differ from those of Pettigrew and Garey (Brain Res. 66: 160, 1974). Possible reasons for these differences are discussed.

670 THE EFFECT OF ACUTE ETHANOL INGESTION ON BRAIN LIPID METABOLISM IN VIVO. G.Y. Sun and A.Y. Sun. Department of Chemistry, University of Missouri - Kansas City, Kansas City, Missouri 64110.

Although results from previous experiments have demonstrated changes in body tissue lipids after alcohol ingestion, the effect of alcohol on brain lipid metabolism has not been investigated in detail. Adult C57/BL mice were fed (incubation) either with an acute dose of ethanol (6 gm ethanol/kg body wt) or an equivalent amount of water. A third group of the mice was treated similarly with 80 mg/kg body wt of amphetamine. At 30 min after drug or ethanol treatment, the experimental and control mice were injected intracerebrally with approximately 1 μc of [1-^{14}C] arachidonic acid (20:4). Mice were then killed at 5 and 10 min after injections and the brain was homogenized individually in 0.32 M sucrose solution. The incorporation of 20:4 into the phospholipids and neutral glycerides in brain homogenates and the subcellular membranes was examined. Among the phospholipids, the incorporation of 20:4 into inositol and choline phosphoglycerides was not affected greatly by the drug or ethanol. Ethanol may increase the incorporation of 20:4 into the inositol phosphoglycerides to a small extent. However, a decrease of 50-70% in radioactivity was found in the brain triacylglycerols (TG) of mice treated with ethanol. The decrease in TG incorporation seemed to be more obvious in the synaptosomal fraction than in the microsomal fraction. No difference in distribution of radioactivity was found between the controls and the group treated with amphetamine. Results seem to suggest the presence of a membrane-associated lipase which is sensitive to ethanol and not to amphetamine. An inhibition of the lipase activity by ethanol would give the resulted decrease in incorporation activity. (Supported in part by U.S. P.H.S. Research Grants NS-09338 and AA-00340).

671 EFFECTS OF SATIATION ON THE BITING REFLEX OF APLYSIA. A.J. Susswein* and I. Kupfermann (SPON: K. Rubinson). Dept. Physiol., N.Y.U. Med. School and Dept. Psychiatry, Columbia University and N.Y. State Psychiatric Inst.; and PHRI, 455 1st Ave., N.Y., N.Y.

Contact of food to the lips of Aplysia elicits a biting reflex. In the course of a meal, animals satiate, i.e., the reflex wanes. To study the neural basis of satiation, it is first necessary to describe satiation on a behavioral level. During the course of a meal, after an initial arousal period, a number of effects of satiation can be seen. 1) The magnitude of the biting reflex decreases. 2) Concentration of seaweed extract needed to elicit the biting reflex increases. Throughout the meal, the magnitude of the biting reflex is concentration dependent: increased concentrations of seaweed extract elicit larger responses. As animals satiate, a given concentration of extract progressively elicits smaller responses, although higher concentrations still elicit a large response. 3) There is an increase of the interresponse interval of the repetitive biting responses which can be elicited by continuous food stimulation. 4) The latency of the biting reflex increases. Latency of the biting reflex is initially less than the repetitive interresponse interval; as the meal progresses, this relationship reverses. The reflex latency at any point in time seems to depend upon the level of filling of the gut. Due to residual bulk in the gut from previous meals, non-starved animals eat smaller meals than do previously starved animals. The latency of the biting reflex during the smaller meal eaten by non-starved animals corresponds with the reflex latency during the latter part of meals of starved animals. The present data suggest a number of testable hypotheses about the types of neural mechanisms that can account for satiation.

672 ELECTROPHYSIOLOGICAL INVESTIGATION OF VISUAL UNITS IN THE CAT: A REVISED CONCEPTION OF RECEPTIVE FIELDS. Erich E. Sutter* (SPON: Betty Ann Brody). Dept. of Psychology, Stanford University, Stanford, CA 94305

The fact that visual cells respond to temporal sequences of retinal stimulation rather than only to geometrical aspects of the stimulus necessitates the revision of the receptive field concept. A new experimental method was developed to investigate those temporal sequences of retinal stimulation which elicit responses. In our preliminary studies single units were monitored in the visual system of immobilized and slightly anaesthetized cats. As a stimulus, a continuously changing pseudorandom sequence of pseudorandom 2-dimensional light-dark patterns is presented to the animal for approximately one hour. The stimulus is produced by input of analog noise into the x-, y-, and z (intensity) channels of a display scope. The stimulus is exactly reproducible, since the noise is played from an analog tape recorder. The response from a visually driven cell is recorded on the same tape in order to preserve its temporal relationship with the stimulus that produced it. Later, response locked averaging of the pre-response stimulus histories will crystallize out the features of those histories which are relevant for the production of responses. This averaging is achieved by photographic means: Pulse analyzers determine the exact time and strength of a response. In the replay, the patterns which occur at time Δt before every response are flashed onto the scope screen with an intensity proportional to the response magnitude. A camera with an open shutter, placed in front of the scope, does the averaging. By varying Δt we can scan through the whole relevant stimulus history milisecond by milisecond. The resulting sequence of pictures give us the desired space-time information. The results obtained so far support the contention that in the effort to understand single unit activity greater consideration should be given to the spatio-temporal structure of the relevant stimuli.

673 A SYSTEMATIC IMMUNOFLUORESCENCE STUDY OF THE CENTRAL DOPAMINE-β-HYDROXYLASE (DBH) NEURONS AND THE DISTRIBUTION OF THEIR PROCESSES IN THE RAT. L. W. Swanson and B. K. Hartman*. Depts. Biol. and Psychiat., Washington Univ., St. Louis, Mo., 63130.

Central presumed noradrenergic and adrenergic neurons and their projections were mapped in the normal untreated adult albino rat with a sensitive immunofluorescence method specific for dopamine-β-hydroxylase (DBH). All cell bodies were located at or below the level of the locus coeruleus in the pontine tegmentum and numbered an estimated 9,425 in one brain based on cell counts in a 1 in 20 frontal series (10 μ) from the olfactory bulb to the caudal medulla. A majority of fibers from the coeruleus and subcoeruleus groups appear to join dorsally to course forward as a single bundle in the midbrain of each side immediately below the central gray, fanning out into a number of projections to the prosencephalon. Distinctive patterns of fluorescent processes were observed in the hypothalamus, thalamus, septal area, hippocampus, and amygdala, as well as the brainstem. Details of these projections and what appear to be associated terminal areas were clarified in additional series cut in the horizontal and sagittal planes. The immunofluorescent technique as applied here appears to reveal more details than the standard Falck-Hillarp method; our results confirm and extend earlier studies with the latter, as well as indicating important connections in areas such as the thalamus, which have received scant attention. Recent evidence from our laboratory suggests certain anatomical as well as physiological similarities between the central (nor)adrenergic and peripheral sympathetic systems. (Supported in part by grants MH24604, NS03777, MH70451, and MH21874)

674 CHANGES IN [K+]0 DURING NEOCORTICAL PROPAGATED SEIZURES. George W. Sypert and A. A. Ward, Jr. Dept. of Neurological Surgery, Univ. of Wash., RI-20, Seattle, Wash. 98195

Direct measurements of extracellular potassium concentration ([K+]o) using a potassium-sensitive microelectrode were carried out in the pericruciate cortex of cats during propagated seizures initiated by repetitive stimulation of the surface of the opposite homotopic neocortex. [K+]o increases during either subthreshold stimulus trains or ictal episodes were dependent on cortical depth and distance from the homotopic point. Minor and major seizures could be classified by typical increases in [K+]o: 0.5 ± 0.06 mM/l and 5.9 ± 0.8 mM/l above the steady state value, respectively. The upper limit for [K+]o during ictal events was 10.2 mM/l. A post-ictal undershoot of [K+]o below steady state was observed. The elevation of [K+]o to a critical value during stimulation was associated with a "threshold" for the initiation of propagated seizures. That value was 0.5 mM/l for minor seizures and 1.8 mM/l for major seizures. Both minor and major seizures were found to act as "all or none" phenomena of variable morphology. [K+]o plays an important role in the modulation of CNS activity and the pathogenesis of propagated ictal phenomena.

675 DOPAMINE β-HYDROXYLASE ACTIVITY AFTER CHRONIC ADMINISTRATION OF ETHANOL. P. Y. Sze, R. Beach* and S. Fergione* Dept. of Biobehavioral Sciences, Univ. Connecticut, Storrs, Connecticut 06268

Mice receiving an anesthetic dose of ethanol (4 g/kg, i.p.) showed a decrease of dopamine β-hydroxylase (DBH) activity in whole brain at 1 hr after treatment. In contrast, after continuous administration of ethanol (6% in liquid diet), brain DBH activity was increased by 38% in 2 weeks and by 57% in 3 weeks. Brain tyrosine hydroxylase activity remained unchanged under either treatment. Adrenal DBH activity was found also to increase after chronic ethanol treatment (+54% in 2 weeks and +303% in 3 weeks). However, in the superior cervical ganglion, chronic treatment with ethanol resulted in reduced DBH activity (-16% in 2 weeks and -44% in 3 weeks). If DBH activity is taken as an index of sympathetic nervous activity, these results support the view that ethanol has significant impact on sympathetic activity. (1) The chronic effect of ethanol in the brain is distinctly different from its acute effect. (2) The effect on the peripheral sympathetic nervous system may not parallel the central effect. (Supported by USPHS grants AA 00297 and RR 00602 and by a grant from The Grant Foundation, Inc.).

676 RAPHE-RETICULAR FORMATION CONNECTIONS IN THE CAT. Elizabeth Taber Pierce, Dept. Anatomy, Harvard Med. Sch., Boston, Mass. 02115.

Tritiated leucine or proline (0.5 μl - 1 μl, 30-50 μCi) was injected into nucleus raphe dorsalis, 4 cats, into nucleus raphe pontis centralis caudalis, 7 cats. Animals were killed 1-10 days later. Autoradiograms of sections cut at 10 μ in the sagittal or transverse plane, coated with NTB-2 emulsion, exposed from 3-8 weeks, stained with toluidine blue were studied. Autoradiograms of the dorsal raphe nucleus revealed a pattern agreeing with ones described using the flourscent technique (Fuxe, '65) and autoradiographic technique (Moolenar, '73 and Conrad et al., '74). Projections from the nucleus pontis centralis caudalis descend at pontine levels within and ventral to the M. L. F., at medullary levels more ventrally, mainly ipsilateral. Terminal sites are within nuclei: pontis centralis caudalis, locus coeruleus, subcoeruleus, abducens, giganto cellularis, paragiganto-cellularis, parvocellularis, vestibular, facial, centralis ventralis, raphe magus and pallidus, hypoglossal and prepositus hypoglossal. The ascending pathway lies ventral to the M. L. F. Terminal sites are in the nuclei: pontis centralis oralis, raphe intermedius and rostralis, trochlear, oculomotor and cuneiformis.

677 ENHANCEMENT OF SEROTONIN BINDING TO A SPECIFIC SOLUBLE PROTEIN BY Fe^{+2}. H. Tamir and M. M. Rapport. Div. Neuroscience, N. Y. State Psychiatric Institute, New York, N. Y. 10032.

In a previous report [Tamir and Huang, Life Sci. 14, 83 (1974)] we described the detection of a soluble protein in rat brain with high binding affinity for serotonin. A subcellular distribution study showed that the protein is located mainly in the synaptosomal fraction and cytosol. It has now been found that Fe^{+2} ($FeSO_4$) increases the binding greatly. At the optimal concentration ($10^{-4}M$), the enhancement is close to 10 fold. Preincubation is required (10 min, 25°) and higher concentrations are inhibitory (30% decrease in maximal binding at $2.5 \times 10^{-4}M$). A much smaller effect was noted with Cu^{+2}, and little or no effect was seen with Fe^{+3}, Mn^{+2}, Ca^{+2}, or Mg^{+2} ($10^{-4}M$). The effect of Fe^{+2} on specific binding was much greater than on non-specific binding, judging from the effect of Fe^{+2} in the presence of excess unlabelled serotonin. Studies based on equilibrium dialysis in the presence of increasing concentrations of serotonin show that the effect of Fe^{+2} is on the affinity of the binding of serotonin to the protein, rather than on binding capacity. The migratory properties in polyacrylamide gels at pH 8.6 of the serotonin-protein complex formed in the presence of Fe^{+2} differ from those of the complex formed without Fe^{+2}. Inhibitory effects of ATP, ADP, and AMP ($10^{-3}M$) on serotonin binding in the presence of Fe^{+2} were also studied. (Supported in part by a grant from the Schizophrenia Research Program of the Supreme Council 33° A. A. Scottish Rite, Northern Masonic Jurisdiction.)

678 FEASIBILITY OF SPINAL CORD OR BRAIN SURGERY IN FETAL RHESUS MONKEYS. Edward Taub, Gilbert Barro*, Epp A. Miller*, Philip N. Perrella*, Alfred Jakniunas*, Patricia S. Goldman, J. M. Petras, Clement C. Darrow, II*, and David F. Martin*. Institute for Behavioral Research, Silver Spring, Md. 20910; NIMH, Section on Neuropsychology, Bethesda, Md. 20014; Walter Reed Army Institute of Research, Washington, D. C. 20012; Litton Bionetics, Inc. Kensington, Md. 20795.

Rhesus monkey fetuses were exteriorized at the end of the second trimester of pregnancy, placed in a temperature-controlled saline bath, subjected to either forelimb deafferentation or prefrontal cortex ablation, and then replaced *in utero* for completion of fetal development. In a series of 20 animals, 9 were given prefrontal cortex lesions and 11 were given forelimb deafferentation. Two of 9 prefrontal animals (22%) and 5 of 11 deafferented animals (45%) were delivered live by Caesarian section near term. One prefrontal animal died at 4 weeks from a respiratory infection; the other is now 15 months old and has exhibited an apparently normal development. The 5 deafferented monkeys were quadriparetic; 3 could use their deafferented limbs to make postural adjustments and stand for brief periods. After displaying progressive impairment, 1 died and 4 were sacrificed at 5-12 months of age. Postmortem examination revealed severe spinal cord crush injuries apparently due to postoperative mechanical deformation of the cervical region. Gross and microscopic study of 3 brains failed to reveal any neuropathological evidence of prenatal asphyxia. Although further technical refinements are required, the present results indicate that neurosurgery in the fetal primate is feasible and can be used to study the development of brain and behavior. (Supported by a grant from the W. T. Grant Foundation and NIH grant FR 5501RR05636.)

679 THE FUNCTION OF MUSCLE SPINDLES IN NORMAL JAW MOVEMENTS OF UNRESTRAINED CATS. A. Taylor*, F. W. J. Cody* and L. Harrison* (SPON: D. G. Stuart). Dept. of Physiol., Coll. of Med., Univ. Arizona, Tucson, Az. 85724.

The first order cells of the mesencephalic nucleus of the fifth cranial nerve in the cat belong exclusively to dental mechano-receptors and to spindle afferents from the jaw closing muscles. We now know that the former are restricted to the caudal part, so that by means of extracellular micro-electrodes implanted in the rostral part of the nucleus we are able to record spindle behavior in entirely unrestrained animals. Some units, believed to be spindle primaries, discharge very phasically at 300+/sec. Others, believed to be secondaries, are much less phasic and have maximum frequencies of 120/sec in normal eating and drinking movements. Simultaneous recording of jaw movement and of temporalis and masseter EMG show that, although there is clear evidence of fusimotor fluctuation, the spindles never speed up during active shortening, but generally behave more like passive length detectors. Eating and drinking movements are highly patterned and we have therefore computed the mean cyclical displacement. Subtracting individual cycles from this gives "error" patterns which, compared with the EMG activity, show little evidence of load compensation.

680 CIRCULATION OF SYNAPTIC VESICLE MEMBRANE IN NEURONS OF SPINAL CORD EXPLANTS. S. Teichberg*, E. Holtzman, S.M. Crain, E.R. Peterson*Dept. of Peds. & Labs., North Shore Univ. Hosp., Manhasset, NY 11030, Cornell Univ. Med. Coll. NY 10020, Columbia Univ. NY 10027, Alb. Einstein Coll. Med. Bronx, NY 10461.

Presynaptic terminals of cultured fetal mouse spinal cord neurons show stimulation-dependent uptake of horseradish peroxidase (HRP) into many small vesicles and occasional tubules and multivesicular bodies. This study investigates the fate of these HRP containing structures. Cultures were allowed to take up HRP during a 1 hr strychnine enhanced stimulation of long lasting synaptic network discharges and then maintained in tracer-free medium with either strychnine (10^{-6}M) or with levels of Mg^{++}(10mM) that depress neurotransmitter release. Under both "chase" conditions there is a loss of HRP-containing structures from terminals. Such loss is appreciable by 4-8 hrs in strychnine and by 8-16 hrs with 10mM Mg^{++}. The loss in elevated Mg^{++} probably occurs by other mechanisms than the membrane rearrangements (presumably exocytosis coupled to endocytosis) that lead to initial tracer uptake; terminals exposed to HRP for 16 hrs with 10mM Mg^{++} show almost no uptake of tracer. HRP is very stable in solution so the loss of detectable tracer with 10mM Mg^{++} is not merely a loss of enzyme activity. During the chases there is a striking increase in the amount of HRP in neuronal perikarya where it is found predominantly in lysosomes. Regardless of chase conditions, the increase in perikaryal HRP is far more marked in cultures initially exposed to HRP with strychnine than in those exposed to tracer with 10mM Mg^{++}. This evidence suggests that some of the HRP-containing structures are transported from terminals to neuronal perikarya for further processing. On the other hand, the enhanced rate of tracer loss from terminals in the presence of strychanine possibly reflects reutilization of vesicle membrane for exocytosis. (Supported by NIMH grant #5TI-MH-6418 and NINDS grants NS-09475, NS-06545, NS-08770.)

681 ROLE OF BRAIN CATECHOLAMINES IN RELEASE OF GONADOTROPIN BEFORE PROESTRUS IN THE CYCLING RAT. E. Terasawa*, W. E. Bridson*, J. W. Davenport* and R. W. Goy. Wisconsin Primate Research Center, Univ. of Wisconsin, Madison

To determine whether brain catecholamine neurons are involved in release of the gonadotropin responsible for estrogen increases before proestrus, various inhibitors and precursors of catecholamine biosynthesis were administered subcutaneously or intracranially to the third ventricle at 10:00 or 20:00 on the 2nd day of diestrus (D II) in 4-day cycling rats. Changes in vaginal smears on subsequent days and ovulation on the day of estrus (E) were examined. 1) Administration of α-Methyl-p-tyrosine (α-MT, 160 mg/kg s.c.), an inhibitor of tyrosine hydroxylase, at 10:00 on D II reduced weights of uterus and intraluminal fluid on proestrus (P), prevented vaginal cornification on E, blocked ovulation in all 10 rats, and induced prolonged diestrus. 2) Administration of bis-(4-Methyl-1-homopiperazinyl-thiocarbonyl)-disulfide (FLA-63, 10 mg/kg s.c.), an inhibitor of dopamine-β hydroxylase, at 10:00 on D II reduced weights of uterus and intraluminal fluid on P, blocked ovulation for a few days but did not prevent vaginal cornification. 3) Administration of α-MT (200 mg/kg) or FLA-63 (15 mg/kg) at 20:00 on D II blocked ovulation in all of 8 and 7 rats, respectively. 4) Administration of L-DOPA (100 mg/kg) or dihydroxyphenylserine (DOPS, 200 mg/kg) with α-MT (200 mg/kg)at 20:00 on D II reversed the effect of α-MT on ovulation in 2 out of 3 and 3 out of 5, respectively. 5) Direct application of α-MT or FLA-63 powder (about 5 µg) to the third ventricle at 20:00 on D II also blocked ovulation in all of 7 and 5 rats, respectively. 6) Injection of estradiol-17β(40 µg, s.c.) with α-MT or FLA-63 partially removed the ovulatory blockade induced by conditions 1, 2, 3 and 5. Therefore, norepinephrine seems to be the more important transmitter in release of gonadotropin secretion before proestrus, but dopamine is also involved at the early stage of estrogen secretion. Supported by RR-00-167 NIH.

682 SELF-STIMULATION OF THE DORSAL MIDBRAIN AS A FUNCTION OF THE INTERVAL BETWEEN CONDITIONING AND TESTING PULSES. R.H. Thalmann* (SPON: John H. Perry) Dept. Cell Biol., Baylor Col. Med., Houston, TX. 77025.

In order to infer response characteristics of neural elements which participate in reward due to stimulation of the dorsal midbrain, the classical neurophysiological technique of measuring the response to conditioning and testing pulses (Lucas, J. Physiol. 51:1, 1917) was modified for self-stimulation tests. Rats were trained to bar press for stimulation via monopolar stainless steel electrodes which were aimed ventrolateral to the periaqueductal gray, in the region of the dorsal norepinephrine pathway. Each bar press was followed by a stimulus which was comprised of 10 pairs of rectangular pulses. Each of these 10 pulse pairs consisted of an initial conditioning (C) pulse which was followed at some predetermined interval (the C-T interval) by a testing (T) pulse. The interval between C pulses was always 20 milliseconds (ms). At the lowest current levels employed, C-T intervals between .3 and .6 ms resulted in bar press rates which did not differ from rates when the T pulses were omitted. With C-T intervals between .6 and .8 ms, however, a marked increment in response rate occurred which approached an asymptote between C-T intervals of 1.2 and 8.0 ms. With increased stimulus intensity, the initial increment in bar press rate occurred between C-T intervals of .5 and .6 ms, and approach an asymptote between .6 and .8 ms. If the response rate increment between .5 and .6 ms corresponded to the recovery from refractoriness of axons which were discharged by each C pulse, then analogy with peripheral nerve would suggest that these axons were myelinated rather than unmyelinated, and further, that they did not correspond to the myelinated axons of smallest diameter. (Grundfest, Annu. Rev. Physiol., 2:213, 1940).

683 EVOKED POTENTIAL CORRELATES OF HUMAN SHORT-TERM MEMORY. Robert W. Thatcher, Brain Research Labs., New York Medical Coll., N.Y., N.Y.

Computer controlled displays were presented to human subjects in a delayed-matching-from sample paradigm. The basic paradigm involved presenting a series of empty squares (control displays) which were followed by a square filled with a letter (information display). Following the information display a variable number of empty squares were presented (inter-test interval displays, ITIs) followed by a square filled with a letter (test display). This test display either matched or mismatched the information display. All displays were presented in a counter balanced order for 20 msec at a repetition frequency of 1/sec. Subjects were instructed to press a lever to the left if the test display matched the information display and to press the lever to the right if it mismatched.

Evoked potentials (EPs) elicited by the various displays were recorded bilaterally from 8 monopolar scalp derivations and averaged. It was demonstrated that EP waveforms elicited by the matching test stimuli differed in a characteristic manner from EPs elicited by identical test stimuli which did not match the information display. These reliable differences between match and mismatch waveforms occurred as a function of information stored in the past.

Factor analysis of averaged EPs demonstrated unique waveforms related to specific variables of the experiment. The most striking finding was a shared factor loading between EPs elicited by the information display and EPs elicited by the matching test display. This consistent finding indicates that the presentation of the match test stimulus results in the release or reproduction of the information wave.

684 PATTERN GENERATOR FOR RHYTHMIC MOTOR OUTPUT IN MELIBE. Stuart H. Thompson* (SPON: A.O.D. Willows). Depts. Zoology and Physiology-Biophysics, University of Washington, Seattle, 98195.

Melibe, a nudibranch mollusc, swims by side-to-side bending movements. Swimming begins when the animal is dislodged from the substrate and continues until the foot regains contact. The behavior is elicited reliably and can be studied for hours in a whole animal preparation in which the CNS is exposed and immobilized for microelectrode recording. Pedal ganglion cells which when stimulated cause contraction of a small area of lateral body wall muscles, fire in bursts during flexion to the same side during swimming. No synaptic interactions have been seen between antagonist pedal ganglion cells. In contrast, one cell in each pleural ganglion causes a complete homolateral flexion movement when stimulated. The two cells are mutually inhibitory and fire in strictly alternating bursts during swimming. Each pleural cell makes excitatory synaptic contacts with numerous synergist pedal flexion cells and inhibitory contacts with antagonist flexion cells. The phase and frequency of the swimming movements can be changed by manipulating the firing of one of the pleural cells, and the swimming movements cease if one or both of the pleural cells are hyperpolarized to prevent firing. It is proposed that the mutually inhibitory pleural cell pair are responsible for generating the rhythmic output pattern and for imposing it on the motoneurons.

685 TILT-ANALYSIS OF PLEOMORPHIC VESICLES IN THE SUPERFICIAL LAYERS OF THE SUPERIOR COLLICULUS OF TWO PRIMATE SPECIES. M. Tigges*, J. Tigges and R. H. Lange*. Yerkes Reg. Primate Res. Center and Dept. Anat., Emory Univ., Atlanta, Ga. 30322, and Dept. Anat., Justus-Liebig-Univ., Giessen, F.R.G.

Pleomorphic or flat vesicle-containing profiles (F-profiles) from the two superficial layers of the superior colliculus of two primates (Galago and chimpanzee) were tilted in a Philips 201 electron microscope, fitted with a goniometer stage. The tissue was initially fixed with two aldehydes in phosphate buffer, sucrose added. The profiles were tilted through a total of 90° at 15° intervals by rotating the section around the horizontal axis 45° to either side. F-profiles in many instances contained ribosomes and exhibited other features typical of dendrites. The F-profiles were grouped according to their positions, either as pre- or postsynaptic. From both primates a total of 85 profiles with over 700 vesicles, that could be observed easily through the complete tilt series, were analyzed. Vesicles that were initially flat gradually broadened during tilting to a circular configuration; vesicles that were initially round gradually became thinner and ellipsoid in outline when tilted through 90°. This indicated that the majority of pleomorphic vesicles fall into a broad category of disc-shaped vesicles. Some vesicles appeared to have the shape of a doughnut, a few resembled blood platelets. It is unresolved whether these variations are fixative dependent or represent genuine vesicular shapes. The pleomorphic vesicles in dendrites, pre- and postsynaptic F-profiles exhibited the same disc-like configuration. Whether all discoid vesicles contain the same or different synaptic transmitters remains unknown. (Supported in part by NIH grants RR-00165 and EY 00638-03.)

686 EFFECTS OF LOCALIZED CHOLINOMIMETICS IN THE AMYGDALA ON RETENTION OF ONE-TRIAL PASSIVE AVOIDANCE. Janet W. Todd* and Raymond P. Kesner. Dept. of Psychol., Univ. of Utah, Salt Lake City, Utah, 84112.

Rats were given a single footshock experience while licking a tube in a lick box situation and tested for retention 24 hours later. Retention was evaluated as an increase in latency to approach the lick tube relative to pretreatment latency. Immediately after the footshock experience, cholinomimetics were injected bilaterally into the amygdala via implanted cannulas. The injections consisted of carbachol (0.5 µg. or 1.0 µg.) or physostigmine (5.0 µg. or 10.0 µg.), dissolved in 1.0 µl. isotonic saline. Unoperated controls and saline controls were also tested. Animals that received 1.0 µg. carbachol or 10.0 µg. physostigmine exhibited amnesia for the footshock experience as compared to control animals and animals receiving 0.5 µg. carbachol or 5.0 µg. physostigmine. Results indicate that an increase in cholinomimetics in the rat amygdala may block normal neural function and normal information processing resulting in retention deficits.

687 OBSERVATIONS ON THE ROLE OF DREAMS IN ENGRAMMING LONGTERM MEMORIES. C. Torda. Mt.Sinai Sch.Med.,& Downstate Med.Center,N.Y.,N.Y.,10029.

The assumption that dreams are essential in engramming longterm memories has been questioned on grounds that we are able to remember new events without sleeping, and we remember events of the early morning and late night equally well (Torda, Comm.Behav.Biol.,1968,A 2,39). Dreams were collected in the present work from 10 college students during exposure to various exogenous and endogenous stimuli. Content analysis of the dreams confirmed previous conclusions that engramming longterm memories is a continuously ongoing process. In order to preserve effective problem solving ability, formation of longterm memories remains one of the intracerebral processes that occurs outside the conscious awareness. Dreaming seems to permit an insight into one of the mechanisms of engram formation. Dreams are here defined as visual representation of a new construct created by combining traces of last day's events and of old memory traces. Statistical treatment of the content of consecutive dreams collected during various experimental conditions suggests that A) Dreaming is not a necessary and indispensable step in the formation of longterm memories. B) Dreaming is only one of the intracerebral processes through which the same memory trace is engrammed in a variety of related forms. C) The stimulus that retrieves the residue of last day's events from the already engrammed events of last day may also be responsible for the retrieval of memories of old events that once were related or offered a solution (relief) in the past to similar stimuli (Torda,Psychophysiology, 1970,6,358). D) The emotional state of the dreamer often affects the content of the dream. E)This is one of the available methods (D) through which the memory-bank can be modified.

688 Scanning and Transmission Electron Microscopy of Isolated Neuronal and Glial Perikarya. Bruce D. Trapp*, Barny Dwyer*, and Joseph Bernsohn. Neuropsychiatric Research Laboratory, V.A. Hospital, Hines, Ill. and Depts. Anatomy and Biochemistry and Biophysics, Loyola Univ. Stritch Sch. Med. Maywood, Illinois 60153.

Recent developments in the isolation of different brain cell types by mechanical and enzymatic methods have provided preparations to allow independent investigation of the metabolism of neurons and glial cells. However, questions as regards the viability and integrity of the cells so isolated have been raised. To obtain some data on this problem neurons, astroglia and oligodendroglia were isolated from rat and calf brain by the method of Norton and Poduslo (Science, 167 (1970) 1144-46). The preparations were then examined by inverted phase microscopy and their viability determined by eosin staining by the method described by Schrek (American J. Cancer 28: 389, 1936). The cells were then suspended on a carbon-coated coverslip and prepared for scanning electron microscopy. Following scanning examination these same cells were embedded for and examined by transmission electron microscopy. It was found that over 90% of the neurons and oligodendroglia were viable as tested by the method cited. The purity of these fractions were also of the same order of magnitude. The astrocyte preparation was less pure, contaminated by processes and broken cellular fragments. All cells retained their plasma and nuclear membranes, but some distortion of intracellular organelles and endoplasmic reticulum was observed. Scanning techniques reveal neuronal soma of varying shape and size, plasma membranes appear to be intact and have a somewhat ruffled appearance. Oligodendrocytes are rounded and appear to have intact plasma membranes which are somewhat smoother than the neuronal membranes. The evidence would tend to support the view that no contraindication exists for the use of the cells described for metabolic studies.

689 SEROTONIN EFFECTS ON THE DEPRESSION, FREQUENCY FACILITATION AND POST-TETANIC POTENTIATION AT A CHOLINERGIC SYNAPSE IN APLYSIA CALIFORNICA. Jacques P. Tremblay*, Paul B.J. Woodson*, Werner T. Schlapfer, and Samuel H. Barondes. Depts. of Neurosci. and Psychi., UCSD and VA Hospital San Diego, Ca. 92161 (SPON: R. Galambos)

Monosynaptic unitary EPSP's produced by minimal stimulation of the right connective were recorded with a 3 M KCl electrode from cell R15.

Trains of 100 stimuli at 2/sec, followed by test pulses at intervals ranging from 5 to 60 sec, were given every 30 min. At this frequency the EPSP's first decreased in size (depression) and then increased to a sustained facilitated plateau (frequency facilitation). The train was followed by a period of post-tetanic potentiation (PTP) during which the EPSP's were even larger than at the facilitated plateau. The PTP lasted for 20 min under the experimental conditions. At least 3 trains were given before perfusing serotonin at concentrations ranging from 5×10^{-6}M to 10^{-4}M. In the presence of this amine, the size of the first EPSP was decreased and the amount of depression was reduced or suppressed. In contrast, the absolute size of the facilitated plateau was unchanged and the relative facilitation ($EPSP_{1000}/EPSP_1$) was therefore strikingly increased. Both the absolute and the relative magnitude of PTP were reduced by serotonin. These effects were attributed to a presynaptic action of serotonin on this cholinergic synapse. The amine decreases fractional release but does not influence the net supply rate of neurotransmitter which limits the magnitude of the frequency facilitation. This contrasts with effects of dopamine (see abstract by Woodson et al.).

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690 METABOLIC STUDIES ON MYELIN - EVIDENCE FOR A PRECURSOR-ROLE FOR MYELIN SUBFRACTIONS. John L. Trotter*, Harish C. Agrawal*, Robert M. Burton*, Raymond F. Mitchell*. Washington University School of Medicine, St. Louis, Mo. 63110.

Myelin prepared from brain tissue of developing rat (15 days old) can be separated into several subfractions. These are (1) "myelin-like" and purified myelin by the technique of Agrawal, et al., Biochem. J. 120:635-642, 1970, and (2) "membrane fraction", "light myelin", and "heavy myelin" by the discontinuous sucrose gradient procedure. "Myelin-like" and "membrane fraction" subfractions appear to be similar in chemical properties but different in detailed morphology by electron microscopy. Both fractions are related to myelin on the basis of demonstrable myelin basic protein by polyacrylamide gel electrophoresis in sodium dodecyl sulfate and the presence of a myelin marker enzyme 2':3'-cyclic nucleotide 3'-phosphohydrolase. These two fractions have a low lipid content (17% for "myelin-like" and 40% for "membrane fraction" subfractions), compared with myelin (67-72%). No cerebroside are detected in these two fractions, whereas cerebrosides are a major component of myelin itself. Administration of [2,3-H^3] tryptophan to young rats results in more rapid incorporation into proteins at the "myelin-like" and "membrane fraction" subfractions when compared with incorporation into myelin. Data will be presented which will be consistent with a precursor relationship for the conversion of "myelin-like" and "membrane fraction" subfractions into myelin.

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691 THE RESPONSE AND INNERVATION PATTERN OF HAIR MECHANORECEPTORS. R. P. Tuckett*, K. W. Horch and P. R. Burgess. Dept. Physiol., Sch. Med., Univ. Utah, Salt Lake City, 84132.

Hair receptors in the cat were studied from two major approaches: first, their response to movement of hairs and skin within the field and, second, the pattern with which single neurons innervated guard hairs within the field. Based on its response to movement of hairs and skin, each fiber was classified as belonging to one of six categories: G_1 hair, intermediate hair, G_2 hair, F_1 field, F_2 field, or D hair. Effective stimuli for each type of unit were then explored with the intent of finding mutually exclusive properties characteristic of each type of receptor. To study the pattern of guard hair innervation for G_1, intermediate and G_2 units, each innervated hair was marked, the innervated area was removed, mounted in its original dimensions, and fixed in formaldehyde. A series of overlapping scanning electronmicrographs was taken of each field and then matched together to form a montage. With the montage for reference, the thickness of each guard hair in the field and the distance between innervated hairs (and for a few fields, the position of each hair) were measured directly from the specimen at 50x. Both G_1 and intermediate hair, and G_1 and G_2 fibers, have been found to innervate the same follicles. This work was supported by U.S.P.H.S. Grants NS08769, NS07938 and NS05244.

692 FORM DISCRIMINATION AND LOCALIZATION PERFORMANCE IN CATS WITH SUPERIOR COLLICULUS ABLATIONS. Judith E. Tunkl and Mark A. Berkley. Dept. Psychology, Florida State University, Tallahassee, Florida 32306

Considerable evidence indicates a strong visuo-motor role for the superior colliculus. Recent studies have also implicated this structure in form discrimination learning. Is it possible to interpret the latter findings in the context of a visuo-motor deficit? For example, the observed deficits in an animal's ability to learn new form discriminations may be due to difficulties in localizing the correct stimulus in the behavioral apparatus rather than to difficulties in identifying the stimuli. The present experiments investigated this possibility. Cats with superior colliculus lesions were trained on form discriminations in an apparatus in which stimulus localization was minimally important. In another behavioral chamber, ability to localize the source of either a light or a sound stimulus was tested. In agreement with previous findings, animals with superior colliculus damage showed impairments in acquisition of form discriminations but eventually learned them. Performance in the localization task was unimpaired with long duration auditory and visual stimuli. These results indicate that form learning deficits in animals with superior colliculus damage cannot simply be attributed to impaired localization capacities. They do not, however, rule out eye movement deficits as a factor.
(Supported by NSF GB 34166 and GU 2612.)

693 COMPUTER SYNCHRONIZATION WITH NEURON ACTION POTENTIALS TO STUDY RELATED FIELD POTENTIALS. C. C. Turbes*, G. T. Schneider*, J. M. Simard* and R. J. Morgan* (SPON: Gilbert Meier). Creighton University School of Medicine, Omaha, Nebr. 68178.

The purpose of this paper is to describe the processing of analog extracellular neuron activity recorded with an FM tape recorder using averaging methods. Dual-read heads on an FM tape recorder, a pulse height discriminator, and an averaging transients computer were used for the determination of the chronological relationship between extracellular neuronal action potentials and slow wave and unit activity preceeding and following the action potential used to trigger the computer. The slow wave and unit activity was studied for evoked potential patterns in the dorsal hippocampus, dorsomedial thalamic nucleus, lateral geniculate, and medial geniculate nuclei. Similar studies were made to determine the chronological relations between action potentials and slow wave and unit activity in areas synaptically related to the regions of the brain mentioned above.

694 REGULATION OF ELECTRICAL ACTIVITY IN MOUSE NEUROBLASTOMA CLONE N1E-115 Jeremy Tuttle* and Elliott Richelson. Dept. of Physiology and Dept. of Pharmacology and Exp. Therapeutics, Johns Hopkins University School of Medicine, Baltimore, Maryland 21205.

Mouse neuroblastoma clone N1E-115 which has high levels of tyrosine hydroxylase and regulates this enzyme (E.Richelson, J.Neurochem.21,1139, 1973) was studied for its electrical properties and the possible regulation of these properties. Cells were treated with 1 μM aminopterin (AMX) for 24 hrs., yielding a population of highly differentiated cells that remained non-dividing for up to 3 weeks. Intracellular recordings under constant superfusion were obtained at various times after treatment with AMX. There was a significant increase in the average resting membrane potential (Vm) for cells 5 to 8 days after treatment (-44.5 mV, n=54), as compared to before (-36.4 mV, n=29). This change in Vm was not accompanied by an increase in internal potassium concentration ($[K^+]_i$), determined by extrapolating Vm vs. $[K^+]_o$ plot to Vm= 0. Also, there was no increase in the portion of Vm attributable to an electrogenic pump (~5mV) which was determined from the depolarization caused by 100μM ouabain and by lowering the temperature of the bath medium. Concurrent with the increased Vm after AMX treatment, there was a development of cation sensitivity which allowed chemical excitation of these cells. Greater than 50% of cells tested (n=90) at >6 days after AMX treatment responded with sustained firing of action potentials when $[Ca^{++}]_o \leq 200\mu M$ and $[K^+]_o = 0$ in the bath medium; while no cells fired when tested earlier (n=30). Diphenylhydantoin at 20μM reversed this chemical excitation with no attendent change in Vm; while other anticonvulsant compounds failed to do so at high concentrations. These results indicate that the electrical activity of mouse neuroblastoma clone N1E-115 is also regulated and that this clone may be useful for studies on mammalian neuronal excitability.(Supported by USPHS,NIMH JHU Drug Abuse Res.Ctr. Grant DA 00266 and NIMH Res. Grant MH 21805).

695 LINGUISTIC DEFICITS IN RIGHT HEMISPHERE LESIONS. Hanna K. Ulatowska and Temple Baker*. Dept. Neurology, Univ. of Texas Health Science Center, Dallas, 75235 and Dept. Comm. Dis., Univ. Texas-Dallas, Dallas, 75230

This study reports the results of a sentence construction test given to patients with right hemisphere lesions. The test calls for the assembly of each of 20 sentences from individual words presented on cards. Questions designed to test comprehension were asked after the completion of each sentence. The test was administered to 27 subjects, etiology CVA, single stroke, unilateral lesion, condition stabilized. The study was a part of an investigation in which the test was also given to patients with left hemisphere lesions with aphasia and a control group of normals. We observed that both linguistic and cognitive strategies were invoked to solve the problem posed by the task. Several response variables were isolated, so that group performance could be assessed not only in terms of simple success or failure, but also in terms of the type of strategy employed. The results of the test revealed that performance of the patients with the right hemisphere lesions differed qualitatively from that of normals, as well as of aphasics. Two subgroups within the sample were distinguished: roughly one half of the sample behaved like the normal control while the other exhibited distinctive linguistic deficits.

696 CYTOARCHITECTURE OF ANTERIOR DORSAL VENTRICULAR RIDGE IN SNAKES. Philip S. Ulinski. Lab. Comparative Neurology, Depts. Anat. and Oral Biol., Loyola Univ., Maywood, Ill. 60153.

In reptiles thalamic relay nuclei receiving afferents from the auditory (Pritz, '74, J. Comp. Neur., 153: 179) and visual (Hall and Ebner, '70, J. Comp. Neur., 140: 101) components of midbrain tectum project to a subcortical nucleus, the anterior dorsal ventricular ridge (ADVR). The structure of ADVR was studied in snakes (Natrix and Constrictor) using Nissl, rapid Golgi, and Golgi-Cox preparations. ADVR protrudes into the lateral ventricle and is separated by a slight but distinct cell poor area from the underlying striatum. It comprises neurons with oval somas, 15 μ to 25 μ long and containing large nuclei and non-basophilic cytoplasm, which are scattered diffusely throughout ADVR. Clusters of two or three touching somas are common, particularly near the ventricular surface of AD VR. Somas lack spines or appendages but give rise to three to five dendrites radiating in all directions. These branch several times and often recurve, forming spherical dendritic fields approximately 300 μ in diameter. Most dendrites bear many pedunculated spines, but some lack spines entirely. Axons arise from either the soma or a proximal dendrite, ramify within ADVR, and sometimes originate a branch running ventrally towards the striatum. The axons bear large varicosities, 5 μ long, at irregular inervals. Thin afferents ascend rectilinearly from the lateral forebrain bundle bearing small varicosities, about 2 μ long, and crossing the spherical dendritic fields of many ADVR neurons. The internal organization of snake ADVR, thus, contrasts sharply with that of the laminated cortical areas which receive efferents from thalamic sensory nuclei in both reptiles and mammals. (Supported by PHS Grant NS 10137)

697 SIZE CONSTANCY DISCRIMINATION IN BRAIN-LESIONED MONKEYS: EVIDENCE FOR CRITICAL EFFERENT PATHWAYS OF INFEROTEMPORAL CORTEX. Leslie G. Ungerleider. Dept. Psychol., Stanford University, Stanford, CA. 94305

Size constancy is the ability to judge an object's size despite changes in its distance from the viewer and hence changes in its retinal image size. Monkeys with inferotemporal (IT) cortex lesions are severely impaired on size constancy problems, and alternate between response strategies based on retinal image and distance hypotheses (Humphrey & Weiskrantz Q.J.exp.Psychol. 21:225, 1969) -- it is as if they cannot integrate form and space information. This is consistent with the theory that IT integrates inputs from two visual systems: a geniculo-striate-prestriate pathway for form and a collicular-pulvinar pathway for space. To further test this theory, the present study compared size constancy deficits in IT-lesioned monkeys to those with pulvinar and prestriate cortex lesions. Rhesus monkeys were preoperatively trained to pull-in with strings one of two trolleys viewed down an alley. Stimulus cards of varying size were mounted on the front of each trolley, and the task was to pull-in the larger of the two stimuli. The stimuli were presented at both equal and unequal distances down the alley, so that the larger stimulus sometimes produced a smaller retinal image size. Monkeys receiving IT lesions (n=4) showed severe postoperative deficits, with a tendency toward retinal image or distance response strategies. By contrast, monkeys given pulvinar lesions (n=4) showed no postoperative loss at all. The latter were then given additional prestriate lesions, thereby eliminating all remaining visual input to IT. When retested, they readily relearned the size constancy problem. These results provide evidence against an afferent integration theory of IT, and indicate that the anatomic pathway critical for the IT deficit must be efferent. (Supported by NIH Special Research Fellowship 5 F03 EY55619-02.)

698 MODULATING INFLUENCES OF HORMONES ON TIME-DEPENDENT MEMORY-STORAGE PROCESSES. Roderick B. Van Buskirk* and Paul E. Gold. Dept. of Psychobiology, U. of California, Irvine, California, 92664.

Many treatments, such as centrally acting drugs and electrical stimulation of the brain, can facilitate retention of newly learned responses, if the treatments are administered shortly after training. In the present series of experiments, we examined the effects of posttrial hormone injections on retention in rats. In these studies, animals were trained on a one-trial inhibitory (passive) avoidance task with a weak footshock. Immediate, but not delayed, posttrial injections (subcutaneous) of epinephrine, norepinephrine, or ACTH facilitated retention performance of the avoidance response as measured 24 hours later. These results indicate that the effects of these treatments are time-dependent. Furthermore, the results suggest that nonspecific consequences of a training experience (e.g., hormonal release) may normally modulate memory storage processes in untreated animals.

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699 UNMYELINATED FIBERS IN FROG VENTRAL ROOTS. W.H. Vance*, R.E. Coggeshall, and W.D. Willis. Marine Biomedical Institute, Univ. Texas Med. Branch, Galveston, Texas 77550

Unmyelinated fibers are found in the ventral roots of the frog. There are 10 segments of the frog spinal cord. The percentage of unmyelinated fibers (calculated from the ratio of unmyelinated fibers to total fibers) in ventral roots from 2 frogs is summarized below:

	Frog 1	Frog 2		Frog 1	Frog 2
Segment 1	1%	8%	Segment 6	42%	59%
2	11%	6%	7	54%	63%
3	--	30%	8	4%	5%
4	51%	59%	9	17%	13%
5	43%	67%	10	84%	86%

Note that there are a large number of unmyelinated fibers in all roots except 1, 2 and 8. If all ventral root axons from these 2 frogs are considered, 26% are unmyelinated. Ventral rhizotomy, dorsal rhizotomy, dorsal root ganglionectomy, and peripheral nerve section are being done to determine the location of the cell bodies that give rise to the unmyelinated fibers in the 7th ventral root.

Physiological recordings from these ventral roots reveal a "C" fiber volley in segments 6, 7 and 9 but not in 8, as Erlanger and Gasser found in 1929. The "C" fiber volley in ventral root 7 could be traced into caudal but not cranial segments of the sympathetic chain.
(Supported by NIH grants NS 11255, NS 10161, Training Grant NS 05743 and the Moody Foundation of Galveston.)

700 THE USE OF BIO-FEEDBACK IN THE TREATMENT OF VAGINISMUS. John G. Varni. Dept. of Exp. Psychophysiol., WRAIR, Washington, DC, 20012

Vaginismus is defined as painful spasm of the vagina due to local hyperesthesia. It may be classified as superficial or deep depending on the locality of the problem at either the entrance of the vagina or the bulbocavernosus and levator ani muscles. The case study to be reported involved a 34 year old patient who had a previously unsuccessful operation severing the levator ani muscle complex. At the time of treatment she reported the persistence of vaginismus preventing her from having normal sexual intercourse. In fact the mere insertion of the smallest size tampon caused her extreme pain. Treatment consisted of thirteen experimental sessions. During these sessions a transducer placed in the vagina converted contractions into electrical analogue outputs. The electrical outputs were then utilized to illuminate an oscilloscope (controlling the vertical tracing position) and to provide an auditory signal which increased in intensity as a function of the pressure placed on the transducer in the vaginal cavity of the patient. Over the course of treatment the subject reported less feelings of anxiety concerning the thought of future sexual intercourse and a greater ability to control her vaginal contractions. These findings were confirmed by the polygraphic tracings obtained. At the end of the treatment sessions the patient reported successful sexual intercourse in her normal social environment. Bio-feedback may be a useful tool with which to treat vaginismus.

701 NEUROTRANSMITTER RECEPTORS IN CNS AXONS: A NON-SYNAPTIC TARGET FOR NEUROTROPIC DRUGS. A. J. Vazquez and H. C. Sabelli, Department of Pharmacology The Chicago Medical School, Chicago, Illinois 60612

Neurotropic drugs are assumed to act only on synapses because the axonal membrane is not chemically excitable (Grundfest, 1957). However, specific receptors for acetylcholine (ACh), catecholamines, serotonin, and histamine are present in peripheral axons (Sabelli and Gorosito, Int. J. Neuropharmacol., 1969). We have now obtained evidence for the presence of neurotransmitter receptors in CNS axons of non-anesthetized, gallamine-paralyzed rabbits. A 5-barrel micropipette system was placed on the corpus callosum either stereotaxically or under visual inspection (after removing the cortex). An extracellular 3M KCl pipette was used for monitoring the rate of firing of corpus callosum fibers; 3 other barrels were used for microiontophoretic administration of drugs (pH 5 to 8; 0.5 M; 10 to 20 nA); a saline barrel was used as output for an automatic current balancing system and also to test for current artifacts. ACh and glutamic acid showed mainly excitatory effects whereas catecholamines usually had no effects or reduced the rate of firing. Different units showed a different pattern of response to the various drugs tested. Although the number of units studied is small at this time, these observations open to question the assumption that microiontophoretically administered drugs act only at synapses. These results, together with the differential effects of drugs on sensory and motor peripheral axons (Sabelli et al., this meeting) suggest to us that specific neurotransmitter receptors located in extrasynaptic areas ("potential receptors", Sabelli, Rec. Adv. Biol. Psychiat., 1964) may also serve as a target for exogenously administered drugs, and possibly for endogenous neuromodulators capable of diffusing from their site of release (e.g., 2-phenylethylamine).
(Supported by NIMH grant #MH-14110.)

702 EFFECTS OF SPINAL, MESENCEPHALIC AND DIENCEPHALIC LESIONS ON METRAZOL INDUCED MULTIPLE UNIT DISCHARGES. Francisco Velasco, Marcos Velasco and Jesús P. Machado*. Sci. Res. Dept., Natl. Med. Ctr., México, D. F. (73-032).

In intact cats, a quantitative analysis of metrazol induced multiple unit discharges (MUD) in various central and peripheral neural structures showed the following sequence: 1.-Activation of non-specific structures (prefrontal cortex, intralaminar thalamic nuclei and mesencephalic and pontine reticular formations), that anticipates, 2.-Activation of specific structures (visual and somesthesic cortices, VPL and GL thalamic nuclei and cranial nerve nuclei) and 3.-Activation of peripheral nerve (Velasco and Velasco 1973). In the present study the effect of lesions at various levels on the activation of non-specific structures was investigated to determine if primary activation of these structures was produced by a peculiar sensitivity to metrazol or to a neuronal interaction between them or both. 1.-Brain stem transections at the level of the medulla completely abolished MUD in sciatic nerve, while no significant changes were observed in the sequence of events among non-specific structures above the transection. 2.-Transections at the intercollicular level delayed the activation of MUD in the intralaminar thalamic nuclei and prefrontal cortex, while MUD at the pontine reticular formation and sciatic nerve appeared earlier and lasted longer than for intact animals. 3.-Lesions in the inferior thalamic peduncle produced similar effect to that produced by intercollicular transections. The results suggest that metrazol has a primary activating effect on the brain stem reticular formation that propagates thereafter to spinal and cortico thalamic structures.

703 SECRETION OF A POSSIBLE RETICULAR NEUROTRANSMITTER DURING ELECTROCORTICAL AROUSAL. Marcos Velasco, Francisco Velasco, Xavier Lozoya and Francisco Estrada-Villanueva*. Sci. Res. Dept., Natl. Med. Ctr. México, D. F. (73-032).

In order to test the possible secretion of a reticular neurotransmitter liberated during electrocortical arousal, crossed-perfusions of homologous brain stem structures were performed in fifty couples of "encephale isole" cats. In each animal, perfusates were obtained by passing into the brain tissue 1 ml. of glucose C-14 labeled artificial cerebro spinal fluid at a rate of 5 µl/min. by means of a Gaddum push-pull cannula. Electrocortical arousal induced by perfusates was quantitatively determined by reduction in alpha and delta EEG waves concentration and by amplitude reduction in cortical recruiting responses. Location and extension of brain stem perfusions were determined by the radioactivity distribution in tissue samples obtained close to the site of the cannula tip.

1- A significant EEG arousal response of the recipient cat was found immediately after intra-reticular injection of a perfusate extracted from an homologous area of a donnor cat aroused by sensory stimulation. 2- A similar, although less pronounced response of the recipient cat was found when perfusate was extracted from a donnor cat showing EEG signs of sleep. 3- Optimal arousal effects were found when cannula tips and maximal radioactivity were found located close to the substantia negra of the donnor animal and to the periaqueductal gray matter of the recipient one. 4- Negative effects were found in animals with crossed-perfusions of the superior colliculi, lateral geniculate bodies and cerebral peduncles.

704 DEFICITS IN TACTILE DIRECTION SENSITIVITY AFTER DORSAL COLUMN LESIONS IN MONKEYS. Charles J. Vierck, Jr. Dept. of Neuroscience and Center for Neurobiological Sciences, Univ. of Fla. Col. of Med., Gainesville, Fla. 32601

Macaca speciosa monkeys were trained to discriminate sequential, punctate stimulation of the lateral calf of either leg in proximal-distal vs. distal-proximal orders. Food reinforcement was delivered if the monkey responded to a manipulandum on the right, following contact of a distal standard point and then a proximal comparison point. Responses to the left were rewarded only after sequential stimulation of the comparison and then the standard points. Skin contacts of 1 sec were separated by 1 sec on each trial. The distance between comparison and standard points was varied in 5 mm steps between blocks of 50 trials so that threshold of 75% correct responses was tracked.

After preoperative thresholds of 6.5 to 9.5 mm were obtained, dorsal column lesions elevated ipsilateral thresholds fourfold or more, and these deficits persisted over months of testing. Isolated lesions of one lateral column did not produce threshold elevations ipsilaterally or contralaterally. (Supported by NIH grant NS 07261).

705 PERSEVERATIVE INSTRUMENTAL BEHAVIOR IN CAUDATECTOMIZED CATS. Jaime R. Villablanca, Charles E. Olmstead, and Robert J. Marcus*. Dept. of Psychiatry, Mental Retardation Ctr., NPI, UCLA, Los Angeles, CA 90024.

The behavior of cats was evaluated on 4 instrumental tasks following unilateral or bilateral removal of the caudate nuclei. The caudate ablation was accomplished by aspiration, using a midline approach. Histological inspection revealed an average of 90% of caudate removal with minimal or no damage to adjacent structures. In an operant, two-bar lever pressing situation, the animals were trained on a bar reversal task and on a self-paced single alternation task. Both the unilateral acaudate (UA) and sham-operated animals readily learned both tasks, while the bilateral acaudate (BA) animals did not learn the reversal-alternation aspects of either. The nature of the deficit was a persistence in the response producing the last reinforcement. The UAs could be differentiated from the shams on the basis of the former showing an asymmetry in rate of pressing between the 2 paws, the paw contralateral to the lesion being the slower. In a T-maze, the animals were trained on a position reversal task and to make a black-white discrimination. Again, the UA, the sham, and the intact cats readily learned the task. All the BAs, however, firmly locked on the position habit concomitant with the first reinforcement. In one animal, as many as 61 trials were required before he would make the first reversal. These results indicate that radical caudate removal does not interfere with the basic processes involved in learning and retention of simple behavioral tasks as previously proposed (Thompson & Mettler, 1963). The findings are instead interpreted in line with our previous observations (Villablanca & Marcus, 1973) in which the rigidity of the animals' behavior, as evidenced by compulsive following of objects and persons, implicate the caudate as important in the inhibition of certain aspects of behavior. (Supported by USPHS Grants HD-05958, MH-07097, & HD-04612.)

706 EEG CORRELATES OF BARBITURATE ADDICTION IN MONKEYS. Predrag Vrtunski and Lee R. Wolin*. Ohio MH & MR Research Center, Cleveland, Ohio 44109.

Seven adult rhesus monkeys were each implanted with a silicone rubber cannula in an internal jugular vein. In addition, six epidural cortical and two hippocampal, bilaterally placed EEG electrodes were implanted. The behavioral training was clock controlled, i.e., during second 15 min of each hour (24 hr/day), a light signal indicated availability of the sodium pentobarbital (10 mg/ml) solution to the animal. Two animals were trained to self-administer the drug with the bar-press and three animals were placed on an automatic injection schedule. The remaining two animals served as controls. EEG recording was made prior to drug training, every 4-5 days during the training, and following withdrawal of the drug. The unit of EEG analysis was one hour session where, in addition to the paper record, the F4-O2 channel equivalent was fed directly into the PDP-12 computer. An 18-sec sample was taken each minute of the session, power spectra were calculated and averages for separate frequency bands were plotted. Analysis of data indicated the principal change in EEG due to barbiturate was a large increment of relative power in delta-theta range with a response latency of 5 to 8 min. With prolonged training, the response latency decreased to virtual zero, and was eventually replaced by an anticipatory response coincident with light signal onset and similar in power-frequency characteristics to the barbiturate response. Establishment of an anticipatory response was evidenced by its resistance to extinction throughout the withdrawal phase. There were also numerous observations of power increase in high frequency bands (15-25 Hz) with latencies of 15 to 25 min. These homologues of REM sleep, however, were not as systematically recorded as literature would suggest. The above results are discussed in terms of EEG pattern development and its significance in drug addiction research.

707 OCTOPAMINE-CONTAINING NEURONS IN THE LOBSTER NERVOUS SYSTEM. Bruce G. Wallace*, Barbara R. Talamo*, Peter D. Evans, *and Edward A. Kravitz.
Dept. of Neurobiology, Harvard Med. Sch., Boston, Mass. 02115

Octopamine and dopamine are the principal amines formed from tyrosine in the lobster nervous system. Norepinephrine is not detected. Two possible explanations could account for octopamine formation without the synthesis of norepinephrine in lobsters. (1) The lobster enzyme catalyzing octopamine synthesis from tyramine (tyramine-β-hydroxylase, TBH) might not convert dopamine to norepinephrine; (2) Octopamine and dopamine could be selectively accumulated in two different types of cells; octopamine cells lacking tyrosine hydroxylase, dopamine cells missing TBH. The second explanation is apparently the correct one. The properties of lobster TBH were studied and the enzyme was found to be similar to mammalian dopamine-β-hydroxylase; soluble and bound forms of the enzyme are present, oxygen and reduced ascorbate are required for activity, metal chelators are inhibitory and both tyramine and dopamine are substrates. A sensitive and rapid radiochemical microassay for TBH was developed to search for octopamine cells in the lobster nervous system. A small cluster of cells high in TBH activity was found within the connective tissue sheath of certain ganglionic roots leaving the thoracic region of the ventral nerve cord. In addition to TBH activity, high levels of endogenous octopamine and the synthesis and accumulation of radioactive octopamine from radioactive tyrosine and tyramine are associated with the cell region. No dopamine synthesis is seen in this region. Histological and electrophysiological studies indicate that the cells are neurons. Each cell has at least one long axonal process that in most cases projects towards peripheral tissues and in a few cases towards the central ganglia. The function of the cells and octopamine is still unknown. (Supported by USPHS Grants # NS-07848, NS-02253).

708 ORIGINS OF PERIODIC FIRING OF SOMATOSENSORY THALAMIC NEURONS. Hardress J. Waller and Lee T. Andrews*. Depts. of Neurosciences and Physiology, Medical College of Ohio, Toledo, Ohio 43614.

Some neurons with cutaneous receptive fields in feline nucleus ventralis posterior (VP) show stable, highly regular resting discharge. Experiments were designed to identify the site of generation of the periodic component. (1) Electrical stimulation: Effects of stimuli (50 μsec, 1 to 4.5 sec interstimulus intervals) at different levels of the somatosensory system were compared with respect to the timing of subsequent discharges. Retiming of the discharge train is revealed by periodic modulation of the pre/post-spike histogram (PPSH). Stimulation of somatosensory cortical area I (evoking antidromic responses of the VP Neuron) and of lateral midbrain lemniscal tracts (evoking early orthodromic responses) never produced clear synchronization of the period (one series of cortical stimuli yielded an equivocal PPSH). In contrast, approximately one-half of the neurons tested by stimulation of the dorsal columns near C1 or near the caudal boundary of the cuneate nucleus showed substantial retiming of the period. All neurons with a prominent rhythm also showed synchronization by suprathreshold stimulation of either skin receptive fields or of the median nerve. (2) Effects of barbiturate: Thiopental or pentobarbital was injected iv. in repeated small amounts while recording activity of a periodically firing neuron. The mean firing rate decreased following injection (initially by a reduced incidence of aperiodic spikes, then by intermittent failure of the periodic component), but there was no significant change in the length of the period. These preliminary data suggest that the periodic component is generated peripherally rather than centrally, presumably by a single primary afferent neuron. (aided by USPHS grant NS-12030).

709 MECHANISM OF ACTION ON THE HYPOTHALAMUS OF AN ANTIPYRETIC DRUG DURING THE HYPERTHERMIA EVOKED BY AN ENDOTOXIN, A PROSTAGLANDIN, 5-HT OR 5,6-DHT. M. B. Waller* and R. D. Myers. Laboratory of Neuropsychology, Purdue University, Lafayette, Indiana, 47907

It has been proposed by Vane (1971) that an antipyretic exerts its action on a fever of bacterial origin through the blockade of the enzyme system responsible for the synthesis of a prostaglandin. The present experiments suggest that this proposal is greatly oversimplified. An array of stainless-steel guide cannulae was implanted stereotaxically above the hypothalamus in the male rhesus or pigtail macaque, which had been trained previously to sit in a primate chair. A micro-injection of an endotoxin, PGE_1, 5-HT, or 5,6-DHT then was given at sensitive sites in the hypothalamus to evoke a transient increase in body temperature. A fever caused by each of these thermogenic substances could be attenuated in a dose-dependent fashion by acetaminophen administered orally. Norepinephrine injected at the same site as PGE_1 was a more potent antagonist of the prostaglandin fever than the antipyretic. Moreover, the aberrant rate of efflux of ^{45}Ca and ^{22}Na from the hypothalamus that occurs during an endotoxin fever is reversed by oral acetaminophen (Myers, 1973). Thus, the physiological mechanism of an antipyretic drug at the level of the diencephalon could be to: (1) decrease the regional synthesis of prostaglandin; (2) increase the release of norepinephrine pre-synaptically; (3) interfere with the 5-HT, cholinergic heat-production pathway; (4) inhibit the pre-synaptic release of 5-HT; (5) re-instate the normal hypothalamic balance in the extracellular ratio of sodium to calcium; or (6) more than one of these alternatives.

710 COMPENSATORY HYPERTROPHY STUDIED IN INDIVIDUAL MOTOR UNITS. J. V. Walsh, R. E. Burke, W. Z. Rymer and P. Tsairis*. Lab of Neural Control, NINDS, NIH, Bethesda, Md. and Dept. of Neurology, Cornell Univ. Med. Coll., N.Y.

Compensatory hypertrophy was produced in the medial gastrocnemius (MG) of cats by excision of all synergist ankle extensors, either unilaterally or bilaterally. Following surgery the cats were kept in a large enclosure with space for walking and jumping. After the first 1 - 2 weeks a mild weakness of ankle extension was the only persistent deficit. Motor unit properties were assessed after 3 to 7 months, using intracellular recording and stimulation to examine the amplitude of composite Ia EPSPs and the mechanical responses of individual muscle units (see Burke et al., J. Physiol. 234, 723; 1973). The properties of 62 motor units, pooled from 3 comparable animals, were matched against data from over 200 similarly studied units from normal cats. The composition of the MG motor unit pool was unchanged (FF = 48%; Unclassified = 6%; FR = 23%; S = 23%) in comparison with normal animals (FF = 46%; Uncl. = 6%;FR = 22%;S = 26%). The histochemical mosaic of the MG muscle also appeared to be unchanged. There was, however, a dramatic increase in mean tetanic tension in all unit classes as compared with the normal sample (FF +149%; Uncl. + 257%; FR + 240%; S + 213%) whereas mean twitch contraction times were either unchanged or only slightly decreased. No changes were evident in mean EPSP sizes or in muscle unit fatigue resistance. In 2 other animals, postoperative scar formation limited ankle extension and provided passive support for the limb. In these, 36 motor units showed no change in mean tetanic tension compared to the normal sample. Under the present conditions, compensatory hypertrophy can result in increased tension output in all classes of motor units with minimal alteration of other unit properties and with no change in the unit type composition of the MG motor unit pool.

711 EFFECTS OF ZONA INCERTA LESIONS AND KNIFE CUTS ON WATER INTAKE FOLLOWING CELLULAR AND EXTRACELLULAR DEHYDRATION. Linda L. Walsh* and Sebastian P. Grossman. Dept. Behav. Sci. Univ. Chicago, Chicago, Ill. 60637

Bilateral lesions in the anterior aspects of the zona incerta (ZI) of male rats produced only a small although consistent decrease in water intake when the rats had ad libitum access to dry laboratory chow. When food was not available, water intake fell promptly to zero , suggesting that drinking occurred not in response to physiological signals which regulate water intake in the intact rat but only as a means of facilitating the ingestion of dry food. Rats with ZI lesions drank normally when extracellular hypovolemia was produced by subcutaneous injections of hyperoncotic polyethylene glycol (PG) but displayed a markedly attenuated response to cellular dehydration induced by intraperitoneal injections of hypertonic saline. The preoptic area was not damaged by the ZI lesions. Horizontal knife cuts dorsal and ventral to the anterior ZI as well as cuts in the coronal plane which transected the anterior connections of the ZI were made to determine the pathways which may be responsible for the observed effects of ZI lesions.Drinking in response to PG or saline challenge and water intake during ad libitum or restricted access to food were differentially affected by various knife cuts. The effects of cellular dehydration in the region of the ZI due to local microinjections of hypertonic saline on water intake were also investigated.

712 Energy Metabolism and Nerve Function in Cockroaches (Periplaneta americana) During Hypoxia. Donnal C. Walter* and Stanley R. Nelson, Dept. Pharmacology and Surgery, Univ. Kansas Med. Sch., Kansas City, Kansas 66103.

Cockroaches survive several hours in nitrogen compared with one-half minute for mice. This resistance to anoxia was studied by placing cockroaches in a series of hypoxic atmospheres with oxygen concentrations ranging from zero to five per cent. Either spontaneous electrical activity of the nerve cord or observations of locomotor events during induction of hypoxic coma were recorded on tape. Cockroaches were also frozen in liquid nitrogen at various intervals of hypoxia, and the lyophylized nerve cords were analyzed for ATP and other substrates. At oxygen levels less than two per cent cockroaches passed through a definite series of locomotor events and/or failures, and these events could be correlated with spontaneous electrical activity. During anoxia ATP disappeared rapidly from ganglia (28 mM/Kg protein to 2.6 mM/Kg protein in 15 min.) while glycogen disappeared more slowly (128 mM/Kg protein to 57 mM/Kg protein in 15 min.). During hypoxia at 0.6% oxygen the behavioral and biochemical changes were not different from those of anoxia. However, at a level of 1.1% oxygen the locomotor events occurred after longer intervals and the biochemical changes were slower or less pronounced. At 2.2% oxygen the only abnormal events observed were hyperventilation and some loss of coordination, and ATP was not depleted. Although the behavioral events were not rigidly correlated with the energy levels in the nerve cord, we conclude that the oxygen concentration from one to two per cent is critical for both metabolism and nerve function in cockroaches. (Supported by NIH Grant NS 11353).

713 BASAL FOREBRAIN UNIT ACTIVITY DURING SLEEP AND WAKING IN BEHAVING CATS. Rex Y. Wang and Jerome Siegel. Dept. Psychol., Univ. of Delaware, Newark, DE 19711.

Bundles of fixed wire microelectrodes (62.5μ dia.) were stereotaxically implanted in the basal forebrain region (BFB) of 5 cats for extracellular recordings. EOG, EMG and EEG were recorded to distinguish four behavioral states: awake (W); light slow-wave sleep (LS); deep slow-wave sleep (DS) and paradoxical sleep (PS).

Fifty-four units were recorded in W, LS, DS and PS. For each cell, interval histograms and mean firing rates were determined. The action potentials recorded from most cells (44/54) were negative-positive diphasic with durations ranging from 0.9-1.6 msec. This suggests that most action potentials were recorded from cell bodies located within the BFB rather than from neural projections to this area.

A majority of cells (33/54) discharged at very low rates (<1 spike/sec) during W. In general, cell firing during slow-wave sleep (SS) and PS was characterized by short bursts of spike activity. However, no bursting or increase in discharge rate was seen in association with the phasic activity of PS. The overall firing rate was higher during SS than in W, and was highest in PS. Median rates, in spikes/sec, were: W, 0.75; LS, 0.89; DS, 1.33; and PS, 1.55 ($p < 0.001$, Friedman Two-way analysis of variance).

The result that cells are least active during W and most active during the sleep stages is consistent with studies which show that the BFB region under electrical stimulation produces EEG synchronization and behavioral sleep. Our data also suggest that there is a reciprocal relationship between the BFB and dorsal raphe nucleus, since McGinty has shown that dorsal raphe cells are most active during W and least active during sleep. (Supported by NSF Grant GB-36657.)

714 MULTIPLE RETENTION DEFICITS IN APPETITIVE LEARNING. Richard A. Wansley* and Frank A. Holloway. Dept. Psychiat. and Beh. Sci. Univ. Okla. Health Sci. Ctr. Oklahoma City, Oklahoma 73190.

An irregular shaped alley was used in an appetitive task to assess the generality of the multiple retention deficit (Holloway and Wansley, 1973). Sixty water deprived rats were given one-trial training to traverse the length of the alley to receive reinforcement. Then, following one of six training-testing intervals (TTI) (10 Ss/group), Ss received a second trial (test). In order to control for the motivational influence of varying hours of deprivation, all animals received 10 min free access to water at 1 hr prior to training and testing. Therefore, despite the TTI, the time since last water ingestion for all Ss at each session was equivalent. The measure of performance was latency from start box to the first lick in the goal box. The results indicated that the multiple retention deficit as previously reported only in avoidance tasks was evident (i.e., retention was significantly poorer at 6 hr, 18 hr, and 30 hr, than at 12 hr, 24 hr, and 36 hr following training). An additional control experiment (sixty rats) was performed to determine whether the fluctuation of retention was related to habituation of task novelty or activity change (as expressed by running time in the absence of reinforcement). In this experiment, all factors were the same as in the first, except that water reinforcement was received in a different apparatus 5 min following entry to the experimental goal box. The findings on the test trial indicated an increased latency at all TTI of approximately the same magnitude, bearing no resemblance to the multiple retention performance in the first experiment. The results indicate 1) evidence for the generality of the multiple retention deficit, and 2) suggest that search for the neural mechanism of this behavior should not be limited to those factors previously associated with avoidance learning, or shock induced stress.

715 INTERMODAL TRANSFER IN THE PROSIMIAN BUSHBABY (GALAGO SENEGALENSIS) WITH LESIONS OF POSTERIOR NEOCORTEX. Jeannette P. Ward and Joy Frank*. Dept. of Psychol., Memphis State Univ., Memphis, Tenn., 38152.

Until recently, methodological difficulties in the demonstration of across modality transfer effects with intact animals have precluded study of the role of intersensory neocortex in the association of sense data between modalities. Ward, Yehle, and Doerflein (Journal of Comparative and Physiological Psychology, 1970, 73, 74-77) were able to demonstrate the transfer of a specific discrimination of rate from vision to audition and the converse. The same stimuli and testing procedures were used in the study here reported. Eight bushbabies were trained to discriminate light flashes of 18/sec and 3/sec in a go, no-go two way shock avoidance task. On completion of visual training, four bushbabies underwent removal of neocortex by aspiration. Two received moderate bilateral lesions of the medial temporal area; two others, more extensive lesions which included parietal, lateral occipital, and the posterior 2/3's of temporal neocortex. After six weeks, both operated and intact animals were returned to training in the original test. On the day following criterion performance on the visual discrimination, auditory clicks of the same rate and contingencies were substituted and maintained to criterion. For all test conditions 20 trials per day were given and criterion performance was five consecutive sessions at 90% correct or better. All eight animals demonstrated rapid transfer and operated animals were not retarded as compared to intact subjects. Thus, transfer of a specific discrimination of rate was observed from vision to audition in the absence of posterior intersensory neocortex.

716 PROJECTIONS OF DORSAL CORTEX IN THE SIDE NECKED TURTLE(PODOCNEMIS UNIFILIS) Carolyn B. Ware. Dept. of Anat., Downstate Med. Ctr., Brooklyn, N.Y. 11203.

The forebrain of the side necked turtle, Podocnemis unifilis, is characterized by expansion of the dorsal cortex which contains several cytoarchitecturally distinct cell groups. This degree of differentiation presents a striking contrast to the thin, relatively homogeneous, dorsal cortical region of other turtles and other reptiles in general. In these turtles, lesions were made in either dorsal cortex or lateral cortex. A few animals received ablations which included the dorsal portion of the dorsal ventricular ridge. Animals were sacrificed after eight to twenty days by perfusion with formol-saline under deep anesthesia. The brains were fixed in formalin, frozen, cut in 25 mu sections, and every fourth section was prepared by the Fink-Heimer method for degenerating axons. Alternate sections were stained with cresyl violet for cell structure. Lesions which involved only dorsal cortex produced degeneration which traveled in both medial and lateral forebrain bundles. Fibers travelling in the lateral forebrain bundle extended into the mesencephalon but could not be followed caudally past the mesencephalic tegmentum. In the diencephalon, preterminal degeneration was observed in the dorsal and lateral geniculate bodies, the nucleus rotundus, and nucleus reuniens. The habenular nucleus and nucleus dorsalis medialis anterior were free of silver deposits. Following lesions which invaded the dorsal ventricular ridge the same distribution of degeneration was seen in the thalamic nuclei, but the density of the silver deposits was increased. In addition, fibers passed to the opposite hemisphere through the anterior commissure.after these deeper lesions. The similarities between patterns of degeneration apparent after lesions confined to the dorsal cortex and deeper lesions which invade the dorsal ventricular ridge suggest that the functions of these different regions may be related.

717 DISTRIBUTION OF [^{3}H]COLCHICINE IN NERVES AND MUSCLES OF RATS. J.E. Warnick, E.X. Albuquerque and F.C. Kauffman. Dept. Cell Biol. & Pharmacol., Univ. Maryland, Sch. of Med., Baltimore, Md. 21201

Extensor digitorum longus (extensor) and soleus muscles of rats whose nerves are exposed to cuffs containing 120 µg of [^{3}H]-labeled or native colchicine (COL) develop signs of denervation, i.e. early 10-12 mV membrane depolarization, high levels of extrajunctional acetylcholine sensitivity, and tetrodotoxin-resistant action potentials. Some of these effects may be produced by an action of COL on the muscle membrane. Thus, we determined the distribution of [^{3}H]COL in rats (170-250 g) (i) having one sciatic nerve with a cuff containing [^{3}H]COL and (ii) having intraperitoneal (I.P.) injections of the drug. 5 days after the cuff was applied, 39% of the [^{3}H]COL had diffused from the cuff and was widely distributed in various tissues and organs. The ipsilateral (cuffed) extensor and soleus muscles contained 5.18 ± 1.28 (S.E.) and 7.94 ± 1.34 p mol/mg wet tissue of [^{3}H]COL, respectively. Although the contralateral muscles contained 31 and 57% of those amounts, we never observed any signs of denervation. After I.P. injection, the levels of [^{3}H]COL in the extensor and soleus muscles after 5 days were 16 and 32% greater than in the ipsilateral muscles of cuffed rats, respectively. However, even after 10 days, when the level of the drug in the muscles was much higher, none of the signs of denervation were observed. On day 5, the concentration of [^{3}H]COL in the nerve enclosed in the cuff was 3.67 ± 1.14 p mol/mg wet tissue, a value 6-fold greater than after I.P. injection of the same total dose of [^{3}H]COL. Higher but toxic systemic doses of [^{3}H]COL gave a level of drug in the nerve equal to that with the cuff and directly produced well defined signs of denervation in the muscles. It is concluded that the denervation-like phenomena observed in skeletal muscles after chronic application of [^{3}H]-COL to the nerve result from a direct action of the drug on the axon and not on the muscle. (Supported by USPHS Grants NS-08233 and GM-08157.)

718 **A NETWORK MODEL OF THE PYLORIC RHYTHM IN THE LOBSTER STOMATOGASTRIC GANGLION.** **Howard S. Warshaw* and Daniel K. Hartline. Dept. Biology, UCSD, La Jolla, Ca. 92037.**

A quantitative physiologically-oriented network model has been used to study the pyloric system of the lobster stomatogastric ganglion. The 14 neurons governing the pyloric rhythm can be functionally treated as a set of 3 units, which fire in sequential bursts of fixed phase relationship. One of these units is thought to be an endogenous burster. A three-phase cycle with the same burst sequence can be produced by the model over a range of model parameters, even in the absence of an endogenous pacemaker oscillation. Model variables include connectivity among cells (both impulse-mediated and slow-electrotonic), PSP's of arbitrary shape (with allowance for facilitation properties and reversal potential effects), thresholds, membrane time-constants, certain active responses including endogenous oscillations, and adaptation. Parameter values used in the model were taken as closely as possible from intra- and extracellular data on the neurons of the pyloric system. The agreement found between experiment and model was compared to that found when alternative connectivity schemes were used in the model.

719 SUPRAGRANULAR LAMINAR LESIONS OF CAT STRIATE CORTEX: EFFECTS ON VISUAL RECEPTIVE FIELDS. D. W. Watkins*, Albert B. Butler*, S. M. Sherman, and J. A. Jane. Depts. of Physiology and Neurological Surgery, Univ. of Va. School of Medicine, Charlottesville, VA. 22901

The visual receptive fields of 34 neurons in the striate cortex of 4 cats were studied following chronic, heat-produced lesions of the supragranular laminae. Using standard criteria, receptive fields (RFs) were classified as simple, complex, or hypercomplex. Two abnormal RF types that could not be assigned to the standard classes were observed as follows: 1) spontaneously active and weakly responsive to visual stimuli but lacking orientation specificity, thus being not classifiable (NC); and 2) spontaneously active (usually more than 3/sec.) with no discernable responsiveness to visual stimuli (NR). To date we have recorded from 16 simple cells, 10 NC cells, 8 NR cells, and no complex or hypercomplex cells. Whereas hypercomplex cells in striate cortex are normally rare, this represents a significant loss of complex cells. Most NC and NR neurons were located in the superficial 1 mm of cortex, while most simple cells were deeper (0.8-2 mm). The properties of the simple cells seemed normal in terms of RF size, binocularity, and responses to moving slits. This finding of normal simple RFs in the absence of complex RFs suggests that the former do not depend on complex cell inputs.

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720 THE INFERIOR OLIVARY COMPLEX - A COMPARISON BETWEEN MARSUPIAL AND PLACENTAL MAMMALS. Charles R. R. Watson* and Paul Herron* (SPON: John Irwin Johnson,Jr.) Sch. Anat., Univ. N.S.W., Australia and Biophys., Psych. and Zool.Depts., Mich. State Univ., E. Lansing, Mich. 48824

The question of correspondence between the subnuclei of the inferior olivary complex (IOC) of marsupial and placental mammals was brought to our attention by the recent study of Bowman and King (J.Comp.Neur. 148: 491) on the IOC of Didelphis marsupialis. We therefore examined serial sections of the IOC of members of all 7 marsupial families (Didelphis marsupialis, Philander opossum, Caluromys sp., Lestoros inca, Antechinus flavipes, Dasyurus viverrinus, Isoodon obesulus, Perameles nasuta, Trichosurus vulpecula, Pseudocheirus peregrinus, Vombatus ursinus, Potorous tridactylus, and Megaleia rufa). We have concluded that the subnuclei of the marsupial IOC are directly comparable to IOC cell groups in well known placentals (cat, rat, and rhesus monkey). All the marsupials studied possess a dorsal accessory olive, medial accessory olive (with 3 major subdivisions), cap of Kooy, and principal olive (with dorsal and ventral laminae). The paradoxical feature of the marsupial IOC is the relationship between the principal and medial accessory nuclei: the so-called medial accessory nucleus is situated lateral to the principal nucleus in all marsupial brains examined. Nauta degeneration studies in Trichosurus show that both the pattern of termination of spinal fibers in the medial and dorsal accessory nuclei of the IOC, and the projection of the red nucleus on the principal olive conform to the arrangement reported in various placentals. Thus, available data indicate that the IOC subnuclei of marsupials correspond closely to those found in placental mammals. (Supported by NSF grants GB 13854 and GB 30783 and NIH grant GM 1819.)

721 EFFECT OF REM SLEEP DEPRIVATION (ON A TREADMILL) FOLLOWING SOCIALIZATION, ON ADULT REACTIVITY IN CBA MICE. Flora M.C. Watson,* James P. Henry,* and Gary C. Haltmeyer*(SPON: David F. Lindsley). University of Southern California, School of Medicine, Department of Physiology, Los Angeles, Calif. 90033

Early socialization has been shown to influence an animal's adult behavior patterns and to have a protective effect on adult ability to tolerate stressful situations. REM sleep is also necessary for processing and integrating the learned social experiences into the existing genetically-determined repertoire of social "aggressive-defensive" behavior. To determine if a short period of REM sleep deprivation on a rotating treadmill can inhibit socialization, CBA mice were divided into 5 groups for testing: isolation (I); isolation with 2½ hr of socialization in a complex population cage (I-Soc); isolation with socialization, followed by treadmill experience (I-Soc-TM); isolation-treadmill experience, followed by socialization (I-TM-Soc); and isolation with treadmill experience (I-TM). The results suggested that REM sleep deprivation after socialization inhibits this learning procedure. The I-Soc-TM animals behaved in a fashion similar to the I-group. Open field activity, corticoid response, blood pressure, and aggressive behavior in the population cage were the parameters used to evaluate the adult reactivity to novel and psychosocial stimuli. (Supported by NIH Grant MH19441-03.)

722 MORPHINE SELECTIVELY BLOCKS THE RAPID IPSPs IN CHOLINERGIC SYNAPSES OF APLYSIA. Rafiq Waziri, Dept. of Psychiatry, Univ. of Iowa College of Medicine, Iowa City, Iowa 52242

Neurons in the ganglia of Aplysia can be classified as H or D neurons on the basis of their responses to ACH (Physiol. Rev, 53:1, 1973). In the abdoninal ganglion of Aplysia there is an identified cholinergic neuron (L_{10}) which has synaptic input on H as well as on D neurons - producing IPSPs or EPSPs on these neurons respectively. Morphine, (1mg% in sea water) selectively and practically irreversibly blocks the rapid IPSPs generated by L_{10} on L_2, L_3, L_5, L_{12}, L_{13} but does not affect slow IPSPs or EPSPs on R_{16} and R_{15}. Previous studies have shown that the rapid IPSPs are due to increased Cl^- conductance, the slow IPSP due to the K^+ conductance and the EPSP are Na^+ dependent. At this low (1mg%) dosage, morphine does not change postsynaptic membrance potential or resistance, nor does it affect presynaptic membrane potential or action potential. Application of ACH to the neurons either by perfusion or ionophoresis in the presence of morphine causes a D response in the D neurons but the H response in H neurons is abolished. Thus, morphine acts opposite to Hexamethonium which selectively blocks the D response, but does not affect the H response.

723 WHOLE MOUNTS OF TADPOLE OPTIC NERVES EXAMINED BY DIFFERENTIAL INTERFERENCE MICROSCOPY: A SIMPLE METHOD FOR QUANTITATIVE MORPHOLOGICAL STUDIES OF CNS DEMYELINATION. Henry deF. Webster, Paul J. Reier, Marian W. Kies*, and Maureen F. O'Connell*. NIH, Bethesda, Maryland 20014.

For more than 10 years, investigators have used cerebellar tissue cultures to study cellular mechanisms of myelin breakdown in the central nervous system. This report describes another technique which we believe to be simple and readily adapted to quantitative measurements. Xenopus tadpoles are transparent and at stage 54, their optic nerves contain 200-500 myelinated axons. Under direct observation, 3-8 µl. of a control solution, of a tracer (albumin bound Evans Blue), or of a myelinotoxic agent (e.g. hexachlorophene) were injected around one optic nerve of a lightly anesthetized tadpole. Evans Blue diffused rapidly and surrounded the opposite optic nerve within one hour. After 24 hrs. and at intervals thereafter, groups of tadpoles were perfused with aldehyde fixative and immersed in it overnight. After tissue wedges were immersed for 2-3 hrs. in dilute glycerol, the optic nerves were dissected free, mounted on glass slides in glycerol, and examined with a differential interference contrast (Nomarski) microscope. This type of illumination allowed us to section the whole mounts optically. Large numbers of myelin sheaths in a CNS tract were surveyed individually over relatively long distances. Hexachlorophene lesions, consisting of vacuolated myelin sheaths and ovoid filled macrophages, were identified easily in both optic nerves, and could be counted. They also resembled those previously described in sections examined by light and electron microscopy. These preliminary results suggest that this simple technique may be a useful morphological tool for investigators interested in multiple sclerosis and other CNS demyelinating diseases. We are now testing the demyelinating activity of immune sera and sensitized cells.

724 HORMONAL REGULATION OF CEREBELLAR THYMIDINE KINASE ACTIVITY AND DNA BIOSYNTHESIS DURING EARLY DEVELOPMENT: CORTISOL AND THYROXINE Morton E. Weichsel, Jr., Dept. of Human Development, Col. of Human Med.,Mich. State Univ., East Lansing, Mi. 48824.

Morphological studies involving cerebellar development in the rat have shown the largest incorporation of labelled thymidine to occur during the phase of maximum cell replication in the external granular layer. Cerebella of rat pups given hydrocortisone in the early newborn period show a decreased uptake of labelled thymidine and a decreased total DNA at maturation. Cerebella of rat pups receiving thyroxine daily from birth have an increase of DNA by 6 days of life following which cell division decreases prematurely. Our studies of rat cerebellar development reveal that hydrocortisone administered in a single dose at birth causes significant suppression of cerebellar thymidine kinase activity from day 3 through day 6 of extrauterine life and suppresses DNA biosynthesis during that period. Conversely, daily thyroxine administration causes a significant increase above control values in cerebellar DNA in rat pups from day 2 through day 6, and an induction of thymidine kinase activity by day 1, lasting through day 5. These studies further elucidate the previously noted reciprocal effects of hydrocortisone and thyroxine on DNA production during early cerebellar development and reveal a reciprocal effect upon the activity of thymidine kinase as well. Although the relationship between the control of DNA synthesis and thymidine kinase activity may involve many factors, these findings support the hypothesis that thymidine kinase may be a critical regulatory enzyme in DNA biosynthesis in brain as well as other developing organs, and that the enzyme may be subject to regulation by hormonal stimuli. Thus the rat cerebellum appears to be an ideal model to study developmental relationships between hormones and enzymes involving nucleic acid biosynthesis.

725 INCREASED LEVELS OF CYCLIC GMP AND CYCLIC AMP ASSOCIATED WITH SYNAPTIC TRANSMISSION IN FROG SYMPATHETIC GANGLION. Forrest Weight, Gary Petzold* and Paul Greengard. Lab of Neuropharmacology, NIMH, Washington, D. C. 20032 and Dept. of Pharmacology, Yale Univ., New Haven, Conn. 06510.

The effect of synaptic transmission on the content of cyclic guanosine monophosphate (cyclic GMP) and cyclic adenosine monophosphate (cyclic AMP) was investigated in the 9th and 10th paravertebral sympathetic ganglia of the bullfrog, in vitro. Cyclic GMP content was determined by radioimmunoassay (Steiner et al., J. Biol. Chem. 247, 1106, 1972) and cyclic AMP content was analyzed by a protein binding method (Brown et al., Biochem. J., 121, 561, 1971). Preganglionic afferent fibers were stimulated in the sympathetic chain between the 8th and 9th ganglia with rectangular pulses of 20 volts and 1 msec duration. Stimulation at 10 Hz for 2 min resulted in a two-fold increase in cyclic GMP content and a seven-fold increase in cyclic AMP content. The cyclic GMP reached this maximal level within 30 sec of stimulation. A half-maximal increase in cyclic GMP occured between 6 and 15 sec of stimulation, whereas cyclic AMP appeared to increase throughout the 2 min of stimulation. When high magnesium (20 mM) - low calcium (0.4 mM) Ringer solution was used to prevent the release of synaptic transmitter, preganglionic stimulation for 2 min did not significantly increase the content of either cyclic GMP or cyclic AMP. The data indicate that the cyclic GMP and cyclic AMP content are increased by synaptic transmission in the frog sympathetic ganglion. A pharmacological analysis of the synaptic pathways involved in producing the increased levels of the cyclic nucleotides is in progress.

(Supported in part by USPHS Grants NS 08440 and MH 17387.)

726 HOMOLOGY OF GIANT CEREBRAL CELLS IN APLYSIA TO THE METACEREBRAL CELLS OF PULMONATE MOLLUSCS. K.R. Weiss* and I. Kupfermann. Dept. Psychiat., Columbia Univ., and N.Y. State Psychiatric Inst.; and PHRI, 455 1st Ave., N.Y., N.Y.

The cerebral ganglion of pulmonates and the opisthobranch mollusc Aplysia has an identified pair of giant cells (GCs) that contain serotonin. The cerebral giant cells in Helix have been extensively characterized by means of electrophysiological (Kandel and Tauc) as well as biochemical techniques (Cottrell, et al.). We have studied these cells in Aplysia to determine their possible homology to pulmonate cells. As in Helix, the GCs in Aplysia send axons to a lip nerve, the cerebral-buccal connective and nerves innervating the buccal mass. Stimulation of cerebral nerves evokes a dual excitatory-inhibitory synaptic potential in the GC. Microinjection of ACh onto the cell produces a depolarizing response, whereas glutamate produces a hyperpolarizing response. As in Helix, firing of Aplysia GCs has been shown to produce synaptic potentials in various cells in the buccal ganglion (Paupardin-Tritsch and Gerschenfeld). We have confirmed this finding and have observed both ipsilateral as well as weak contralateral connections. The electrophysiological properties of the Aplysia GCs resemble those previously described in Helix in that both cells show anomalous rectification and have similar spike heights, resting potentials and spontaneous spike activity. The use of multiple criteria has led us to the conclusion that the GCs in the opisthobranch mollusc Aplysia are true homologues of the metacerebral cells of pulmonate molluscs. Thus, identified cells can be used to study homologies between ganglionic structures and perhaps behaviors in different gastropod subclasses. Supported by Training Grant MH 10315-09 and NIH Grant NS 10757.

727 SIGNIFICANCE OF ALTERED CEREBRAL ARTERIOVENOUS BLOOD LEVELS OF CYCLIC AMP AFTER CEREBRAL INFARCTION IN MAN. K.M.A. Welch, John Stirling Meyer* and Anthony N. Chee*. Dept. of Neurol., Baylor Coll. Med., Houston, Texas 77025

There is little information on cyclic 3',5' adenosine monophosphate (cAMP) exchange across the blood brain barrier (BBB) in animals and man. In the present study no significant arteriovenous (A-V) difference for cAMP was measured across the brain and limb of normal baboons. Cerebral venous cAMP levels were significantly higher than arterial in human subjects with recent onset of cerebral hemispheric infarction. No significant A-V difference was noted across the limb. In the same subjects, cerebrospinal fluid cAMP levels were elevated compared to control series. Results suggest movement of cAMP into cerebral venous blood of human subjects with cerebral infarction may be due to (1) BBB damage and (2) extracellular cAMP release, perhaps secondary to abnormal neurotransmitter activity and/or impaired neuronal membrane function.

728 PERIPHERAL RECEPTIVE FIELDS OF BARRELS IN SmI OF THE RAT. Carol Welker. Research Dept., Central Wisconsin Colony, Madison, Wisconsin, 53704

Distinct aggregates of neurons, termed barrels, comprise a cytoarchitectonic field in the neocortical somatosensory (SmI) face area of the rat. These barrels provide a unique opportunity to study the interrelationships among morphology, physiology and behavior. Previous studies have shown that some of the largest barrels which are organized in five rows (A-E) are definitely related to the five main rows (A-E) of large vibrissae on the contralateral face, but the peripheral relationships of other barrels have been uncertain. In the present study I identified the exact peripheral receptive fields (prfs) of single units and unit-clusters in different sized barrels from all locations in the barrel field. All of the barrels in the rat are restricted to SmI. Several long sinus hairs above the eye project to the large barrels located outside of rows A-E but adjacent to barrel A. Barrels which are lateral to rows A-E receive projections from vibrissae in rows F and G on the face. These sinus hairs are shorter and less robust than in rows A-E and their barrels are smaller and less densely packed with small neurons than barrels in rows A-E. Further laterally the barrels continue to decrease in size and these receive projections from the very short sinus hairs on the upper lip. The prfs of the rostro-lateral and rostro-medial barrels are sinus hairs on the buccal pad and lower lip, respectively. Thus, the barrels in SmI of the rat receive somatosensory input from the large vibrissae which participate in exploratory whisking movements of the mystacial pad as well as from smaller sinus hairs on other regions of the face which are not involved in whisking.

729 NERVE GROWTH FACTOR FACILITATES RECOVERY OF BOTH LEARNED AND UNLEARNED BEHAVIORS AFTER PARASAGITAL LATERAL HYPOTHALAMIC KNIFE CUTS. Gerald L. West. Dept. Psychiat. and Beh. Sci. Univ. Okla. Health Sci. Ctr. Oklahoma City, Oklahoma 73190.

Adult male albino rats were given bilateral parasagital lateral hypothalamic knife cuts (Kent & Grossman, Phys. & Beh., 10: 953, 1973). Immediately after withdrawal of the knife either nerve growth factor (NGF) or normal saline was injected directly into the cut. Non-cut control rats received either NGF or saline into the region that would have been cut. Body weight (gm), water intake (ml), and dry food intake (gm) were recorded daily at least one day prior to surgery and then daily for at least 30 days after surgery. All rats were tested for active (step-up) and passive (one-trial step-through) avoidance of footshock on days 2, 5, and 12 after surgery to determine degree of deficits and recovery rates. Knife-cut rats were also tested on days 19 and 26. Finally, knife-cut rats were food-deprived on days 30-33 to determine whether drinking was prandial. The knife cuts produced a syndrome similar to, but less severe than, the LH anorexic syndrome of Teitelbaum & Epstein (Psych. Rev., 69: 74, 1962), including transient adipsia and aphagia and weight loss. NGF produced sharp increases in drinking on days 2 and 3 in knife-cut and in injection control rats. In saline injected rats with knife-cuts, prandial drinking was more apparent than in NGF rats with knife-cuts. NGF accelerated recovery from deficits in active avoidance, but did not alter recovery from deficits in passive avoidance.

730 A NEUROPHYSIOLOGICAL TIME COURSE OF AXON SPROUTING. James R. West*, Sam A. Deadwyler, Carl W. Cotman, and Gary S. Lynch. Dept. Psychobiol., Univ. California, Irvine, Ca. 92664.

Recent neuroanatomical evidence from our laboratory has shown that the commissural projections to the dentate gyrus "sprout" into the outer molecular layer which has been dennervated by lesions of the ipsilateral entorhinal cortex in adult rats (Lynch et. al., Brain Res., 1973). We have previously shown that sprouted commissural terminals form permanent functional contacts when the lesions have been performed in developing animals (Lynch et. al., Science, 1973). In this study we demonstrate the fact that the sprouted commissural projections function in adult animals also. In addition we further demonstrate the time course of these postlesion changes in adult animals. Neurophysiological studies employing laminar analyses of extracellular field potentials derived from the molecular layer of the dentate gyrus were the criterion by which these functional changes were determined. Experiments included testing normal (n=5) and lesioned rats (n=27) at various time points following lesions to the ipsilateral entorhinal cortex. In these experiments individual animals were tested once at postlesion delay intervals ranging from 3 days to 90 days. From these experiments it was determined that the commissural evoked potential in the molecular layer of the dentate could be detected at distances which were 50-100 microns more distal (i.e. farther out on the granule cell dendrites) to its normal location in unlesioned animals. In addition we found that the time course for this neurophysiological change was between 9-15 days after the lesion. Additional experiments in which other animals (n=5) were tested repeatedly using chronic recording procedures verified these conclusions. The findings indicate that sprouting of commissural projections seen after entorhinal lesions results in the rapid formation of permanently functional contacts in adult rats.

731 RESPONSE OF RAT DORSAL ROOT AND SUPERIOR CERVICAL GANGLION CULTURES TO CONGENERS OF CHLORPROMAZINE. Norman R. West. Dept. Anat., Washington Univ. School Med., St. Louis, Mo. 63110.

Observations on the response of cultured rat dorsal root ganglion (DRG) neurons to chlorpromazine (CPZ) treatment as described by Brosnan, Bunge and Murray (J. Neuropath. Exp. Neurol. 29: 337, 1970) have been extended to several congeners of this drug and to a similar study in cultures of rat autonomic superior cervical ganglion (SCG) neurons. The response of cultured DRG treated for 6 min with 7 x 10^{-5} M trifluoperazine included a marked cytoplasmic granularity which, as reported for CPZ, corresponded to a lysosomal proliferation. The maximum effect occurred at 36 hr and was reversible. Treatment with thioridazine, however, produced a dramatic degeneration of the neurons and their supporting cells. In our second study, light and electron microscopic observations of autonomic neurons established that these responded to CPZ in the same manner as sensory neurons. Similar responses were also noted in SCG cultures 36 hr after treatment with trifluoperazine, promethazine (a tricyclic antihistaminic) and trimeprazine (a tricyclic antipruritic). In addition to the large whorled myelin figures which characterize the lysosomal response in DRG, the homogeneous lysosomal matrix of SCG neurons became flecked with small electron dense granules. We conclude that a variety of phenothiazine agents can elicite a characteristic lysosomal response in autonomic as well as sensory neurons. (This work was supported by a fellowship from the Pharmaceutical Manufacturer's Association Foundation and NIH grant NS-09923).

732 MIDGET BIPOLAR CELLS IN THE GROUND SQUIRREL RETINA. Roger W. West. Dept. of Psychology, Memorial U. of Nfld., St. John's, Newfoundland.

Among mammalian retinas midget bipolar cells have been convincingly demonstrated only in the primate. These supposedly form a private channel between a single cone and a midget ganglion cell. Electron microscopy of Golgi-stained retinas has now given equally firm evidence that midget bipolar cells comprise a sizeable proportion of the bipolar cell population in the ground squirrel retina. As in primate there are two types of midget bipolars, one making ribbon related contacts onto cone bases and the other making non-ribbon related contacts. Electron microscopy of serial sections of seven Golgi-impregnated ribbon related midgets shows that they consistently go to only one cone. However, unlike what has been reported for primate the ground squirrel midget does not fill all of the central elements of receptor triads. The other midget type sends an axon-like process to one receptor base and seems to be the counterpart of the primate flat midget bipolar. The descending process looks very much like a dendrite, but electron microscopy has confirmed that this type of cell makes bipolar-like dyad connections so that it is not in fact an amacrine cell with an ascending axon. The variety of morphological types of ground squirrel ganglion cells is legion but apparently does not include a classical primate midget type. Nor have midget ganglion cells been electrophysiologically recorded in the ground squirrel. Thus, it is possible that the ground squirrel midget bipolar system while quite prominent does not serve as a private channel to higher centers.

733 THE EMERGING NEUROHOLOGRAPHIC CONCEPT. Philip R. Westlake. Univ. Calif, Los Angeles, 90024

Experiments in adaptation of vision to specifically oriented spatial gratings (such as those of F. W. Campbell and others) lead one to postulate the existence of independent spatial frequency channels. The validity of the argument, "If you can adapt to it, it is there", is examined. Consideration is given to the relevence of orthogonal expansions other than the Fourier. If in addition to the existence of independent spatial frequency channels, suitable channels for phase information also exist, it then can be claimed that some form of holographic process is used in vision. Experiments are emerging which show evidence of the existence of just such phase information channels. These experiments are examined and possible models of sampled and quantized neuroholographic processes relating to the data are explored. Some consideration is given to the non-linearities involved.

734 EFFECT OF OLFACTORY BULB REMOVAL IN NEWBORN RATS ON RESULTANT AXON PATTERNS IN OLFACTORY CORTEX. Lesnick E. Westrum. Departments of Neurological Surgery and Biological Structure, Univ. of Washington, Seattle, 98195.

Since electron microscope observations in newborn rats following olfactory bulb removal suggested possible reinnervation of new or denervated postsynaptic sites in olfactory cortex (Westrum, Anat. Rec., 178: 486, 1974), major changes in axonal connections may subsequently be expected in such neonatally operated animals. Healthy adult rats which had one olfactory bulb removed at birth were submitted to second lesions of various sizes within the ipsilateral olfactory cortex. Normal littermates without previous bulb removal, but with similar cortical lesions, were used as controls. Following survival times of 2-4 days, aldehyde-perfused, reduced silver-stained frozen sections were studied. Special attention was given to degeneration rostral and adjacent to the cortical lesion, especially that occurring in layer I or dendritic layer of the olfactory cortex. The control animals show a distribution of degeneration mainly in the middle and deeper parts of layer I (Ib-proximal dendrites), whereas in the double lesion animals degeneration may be distributed throughout layer I but, in some regions, occurs primarily in the superficial half of layer I (Ia-distal dendrites). The distal dendrites (layer Ia), are normally innervated by afferents from the olfactory bulb. The observations suggest that the "intracortical" axonal pathway has innervated or reinnervated the distal dendrites which have been denervated by removal of the olfactory bulb afferents at birth.
(Supported by NIH Grants NS09678 and NS04053).

735 EFFECTS OF SINGLE HINDLIMB DEAFFERENTATION UPON TREADMILL LOCOMOTION IN CATS. M. C. Wetzel, A. E. Atwater, J. V. Wait* and D. G. Stuart. Depts. Psychol., Phys. Ed. for Women, Elec. Eng., U. of Ariz., Tucson 85721; Dept. Physiol., Coll. of Med., U. of Ariz., Tucson 85724

Studies of motor control have not separated the contributions to rhythmic stepping by intrinsic central programming, intersegmental afferent inputs, or local afferent input. To generate data on the significance of local input, preoperative cinematographic measurements of gait were taken for cats moving unrestrained on a treadmill. The left L2-S2 dorsal root ganglia were then removed extradurally. Postoperative measurements (most at 2 weeks) revealed that forelimb footfalls were not markedly perturbed, but both hindlimb footfalls differed from preoperative walking and trotting patterns. Hip flexion movements of the operated limb were relatively normal, but knee and ankle joint flexion were usually insufficient to keep the limb from dragging. Upon touchdown the foot was placed awkwardly (plantigrade or on the dorsum). Extensor force (in both yield and thrustoff) was deficient during the stance. Deficits were severe at all belt speeds. Usage of distal joints improved after several months. The data were compatible with a model of the control of stepping in which a semblance of rhythmic behavior can exist independently of afferent input from all 4 limbs. The 4-limb input is required for generalized motoneuronal excitability, interlimb coordination, and normal timing and vigor in the homonymous limb. This report emphasizes that with loss of afferentation from even one limb the central program cannot provide the coordinated locomotion necessary for the animal's survival in its natural environment. (USPHS grants NS 11491, GRS FR 07002 to U. of A. and FR 05675 to its Coll. of Med. and a grant from the U. of Ariz. Found.)

736 TASTE PREFERENCES OF THE CAT FOR NEUROPHYSIOLOGICALLY ACTIVE SUBSTANCES. T. D. White* and J. C. Boudreau. (Sponser: Chiyeko Tsuchitani). Sensory Sciences Center, Graduate School of Biomedical Sciences, University of Texas at Houston, Texas, 77025.

Six cats were tested for taste preferences for neurophysiologically active substances utilizing a two bottle-48 hour exposure technique. Test chemicals were selected on the basis of their action on single unit spike activity in the Group II chemoresponsive neurons of the geniculate ganglion. Two groups of chemicals were chosen: (1) "excitatory" substances (L-proline, L-lysine, L-histidine) which increase group II spike activity at 50mM (or saturated) concentrations and (2) "inhibitory" substances (L-tryptophan, L-isoleucine, and adenine) which decrease group II spike activity at 50mM (or saturated) concentrations.

Each test chemical was presented in three concentrations (.5, 5, and 50mM in 50mM saline solutions) with a comparison solution (50mM saline). Deionized, distilled water was used in preparing the solutions. A preferred solution was defined as one which represented greater than 50% of the total fluid consumed in a test session.

Results indicate that while discrimination of solutions was possible at all three concentrations, preference for the "excitatory group" and non-preference for the "inhibitory" group was seen for all animals only at the highest concentration. (Supported in part by N.I.H. and N.S.F. Research Grants).

737 CHANGES IN GOLDFISH RETINAL GANGLION CELLS FOLLOWING INTRAOCULAR INJECTION OF VINCRISTINE. W.R.White*, and B.Grafstein. Dept. Physiol. and Dept. Surg., Cornell Univ. Med. Coll., New York, N.Y., 10021

Vincristine, which is known to block axonal transport of protein, was found to reduce the amount of radioactive protein which was axonally transported to the optic tectum of goldfish, measured 24 hours after the intraocular injection of ^{3}H-proline. The amount of transported material was reduced by about 55% if 0.5μg of drug was injected together with the isotope, and by 85% if the drug was injected 8 hours earlier than the isotope; with an interval of 8 days almost no transported material was detectable. The initial effect of the drug was at least partly due to an inhibition of protein synthesis, since retinal incorporation of the isotope was reduced by 40-50%. By three days after the drug injection, the proportion of ganglion cells with detectable nucleoli had doubled, the same response as would have been expected from axotomy instead of drug treatment. However, all of the effects of the drug could not be attributed to frank axonal injury since, a) although axonal degeneration occurred, it did not begin until more than 5 days after the nucleolar response was evident, and b) axonally transported protein was retained in the nerve terminals for at least a week after the drug injection.

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738 RESPONSE OF SOMATOSENSORY CORTICAL NEURONS TO MOVING TACTILE STIMULI. B.L.Whitsel, P.R.Loe, and R.C.Schreiner* Dept. Physiol., UNC, Chapel Hill, N.C., 27514. Supported by NIH grants NS07712, NS10759 and DE02668.

Single unit activity was recorded extracellularly from individual S-I neurons located in cytoarchitectural areas 1 and 3 in the postcentral gyrus of unanesthetized macaques. In this study we have sought to describe relations between the characteristics of the mechanical stimulus employed (brush motion at constant velocity) and 1) the mean rate of neural discharge as well as 2) the estimates of variability of the interspike intervals recorded during stationary periods of the response elicited by such stimulation. An additional objective was to determine the effects of changes in stimulus parameters on the interspike interval distributions obtained from somatosensory cortical neurons. In general, we find that for somatosensory cortical neurons the relative variability in neuronal firing (as estimated by the coefficient of variation) is independent of changes in stimulus parameters which markedly affect mean rate (e.g., stimulus duration, velocity, intensity, size, direction, and orientation). Moreover, we have noted that although the C.V. for the driven activity recorded from an individual S-I neuron is constant over most of the unit's dynamic range, this measure varies widely between different S-I neurons. The suggestion is, therefore, that the S-I neuronal population may be divided into groups which are characterized by the magnitude of the C.V. for activity elicited during peripheral stimulation: i.e., each population may be distinguished by a unique slope of the line relating mean interval and standard deviation for driven activity. In additional experiments we have examined the relation of this apparently fixed property (C.V. during steady peripheral drive) for a single S-I neuron to: 1) cytoarchitecture; 2) the unit's feature-detection properties; and 3) quantitative measures of the neuron's spontaneous activity.

739 EFFECTS OF LIGHT AND DARKNESS ON DOPAMINE AND NOREPINEPHRINE LEVELS IN THE RAT BRAIN. Ulysses G. Whitworth*, Joseph O. Owasoyo* and Charles A. Walker. Department of Physiology and Pharmacology, School of Veterinary Medicine, Tuskegee Institute, AL 36088

The midbrain, cortex, caudate nucleus, cerebellum and whole brain of male Sprague-Dawley rats were analyzed for dopamine and norepinephrine levels in identical tissues at different times of the day. The acrophases for both compounds occurred during the dark phase of the 12-hour dark - light photoperiod. Dopamine concentrations were greater than norepinephrine concentrations in specific brain areas. The acrophases for norepinephrine were more sustained and followed dopamine peaks for most periods examined on the cycle as would probably be expected since dopamine is the precursor for norepinephrine synthesis. Norepinephrine and dopamine showed similar patterns during the light phase of the photoperiod with troughs occurring during this phase for both compounds. All animals were adapted to a laboratory condition with automatically timed light-dark photoperiods for a minimum period of three weeks at ambient temperature of 23 ± 1°C before experimentation. The catecholamine levels in whole brain and in brain parts were extracted and analyzed according to the fluorometric procedure of Welch and Welch (1966). The sensitivity of other analytical methods for catecholamines were studied and compared. It is possible that different neurohumoral roles for dopamine and norepinephrine exist. A direct circadian relationship between dopamine and norepinephrine and the importance of dopamine in chronotherapy is indicated.

740 REORGANIZATION OF OCULAR DOMINANCE COLUMNS IN MONKEY STRIATE CORTEX. T.N. Wiesel & D.H. Hubel. Department of Neurobiology, Harvard Medical School, 25 Shattuck Street, Boston, Mass. 02115

In the present study we asked if the ocular dominance columns in the monkey striate cortex could be modified by changing the normal visual input. One eye was removed shortly after birth in 2 monkeys and the animals were studied 12 to 14 months later. Autoradiography of the lateral geniculate body (LGB) a few days after injection of ^{3}H-proline into the vitreous of the remaining eye showed labelled terminals restricted to appropriate layers, with no obvious label in the deafferented atrophic layers. Microelectrode penetrations through the LGB gave rich unit activity in normal layers and relative silence in the deafferented layers. Thus, no evidence was found for sprouting in the LGB. In the striate cortex, tangential microelectrode penetrations along layer IV C gave continuous unit activity which was actively influenced from the remaining eye. There were no obvious silent regions as expected from the normal distribution of right eye and left eye ocular dominance patches. These observations were supported anatomically by making small lesions restricted to one of the normal dorsal layers of the LGB; after 4-5 days survival time, the striate cortex was stained for terminal degeneration. Instead of the usual patches of degeneration corresponding to the representation of one eye, there were widespread areas of degeneration and only occasional small gaps with no degeneration. The intensity of terminal degeneration varied within the extended patches of degeneration. In Nissl stained sections, layer IV C was of uniform and normal thickness and had a normal cell density. These findings suggest a reorganization of the ocular dominance columns so that the columns with normal visual input enlarge at the expense of the deprived ones, presumably by a process of sprouting. This work is supported by NIH grant EY 00606.

741 EFFECTS OF SINUSOIDAL STRETCHING OF FOREARM MUSCLES ON PRECENTRAL NEURONES IN MONKEYS. Mario Wiesendanger, Gregory Lucier* and Dieter Rüegg*. Dept. of Physiology, Med. Sci. Bldg. University of Western Ontario, London, Ontario, Canada N6A 3K7.

Experiments were designed to study, in lightly anaesthetized (N_2O, Surital) monkeys, the possible role of afferent signals from stretch receptors in the regulation of motor cortical output. Controlled sinusoidal stretching of forearm muscles at low frequencies (2-12 Hz) elicited responses in precentral neurones. However, the effects, even to large amplitude stretches (up to 5.5 mm peak to peak), were generally weak. The lowest threshold amplitude was 1.7 mm (2 cycles at 12 Hz) but most units responded to minimal amplitudes of 3 to 4 mm. The latencies ranged from 18 to 120 msec (peak at 30 msec). Increased probability of discharge following each low frequency stretch cycle was observed in about a third of the units. In sharp contrast, cells of somatosensory area 3a would, under the same experimental conditions, respond to sinusoidal displacements as small as 12 μm and at minimal latencies of 8 msec. These units were not fired antidromically by corticospinal stimulation. The results are compatible with the view that load changes may be signalled by secondary spindle endings and used to modify motor cortical output. The gain of such a transcortical loop was, under the present experimental conditions, rather low, but it is possible that transcortical load compensation may be more effective with conjoint input from skin and joint afferents. (Supported by the MRC of Canada).

742 EFFECTS OF HYPOTHALAMIC STIMULATION UPON SEPTAL PACEMAKER MECHANISMS INFLUENCING HIPPOCAMPAL THETA RHYTHM. Charles L. Wilson*and Donald B. Lindsley. Depts. of Psychology, Physiology and Psychiatry, and Brain Research Institute, UCLA, Los Angeles, Ca. 90024.

Previous research employing rabbits (Petsche et al., Electroenceph. clin. Neurophysiol., 1962, 14, 202-211) has provided evidence that the medial septum contains cells which act as pacemakers for hippocampal theta rhythm. Anchel and Lindsley (Electroenceph. clin. Neurophysiol., 1972, 32, 209-226) found that in the cat, medial hypothalamic stimulation produces hippocampal theta rhythm and lateral hypothalmic stimulation produces desynchronization of hippocampal electrical activity. Our studies investigated the influences of medial and lateral hypothalamic stimulation upon septal cellular discharge and hippocampal EEG in the cat. Operative procedures were carried out under halothane anesthesia and recordings were obtained during artificial respiration with a mixture of N_2O and O_2 after immobilization with gallamine triethiodide and infiltrations of wound margins and pressure points with lidocaine. Extracellular microelectrode recordings from cells in the medial septum showed that these cells fire in rhythmic bursts in phase with theta rhythm simultaneously recorded in the CA-1 field of the dorsal hippocampus during 100 Hz medial hypothalamic stimulation. During 100 Hz lateral hypothalamic stimulation which desynchronized hippocampal EEG activity, septal cells were either inhibited or their rhythmic bursting pattern was disrupted. These results provide further support for the existence of two functionally distinct hypothalamic systems influencing hippocampus by their differential effects upon medial septum. They also suggest that hippocampal desynchronization is mediated by septal projections to hippocampus, although desynchronization of hippocampus can be obtained in the absence of septal input. (Supported by USPHS grant NS-8552 to D. B. Lindsley)

743 RECEPTIVE FIELD CHARACTERISTICS IN CAT STRIATE CORTEX: CHANGES WITH VISUAL FIELD ECCENTRICITY. James R. Wilson and S. Murray Sherman. Dept. of Physiology, Univ. of Virginia, Charlottesville, Virginia, 22901

One hundred and sixty-three neurons in striate cortex of 15 cats were studied to explore possible changes of visual receptive field properties with eccentricity in the visual field. Lacquer-insulated, metal microelectrodes were used extracellularly to monitor unit activity. The field positions varied in eccentricity from the area centralis to the monocular segment of the visual field. Cells were classified into simple, complex, and hypercomplex, and the following excitatory receptive field characteristics were studied: size, orientation, speed selectivity, and binocularity. On-line computer histograms were used to quantify these characteristics for some of the units. Although hypercomplex fields were found throughout the visual field, too few have been encountered as yet to consider their changes with eccentricity. There were trends in going from the area centralis to the far periphery towards a higher complex/simple ratio and towards more units being driven only by the contralateral eye. Also with increasing eccentricity, there was an increase in both simple and complex receptive field size and a wider range of stimulus orientations to which these cells responded. Speed selectivity for complex units tended to increase with eccentricity, but did not change much for simple cells. These data indicate that cortical neurons show a general trend towards decreasing stimulus specificity with increasing receptive field eccentricity, but there are no outstanding qualitative differences between central and peripheral visual neurons.

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744 A TECHNIQUE FOR VOLTAGE CLAMPING WITH A SINGLE MICROELECTRODE. Wilkie A. Wilson and Marcia M. Goldner*, Epilepsy Ctr. and V.A. Hosp. and Dept. Physiology, Duke Univ. Med. Ctr., Durham, N. C., 27705.

Conventional voltage clamping requires the use of two intracellular electrodes. This requirement precludes the study of small and/or visually inaccessable neurons. A technique has been developed to voltage clamp with a single microelectrode.

The single microelectrode is rapidly switched from a current passing to a recording mode. The circuitry consists of: 1) an electronic switch; 2) a high impedance, ultra low input capacity amplifier; 3) a sample-and-hold module; 4) conventional voltage clamping circuitry. The closed electronic switch allows current to flow through the electrode. The switch then opens, and the electrode is in a recording mode. The low input capacity of the preamplifier allows the artifact from the current pulse to rapidly abate, after which time the circuit samples the membrane potential. The switch then closes and current again flows. This cycle is repeated at rates up to 10 KHz. The voltage clamping amplifier senses the output of the sample-and-hold module and adjusts the current pulse amplitude to maintain the desired membrane potential.

This system was evaluated using 10 Aplysia neurons. Two microelectrodes, 6 MΩ, were inserted into each cell, 300-400 μ apart. One electrode was used to clamp the cell, and the other to independently monitor membrane potential. With a 50 mV command pulse, transmembrane potential measured by the monitoring electrode reached steady state in 2 msec and was within 1 mV of the command voltage.

Possible applications and limitations of this technique in vertebrate and invertebrate preparations will be discussed.

745 ELECTROPHYSIOLOGICAL ANALYSIS OF INPUT TO A MULTIMODAL COMMAND INTERNEURON IN THE CRAYFISH. Jeffrey J. Wine, Richard Gauthier* and Jay E. Mittenthal. Dept. Psych., Stanford Univ., Stanford, CA. 04305 and Dept. Biol. Sci., Purdue Univ., West Lafayette, Ind. 47907.

Crayfish can escape by a rapid flexion of the abdomen. When elicited by a phasic tactile stimulus to the animal's anterior, or by a rapidly approaching object, the escape response is almost always mediated by a pair of giant command interneurons with cell bodies and dendrites in the supraesophageal ganglion ('brain') and axons that run the entire length of the nervous system. These axons activate motoneurons to produce the flexion portion of the escape response. Although the output of these command cells is well-described, the input circuitry is unknown. Our interest in this particular circuit is enhanced because it is a multimodal (optic and tactile) interneuron with a known function, and because both the optic and tactile modes are subject to profound modulation by inhibitory networks and show pronounced habituation.

A semi-intact preparation has been developed in which we record depolarizing potentials from the axons of the command cells with intracellular electrodes placed near the caudal margin of the brain. Concomitant extracellular records were obtained with suction electrodes on the desheathed nerves and connectives. Electrical and natural stimuli were used to drive cells in the optic tracts and antennal nerves.

Preliminary results indicate that (1) shocks to the antennal or optic tracts produce compound depolarizations in the command cells; (2) these depolarizations consist of an early, stable phase and a later phase that decrements with repetitive stimulation; (3) interneurons in the circumesophageal connectives produce depolarizations in the command cells that can follow without alteration at several hundred Hz; (4) one class of optic units, Wiersma's 'sustaining fibers', do not produce PSPs in the cell.

746 ALTERNATION BEHAVIOR IN CATS WITH SMALL ABLATIONS OF MEDIAL VISUAL CORTEX. J. Winer* and J.F. Lubar. (Department of Psychology, Duke University, Durham, North Carolina, 27706; Department of Psychology, University of Tennessee, Knoxville, Tennessee, 37916).

Discrete lesions of cat medial visual cortex disrupt acquisition of two-way active avoidance while leaving pattern discrimination ability and motor behavior intact (J. comp. physiol. Psych., 1966, 62, 263-269; Physiol. behav., 1967, 2, 179-184). In order to examine each of the several factors which might be responsible for the avoidance deficit (e.g., contingency, spatial cues, task difficulty), ten experiments were undertaken in a Yerkes alley. Each of the twenty-four animals received twenty-four trials per day; no correction of errors was permitted and animals were maintained at 90% of their normal weight. The results of approximately forty thousand experimental trials indicate that the performance of ablated animals is poorest during reversals or in purely spatial (uncued) tasks or when peripherally occluded. Performance is improved through the addition of cues which modify spatially homogeneous situations. The more completely cued the experimental context, the more closely the behavior of ablated animals approximates that of controls. The active avoidance deficit can be compared with this model since avoidance is essentially spatial. The locus of ablation was between A 6 and A 14 in most animals; retrograde degeneration was confined to the anterior pole of the dorsal lateral geniculate nucleus.

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747 METABOLIC PARTICIPATION IN RECEPTOR CURRENT GENERATION IN RAT AND RABBIT RETINAS. Barry S. Winkler. Institute of Biological Sciences, Oakland University, Rochester, Michigan 48063

Investigations of rat retinas suggest that, under certain conditions, metabolic processes play a primary role in the generation of electrical currents along the photoreceptor cell. Incubation of isolated rat retinas in calcium-free medium shows that the receptor potential (RP), recorded intraretinally, can be elicited in the experimentally contrived absence of a sodium concentration gradient during normal metabolic activity. Thus, in calcium-free medium containing 25 mM sodium the absolute amplitude of the RP of the rat retina is increased relative to its amplitude in 2 mM calcium and 145 mM sodium. However, in the absence of glucose or in the presence of metabolic inhibitors the RP depends solely on the existence of a sodium concentration gradient across the membrane. Similar experiments were also performed on isolated rabbit retinas. When the RP of the rabbit retina was measured during incubation conditions which were identical to those used in the experiments on the rat retina, the observed changes in the RP of the rabbit were similar to the changes seen in the RP of the rat retina although the magnitudes of the effects varied. These results suggest that metabolic processes are directly involved in the production of electrical current in rat and rabbit receptor cells and that the degree of this involvement is a function of the calcium concentration in the medium.

748 THE MESENCEPHALIC NUCLEUS OF THE FIFTH NERVE IN THE SELACHIAN BRAIN. Paul Witkovsky and Barry L. Roberts*. Depts. Physiology and Ophthalmology, Columbia Univ., N.Y. and Marine Biological Laboratory, Plymouth, England.

The mesencephalic nucleus (mes V) of the fifth nerve was studied in the brains of dogfish (sp. Mustelus, Scyliorhinus) and rays (sp. Raja). In a 1 ft. ray or 2 ft. dogfish, the mes V nucleus contains 900-1100 cells. Mes V cell bodies lie just dorsal to the ventricle and near the midline of the tectum. A few mes V cell bodies are found in the cerebellar granular eminences adjacent to the tectum. Each mes V cell gives rise to many short, stout dendrites and a single axon which joins one of several bundles situated laterally to the perikarya on the ipsilateral side. The collected axons course posteriorly; the most medial 10-15% enter the cerebellum and terminate in close proximity to Purkinje cell bodies of the anterior cerebellar lobe. The remaining axons form a single tract on either side of the midline which exits via branches of the fifth nerve. Two kinds of synaptic terminals are found on mes V cell bodies and dendrites, one contains agranular, elongated vesicles, the other, agranular round vesicles as well as dense-cored vesicles. Processes of deep tectal neurons appear to be one source of synaptic input to mes V cells. In addition, neighboring mes V cells and dendrites are joined by specialized junctions resembling zonulae adherens. Intracellular recordings show that some mes V cells are driven directly by ipsilateral fifth nerve stimulation, others by cerebellar stimulation. The former are sensory afferents with peripheral receptive fields in the jaw and mouth region.
Supported by NIH grant EY 01063.

749 **A PROGRAMMABLE ELECTRONIC ARRAY FOR BRAIN MODELING.** Larry D. Wittie. Comp. Sci. Dept., SUNY/Buffalo, Amherst, N.Y. 14226.

An integrated circuit (IC) array has been designed for modeling many different nerve nets including ones exhibiting learning. For models involving 4096 neurons, the IC array runs 40,000 times faster than existing digital computer simulation programs and at least 20 times faster than the brain itself. Each neural element in the array contains digital logic as well as several hundred bits of flipflop memory. Besides functioning locally to control neural firing, all bits in the entire array together form a huge shift register. A program in a separate digital computer initializes the array for each new brain structure by filling its memory a bit at a time. The main problem in designing the array is the myriad connections needed to model all brain structures. In any model, each neural element may receive firing signal pulses from itself, its 15 neighbors, and any 16 other, more distant elements. Memory values determine which elements are logically connected. Each neural element is wired to all its neighbors. Unneeded connections are logically cut by clearing their enabling bits. Signals between distant neurons use shared wires between groups of neural elements. The array may be expanded to 65,000 or 1,000,000 elements without changing the design. Using current IC fabrication techniques, an IC array for models of up to 4096 neurons should cost about $50,000. Within the next four years, higher density ICs will reduce the price to about $1,000. A prototype of the array is currently being built.

750 THERAPY OF ANTICHOLINESTERASE INTOXICATION USING COMPOUNDS WITH VERATRINE-LIKE ACTION AND THE ROLE OF CALCIUM. O.L. Wolthuis and V.J. Nickolson, Medical Biological Laboratory TNO, 139 Lange Kleiweg, Rijswijk Z.H., The Netherlands.

In previous studies it was shown that respiratory paralysis in rats due to neuromuscular block after intoxication with the anticholinesterases paraoxon and DFP can be prevented by therapy with compounds having veratrine-like action (1). After intoxication with the centrally acting cholinesterase inhibitor soman, injection of the veratrinic compound 9-anthroic acid (ANCA) causes a delay of 2.5 hours in the onset of respiratory failure (2). Increasing the dose of ANCA results in death of the animals in spite of artificial respiration. Their muscles are abnormally rigid and their hearts are contracted. It was hypothesized that ANCA, in combination with soman, causes an accumulation of calcium in the muscles. This hypothesis was tested in anaesthesized, atropinized, soman-poisoned rats. It was found that ANCA causes repetitive firing and prolonged contractions of the muscle fibers. Furthermore, ANCA causes a slight decrease of the calcium content of the blood, which is potentiated by soman. Combined treatment of rats with soman and ANCA results in accumulation of calcium in stimulated but not in non-stimulated muscles. This accumulation is partly antagonized by EDTA, which lowers the concentration of free calcium ions in the blood. In addition, treatment with EDTA postpones respiratory failure. It is concluded that ANCA causes accumulation of calcium in the stimulated muscles of soman-intoxicated animals and thereby hampers its own therapeutic effect.

1. Wolthuis, O.L. and Postel-Westra, K.B., 1971, Eur.J.Pharmacol., 14, 93.
2. Wolthuis, O.L. and Cohen, E.M., 1973, in: Pesticides and the Environment: a continuing controversy, ed. W.B. Deichmann, Intercontinental Medical Book Corp., New York, p. 469.

751 GENETIC CONTROL OF FLIGHT MOTOR FUNCTION IN DROSOPHILA MELANOGASTER. P. T. Wong*, K. Ikeda, and W. D. Kaplan*. City of Hope Natl. Med. Ctr., Duarte, California 91010.

A double shaker mutant eag Sh^5 which we are studying has apparent defects in the indirect flight motor system. Intracellular recordings from the indirect flight muscles showed spontaneous firing not found in the wild type or eag and Sh^5 by themselves and did not correspond to firing typical of normal flight. This abnormal firing is patterned and can be classified into one of three types, all of which can be found in the same muscle fiber at various intervals during recording. Temporal analysis of these firings showed that all muscle fibers have the same firing pattern at any one time, indicating a common neuronal control. Cutting the excitatory nerve innervating the longitudinal muscle fibers stopped firing in these fibers, further supporting a neuronal basis for such firing; when the cut end of the nerve was artificially stimulated, the response of the muscle fiber was normal compared to that of the wild type, indicating that the function of muscle, neuromuscular junction, and axonal conduction was normal in these mutants. (Supported by USPHS grants NS07442 and NS08014)

752 DEMONSTRATION OF GENICULOCORTICAL RELAY CELLS IN THE SQUIRREL MONKEY BY MEANS OF RETROGRADE TRANSPORT OF HORSERADISH PEROXIDASE. M. Wong-Riley, Dept. Anat., Sch. Med., UCSF, San Francisco, 94143

The purpose of this study was to demonstrate the sources of primary afferents to the dorsolateral striate cortex in the squirrel monkey (Saimiri sciureus) by utilizing the uptake of histochemically identifiable protein. Horseradish peroxidase (HRP) at a concentration of 300ug per ul of normal saline, was injected into the gray matter of the dorsolateral striate cortex which represents the central 5-8° of visual field. Five animals were perfused at 1 to 5 days after injection with aldehyde fixative, and frozen sections of their brains were incubated for the HRP reaction (Graham and Karnovsky, J. Histochem. Cytochem., 14:291-302, 1966). Intense labelling of neuronal perikarya was found in the ipsilateral lateral geniculate nucleus (LGN) between day 1 and day 5. The labelled cells occupied a distinct wedge-shaped sector extending from the parvo- to the magno-cellular laminae. The sector invariably occurred in the central portion of the posterolateral LGN. HRP was not demonstrable in neurons or axons within the superior colliculus, pulvinar, peristriate cortex or contralateral visual cortex. The results indicate that (1) HRP was actively taken up by the terminals of geniculocortical relay cells and transported back to their cell bodies. (2) The well-defined boundary and location of the labelled sector in the LGN demonstrates a topographical projection of fibers from LGN to the striate cortex. In this case, both the sector and the injection sites represent the central field of vision. (3) The labelled sector corresponds to the wedge of degenerating LGN cells seen after cortical lesions previously reported in the macaque.

753 VISUAL ACTIVITY OF THE SUPRAESOPHAGEAL GANGLION OF THE CRAYFISH. Howard L. Wood* and R. M. Glantz. Dept. Biol. Rice U. Houston, 77001

The supraesophageal ganglion (brain) is a major integration station between the optic nerve and neurones controlling the visual behavior of the crayfish. Extracellular microelectrodes were used to record the response in the brain to a variety of visual stimuli. Some of the units encountered differed from the response previously observed in the optic nerve in terms of triger features, response form and receptive field. Such differences include units very responsive to movements of white objects, those giving phasic on responses and units with binocular receptive fields. Units with properties not observed in the optic nerve must represent higher order visual integration. The visually induced activity of cells in the brain may be studied either as the processed output of the optic nerve or as the input to neurones controlling the visually triggered or guided behavior of the animal. The behavorial significance of these units is indicated by direct electrical stimulation of visual fibers from the esophageal connectives eliciting defensive behavior. Repeated visual stimulation results in habituation of the phasic interneurons response and direct electrical stimulation results in habituation of the elicited defence reflex.

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754 IDENTIFICATION OF CYTOCHEMICAL PRODUCTS AT REACTION SITES FOR BIOGENIC AMINES. Joe G. Wood and F. David Prentice, Neurobiology, Univ. Tx. Med. School at Houston, Texas Medical Center, Houston, Texas 77025.

Biogenic amines have been identified electronmicroscopically using heavy metal cytochemical techniques in chrommaffin cells (adrenal medulla) argentaffin cells (gut), and nerve endings (pineal gland). Such identifications are dependent upon the reaction of the unsubstituted amine with glutaraldehyde and the eventual formation of an isoquinoline derivative. This isoquinoline derivative subsequently will react with a heavy metal resulting in an electron dense product. Refinement in methodologies has led to the positive identification of central nervous system areas which contain the same reaction product in nerve fibers and in some neurons in the hypothalamus. Newly developed procedures have minimized the loss of the reaction product by diffusion and positive identification of "lakes" of intraneuronal material are seen. Electron probe studies have been conducted to determine the presence of heavy metals at such dense sites. These studies have been done on adrenomedullary tissue utilizing norepinephrine (NE) cells as a model system. Positive NE cell reaction with glutaraldehyde and subsequent reaction with molybdate (Mo) or chromate (Cr) or both yield positive electron probe results for Mo and Cr in adrenomedullary granules. This correlates with in vitro studies. Positive hypothalamic neurons have been identified and subjected to the electron probe analysis. Results show that the reaction products seen at the electron microscopic level contain not only the isoquinoline derivative, but Cr and Mo. Such results lead to a better understanding of biogenic amine localization and to the discrimination of "dense" areas in neurons.

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755 THE VISUALIZATION OF CONCANAVALIN A BINDING SITES IN PURKINJE CELLS OF RAT CEREBELLUM. John G. Wood and Barbara J. McLaughlin. Div. Neurosci., City of Hope Medical Center, Duarte, CA. 91010 and Dept. Anatomy, Univ. Tennessee Medical Center, Memphis, Tennessee, 38103.

Concanavalin A (con A) was used to localize glycoprotein rich organelles in Purkinje cells. Adult rats were perfused through the aorta with a fixative containing 4% paraformaldehyde and 0.1% glutaraldehyde in Millonig's phosphate buffer, pH 7.2. The cerebellum was stored overnight in phosphate buffered 4% paraformaldehyde, and sectioned parasaggitally in 75 μ slices. The slices were incubated in con A (1 mg/ml) in phosphate buffered saline (PBS) for 30 min and washed 3 times in PBS for 30 min. The con A binding sites were visualized using a peroxidase-diaminobenzidine labeling technique (Exp. Cell Res. 64, 232 (1971)) and the slices were post-fixed in 2% phosphate buffered OsO_4 and processed for electron microscopy. The blocks were sectioned parallel to the original parasaggital face and superficial sections were examined in the electron microscope. The con A binding sites in the Purkinje somata were all membrane bound. The most conspicuous labeling was the nuclear membrane which was seen to be continuous with labeled rough endoplasmic reticulum which was in turn continuous with smooth ER (SER). The Golgi apparatus was also labeled. At the periphery of the cell the labeled SER flattened into the hypolemmal cisternae (Cerebellar Cortex, 1974, Palay and Chan-Palay, p. 28) which continued to be labeled throughout most of the dendritic tree. Other SER profiles in the dendrites were not labeled. Mitochondrial membranes were never labeled. Such a cisternal system could be a reservoir for renewal of plasma membrane glycoproteins or it could be a channel through which materials might be transported from the Purkinje cell body to the distal portions of dendrites. Supported by NIH grants NS-01615 and NS-09578.

756 THE CHOLINERGIC SYSTEM AND TONIC IMMOBILITY IN THE RABBIT. Michael L. Woodruff, Daniel C. Hatton* and Merle E. Meyer* Dept. of Psychology, Middlebury College, Middlebury, Vt., 05753: Dept. of Psychology, University of Florida, Gainesville, Fla., 32608.

Thompson et al. (J. comp. Physiol. Psych., in press) have reported that injection of physostigmine, which facilitates cholinergic activity, prolongs tonic immobility (TI) in chickens and that scopolamine, which blocks cholinergic activity, shortens TI. This observation is congruent with the hypothesis that the central cholinergic system provides the neural substrate of behavioral inhibition (Carlton, in J. Tapp (ed.) Reinforcement and Behavior, 1969). Injection of anticholinergic drugs is also known to produce many of the same behavioral effects as does lesioning of the hippocampus (Carlton, ref. cit.). Hippocampal lesions in the rabbit prolong TI, and do not mimic the effect of scopolamine in the chicken (Woodruff, et al., J. comp. Physiol. Psych., in press). The present experiment was done to determine whether scopolamine would produce the same result on TI in rabbits that it did in chickens, or whether its effect in rabbits would mimic the effect of hippocampal lesions. Scopolamine (0.1 and 0.4 mg/Kg) significantly prolonged the duration of TI, while injection of physostigmine (0.04 and 0.15 mg/Kg) significantly shortened this response. These data are congruent with the effect produced by hippocampal lesions in the rabbit, but are opposite to the effects of scopolamine and physostigmine on TI in chickens. The nature of cholinergic modulation of TI in the rabbit appears to be at variance with the response suppression hypothesis of Carlton. However, if TI is viewed as a response of the rabbit to sudden inversion and restraint, rather than simply as cessation of movement, disrupting cholinergic activity might potentiate TI by allowing a disinhibition of a response which, in this case, involves the arrest of movement.

757 ACTIONS OF CATECHOLAMINES AND RELATED COMPOUNDS ON PLASTIC CHOLINERGIC SYNAPTIC TRANSMISSION IN THE ABDOMINAL GANGLIA OF APLYSIA CALIFORNICA. Paul B.J. Woodson*, Jacques P. Tremblay*, Werner T. Schlapfer and Samuel H. Barondes. Depts. of Neurosci. and Psychi., UCSD and VA Hospital San Diego, Ca. 92161

Catecholamines act both pre and postsynaptically to modulate cholinergic neuromuscular transmission (Gallagher & Karczmar, Neuropharm.12:783-791, 1973). We have studied the action of catecholamines and related compounds upon a cholinergic EPSP (elicited by stimulation of the right visceropleural connective) recorded in the cell R15 in the abdominal ganglion of Aplysia californica. Normally, this synapse responds to repetitive stimulation at 2 per second with an early depression of the EPSP size followed by facilitation to a plateau. If the stimulus train is then interrupted, post-tetanic potentiation (PTP) is observed. D-amphetamine and L-Dopa had no effect. Dopamine, octopamine, norepinephrine and synephrine all hyperploarized R15. In addition, octopamine, norepinephrine and synephrine lowered earlier EPSP's of a train more than they lowered later EPSP's. These agents also reduced the initial depression and PTP. Dopamine lowered early EPSP's compared to control, but it elevated later EPSP's of a train compared to control. Dopamine also reduced initial depression and PTP. The effect of octopamine, norepinephrine and synephrine is explained by inhibition of the release process. The effect of dopamine is explained by a combination of inhibition of release and stimulation of the transmitter supply rate. The effects of dopamine administered in the presence and absence of elevated Ca^{2+} in the media are consistent with this hypothesis.

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758 DEVELOPMENT OF CEREBELLAR AFFERENT SYNAPTIC INPUT AND INHIBITORY INTERNEURONAL FUNCTION. D. J. Woodward and D. G. Puro. Dept. Physiol., Univ. of Rochester, Rochester, N.Y. 14642.

Needle electrodes were inserted into limb muscles of rats anesthetized with 0.5% halothane at various developmental ages to provide for an activation of mossy and climbing fibers projecting to the cerebellum. On postnatal day 9 were found the first unit responses of Purkinje cells driven by mossy fiber input that were mature with respect to short latency (7-10 msec) and ability to follow at repetitive stimulation (up to 20/sec). This occurs at a relatively early stage of morphological maturation of glomeruli. Suspected mossy fiber responses at longer latencies were also found on day 7. The earliest climbing fiber inactivation responses evoked by similar stimulation were found at least at day 3, but at long latencies (up to 250 msec) and only at low stimulation rates (as slow as once in 15 sec). Latencies can reach a mature range (20-40 msec) by day 7 to 8, and at day 9 will follow at 2/sec stimulation as in adults. Surface stimulation of parallel fibers was employed to assay possible basket and stellate cell inhibition of Purkinje cells. The presence of off-beam inhibition suggested an appearance of inhibitory cell function between days 8 and 10. This result correlates with a growth of inhibitory cell axons as demonstrated by Golgi stain techniques. We find that the developing cerebellar circuitry at day 9 in the rat has achieved the basis of a mature framework with respect to the latency and frequency of afferent input and functioning of inhibitory interneurons. These functions appear at the end of the major phase of expansion of cerebellar folia but when only 30-40% of the adult complement of granule cells have been formed. (Supported in part by USPHS grant TF AM 1004-08, NSF GB 28873X, NINDS IF11NS 11,030.)

759 DIFFERENCES IN EXTRACELLULAR CURRENT REQUIRED TO ACTIVATE CORTICAL NEURONS OF DIFFERENT AUDITORY RECEPTIVE PROPERTIES AS FUNCTIONS OF STIMULUS, STIMULUS-ASSOCIATION, AND CONDITIONING. C.D. Woody, J.D. Knispel, T.J. Crow and P.A. Black-Cleworth. Laboratory of Neurophysiology, Mental Retardation Research Center, UCLA, Los Angeles, Ca. 90024.

Single cells from the mid lateral and supra-sylvian cortex were studied in 1)"conditioned" cats - previously trained with 70db click-CS followed 400 msec later by glabella tap-US, 2)"random-paired" cats - previous presentation of click and glabella tap in random temporal order, and 3)"naive" cats - untrained. During recording (glass microelectrodes) groups 1 & 2 received click and glabella tap paired as in previous training, while naive cats received click alone. All groups received unpaired hiss (comparable loudness, but longer duration) separately. Only the "conditioned" group had an observable conditioned blink response to click. The amount of extracellularly delivered current (or intracellular current) required to fire each cell was determined prior to presenting the auditory test stimuli. Cells were grouped according to their auditory response characteristics. PST histograms were compared between "click" cells (increased firing to click), "hiss" cells (increased firing to hiss), and "other" cells (no response to either stimulus). Activity (particularly spontaneous) was selectively enhanced in the click cells of the random paired and conditioned animals and less extracellularly injected current was required to fire click cells than other cells. No significant differences in extracellular currents were found between these types of cells in naive cats, nor in intracellularly delivered firing currents in conditioned animals. The results suggest the presence of intrasynaptic or, presynaptic changes subserving the observed differences in activity and excitability. Such changes may contribute to mediation of the specificity of stimuli of "conditioned" or "associated" significance (cf. sensory preconditioning) in evoking a "learned" response. (Supp. by USPHS HD-05958 and HD-04612.)

760 HOW TO ACCOUNT FOR "HYPERCOMPLEX" VISUAL PROCESSING IN PERIPHERAL DIRECTIONALLY SENSITIVE UNITS. Harry J. Wyatt* and Nigel W. Daw. Dept. Physiol., Washington Univ. Sch. Med., St. Louis, Mo. 63110

Directionally sensitive cells in the rabbit retina are, in a sense, "hypercomplex"; that is, they are specific for the size of a stimulus as well as its direction of motion. This size specificity may be quite lax for stimulus motion in the preferred direction, but tends to select stringently for small stimuli when motion is perpendicular to the preferred direction. A corollary of this is that directional sensitivity is often more specific for large than for small stimuli. Similar properties have been observed in pigeon retina (Miles, Brain Res. 48: 65, 1972) and there may be a common explanation.

We hypothesize that the inhibitory connections responsible for size specificity are the same as the connections responsible for directional sensitivity. This hypothesis is evaluated by experiments on (i) spots and bars of different sizes moved through different parts of the receptive field, (ii) two bars flashed sequentially with different spatial and temporal separations and (iii) stimuli moved through different parts of the receptive field in different directions at the same time. Inter alia we find that two bars flashed in a preferred direction sequence give a maximum response when the time delay corresponds to the preferred velocity for movement in the preferred direction.

761 PSYCHOPHYSICAL EVIDENCE FOR A SHORT-WAVELENGTH CONE MECHANISM IN THE PIGEON RETINA. Dean Yager, State College of Optometry, New York 10010 and Martha Romeskie*, Brown Univ.

Pigment extraction and microspectrophotometry studies have revealed cone pigments in the pigeon with peak absorptions at 544 and 562nm. Most pigeon cones also contain an oil droplet which transmits very little light in the short-wavelength region of the spectrum. Light-adapted spectral sensitivity functions obtained by electroretinographic and pupillometric techniques rise at wavelengths shorter than 450nm. Blough (JOSA, 47:48, 1957) also reported a rise in sensitivity at short wavelengths using a behavioral technique.

We have employed a two-choice operant discrimination procedure to determine the spectral sensitivity function for the red field of the pigeon visual system, under different conditions of light adaptation. The data are consistent with a proposed model of the visual system which assumes that spectral sensitivity is determined by an additive combination of responses from cones containing the 562 pigment, and cones containing a postulated pigment with a peak absorption at 415nm.

762 STUDIES ON THE ANTINOCICEPTIVE PROPERTIES OF HALOPERIDOL AND DIAZEPAM. Tony L. Yaksh and Thomas A. Rudy. School of Pharmacy, University of Wisconsin, Madison, 53706.

Clinically, haloperidol and diazepam can alter the response to painful stimulation. To further investigate the characteristics of this apparent antinociceptive action, rhesus monkeys were adapted to primate restraining chairs in a soundproofed chamber and trained to perform a discrete trials shock titration task as described by Fields and Glusman (J.C.P.P., 68:334, 1969). Experiments were then carried out in which injections of haloperidol (5-50 µg/kg, i.m.), diazapam (0.5-10 mg/kg, i.m.) or morphine sulfate (1-10 mg/kg, i.m.) were made. All compounds tested resulted in a dose-dependent increase in not only the mean titration threshold, but also the minimum shock which would support simple escape behavior. Based on the molar doses required to produce a 50% of maximum response, haloperidol was 100 times as potent as morphine, while diazepam was 1/5 as potent as morphine. Increasing the intertrial interval (ITI) in the absence of drugs had little effect on the level of shock tolerated by the animal. However, following the administration of haloperidol, diazepam or morphine, increasing the ITI over a range of 1 to 20 sec resulted in a reliable reduction in the mean titration threshold. Since long ITI's reduce the contribution of the avoidance component in an operant paradigm, this drug-ITI interaction can be taken to indicate that at least a portion of the threshold shift is due to an effect on an avoidance component. On the other hand, the fact that the shock intensities for simple escape were also elevated indicates that the actual threshold to noxious stimulation may also be affected.

763 PROTEIN SYNTHESIS WITH ISOLATED NERVE AND GLIA CELL-FRACTIONS: TWO MODES OF SYNTHESIS. T. Yanagihara. Mayo Clinic and Mayo Foundation, Rochester, Minnesota 55901.

Protein synthesis in isolated nerve cells and glia cells and the viability of these isolated cells were investigated with two different incorporation systems for protein synthesis. The nerve-cell and glia-cell fractions were isolated by ficoll discontinuous-gradient centrifugation. System A, for incorporation of L-leucine, was a buffer-electrolyte system that has been used for protein synthesis with brain slices. System B has been used for protein synthesis with isolated polysomes, and contained ATP, GTP, and pH 5 enzymes.

With system A the neuronal fraction incorporated twice as much as the glial fraction. Cycloheximide (100 μg/ml) inhibited incorporation by each fraction to 70%, but puromycin (50 μg/ml) inhibited the neuronal fraction less. Both fractions were dependent on glucose for maximum incorporation, but the neuronal fraction more so. Well-oxygenated atmosphere resulted in high incorporation by both fractions.

With system B, leucine incorporation was 1.5 times greater in the neuronal fraction. Puromycin (50 μg/ml) inhibited incorporation by each fraction to 70%. Both were highly dependent on ATP, GTP, and pH 5 enzymes, but neither required glucose or oxygen atmosphere for maximum incorporation.

The findings indicate that the isolated cell fractions retain ability to synthesize protein at the whole-cell level and at the polysomal level, and that these systems can be used for neurobiologic or neuropharmacologic investigation. (Supported in part by NIH grant NS-6663 and by the Charles S. Lips Fund.)

764 CORTICAL SYNCHRONOUS ACTIVITY MEDIATED BY NUCLEUS RETICULARIS THALAMI. C. D. Yingling,* G. L. King,* and J. E. Skinner (SPON: P. Kellaway). Rice U., Tex. A.M.U., Baylor Coll. Med., and Methodist Hospital, Houston, Texas 77005.

These experiments were performed to test the Scheibels' (1966) hypothesis that nucleus reticularis thalami (R) could play a major role in the generation of synchronous activity. Intracellular recordings have demonstrated prolonged IPSPs gating thalamic relay cells during recruiting responses (RRs) (Purpura et al., 1962), but the mechanism underlying these IPSPs has remained uncertain. Cats were implanted with stimulating electrodes in medial thalamus (NCM), mesencephalic reticular formation (MRF) and VL, and recording electrodes in ant. sigmoid cortex (AS). Single units were recorded in the anterior pole of R. During 8/sec stimulation of NCM, R units recruited in parallel with the cortical response, firing a few spikes to the first stimulus and developing sustained high frequency bursts by the time of maximal cortical recruitment. Stimulation of the MRF, which inhibits spontaneous activity of R units, also reduced or abolished responses of these cells to NCM stimulation as well as abolishing the cortical RR. Stimulation of VL had no effect on the activity of R units. These data are consistent with the following conclusions: 1) Sustained IPSPs in thalamic relay cells during RRs are the result of inhibitory projections from nucleus reticularis thalami. 2) Desynchronization produced by MRF stimulation is a result of inhibition of R units thus removing their gating effect on thalamo-cortical projections. 3) Our previous interpretation (Skinner and Yingling 1973) that the large positive slow potential recorded from R during conditioned attention or MRF stimulation is due to hyperpolarizations in R cells. 4) Augmenting responses produced by VL stimulation must be mediated by a separate mechanism not involving R.

765 DOPAMINE MEDIATION OF INTRACRANIAL STIMULATION AND AMPHETAMINE REWARD IN THE RAT. Robert A. Yokel*, Ronald Pantel* and Roy Wise. Center for Research on Drug Dependence, Sir George Williams University, Montreal, Canada

Intracranial electrical self-stimulation and intravenous amphetamine self-administration were examined after injections of the alpha-adrenergic blocker phentolamine (2.5, 5 and 10 mg/kg), the beta-adrenergic blocker l-propranolol (5, 10 and 20 mg/kg) and the dopamine blocker pimozide (0.125, 0.25 and 0.5 mg/kg). Propranolol greatly reduced self-stimulation with paraventricular electrodes, and slightly attenuated self-stimulation with lateral hypothalamic and substantia nigra electrodes. Phentolamine attenuated self-stimulation from all three sites, being least effective with paraventricular placements. Pimozide produced the strongest reduction in self-stimulation (70% decrements at high dose) at all sites. The adrenergic blockers decreased or had no effect on amphetamine self-administration. Pimozide had the same effect as reducing injection dose or substituting saline for amphetamine; it caused elevated rates of lever pressing, followed by extinction of pressing at the high dose. These data suggest that dopamine plays a role in the rewards of intracranial stimulation and amphetamine administration, while noradrenaline may be involved in important supportive functions. The fact that dopamine blockade affected paraventricular self-stimulation (where there are no known dopamine fibers or terminals) suggests that the critical dopamine reward system need not be at the electrode tip to support self-stimulation.

766 MORPHOLOGICAL CHANGES IN THE TECTAL LAYERS FOLLOWED BY REORGANIZATION OF RETINOTECTAL PROJECTION IN GOLDFISH. Myong G. Yoon. Dept. of Psychology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1

In goldfish, the retinotectal projection may reorganize itself to readjust to a size-disparity experimentally induced between the retina and the optic tectum. About three months after excision of the caudal half of the tectum, the visual projection from the whole retina becomes compressed in correct retinotopic order onto the remaining rostral half-tectum (which previously received projections only from the temporal hemiretina). Histological examination of the half-tectum by Bodian's silver impregnation method shows the following morphological changes in its laminar pattern: The incoming optic fiber and outer plexiform layer (Stratum griseum et fibrosum superficiale) becomes conspicuously thicker in the half-tectum. A threefold increase can be observed relative to the intact contralateral tectum. In contrast, the thickness of the cellular and inner plexiform layer (Stratum griseum centrale) was drastically reduced in the half-tectum. Neither the deeper fiber layer (Stratum fibroseum profundum) nor the innermost cellular layer (Stratum griseum periventriculare) showed any significant change. The rostral half-tectum did not show any sign of cellular regeneration at its severed caudal margin nor an increase in cell density. These morphological changes suggest that the reorganization of retinotectal projection may involve an orderly readjustment of synaptic linkages within the outer and the inner plexiform layers of the remaining rostral half-tectum.

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767 MEMBRANE CHANGES INDUCED BY SECRETAGOGUES IN ADENOHYPOPHYSIAL CELLS GROWN IN TISSUE CULTURE. Donald H. York, Dept. of Physiology, Queen's University, Kingston, Ontario, Canada.

A variety of agents including dibutyryl cyclic AMP, and ouabain are known to release hormones from the adenohypophysis, in vitro, only in the presence of Ca^{++} ion. The present study was undertaken to investigate the membrane changes occurring in adenohypophysial cells grown in tissue culture when hormone release was triggered by various secretagogues. Intracellular impalements were made with a potassium citrate filled microelectrodes connected to a bridge circuit which allowed for the passage of current pulses through the electrode to monitor membrane resistance (Rm). Intracellular recordings were obtained from several different cell lines consisting of dispersed adenohypophysial cells, clonal derived somatotrophs and growth hormone tumor cells (GH_1). Each of these cell lines were actively releasing growth hormone into the media. Mean transmembrane potentials of the above cell types were 12.1 mV, 12.5 mV and 10.7 mV respectively. The addition of 10 µl of dibutyryl cyclic AMP (2.3 µM) caused a consistent transient hyperpolarization, which was associated with an increase in Rm. This was the only response observed in the somatotrophs and GH_1 cells and was the predominant response observed in dispersed adenohypophysial cells. The magnitude of the membrane change ranged from 2.5 - 4 mV with an increase in Rm of 2 - 6 megohms. The duration of the membrane response was considerably longer (68 sec) in the GH_1 tumor cell compared to the somatotroph cell line (40 sec). Ouabain which has been shown to cause release of adenohypophysial hormones, as well as causing an enhanced uptake of $^{45}Ca^{++}$, also produced a transient hyperpolarization with increase in Rm in the dispersed adenohypophysial cells. These results suggest that secretagogues may trigger growth hormone release by causing an increase in intracellular calcium ion. (Supported by MRC and NCI of Canada.)

768 PROPERTIES OF RESPONSES TO TONES AND NOISE OF SINGLE CELLS IN THE DORSAL COCHLEAR NUCLEUS OF UNANESTHETIZED CATS. Eric Young* and William E. Brownell. Pharm.& Physiol. Sci., U. of Chicago, 60637.

Inhibition is a much more prominent feature of the discharge patterns of single cells in the dorsal cochlear nucleus (DCN) of unanesthetized cats than in the DCN of cats anesthetized with Nembutal [Evans and Nelson, Exp. Brain Res. 17, 402 (1973)]. We studied the response properties of single cells in the DCN of decerebrate cats to tones and noise bands. The units studied were histologically localized relative to the three layers of the DCN. Roughly half the DCN cells encountered showed tuning curves consisting of a central V-shaped inhibitory region flanked at lower and higher frequencies by thin bands of relatively weak excitation. The response in the central region is mixed, usually consisting of an onset discharge, followed by suppression of discharge; large afterdischarges are frequently seen. The excitatory bands meet below the central inhibitory region at the best frequency of the cell. The prominence of the excitatory bands varies from unit to unit. Inhibitory sidebands are seen at frequencies above and below the excitatory bands. When an anesthetic dose of Nembutal is administered during the study of one of these cells, its spontaneous activity is reduced and its central inhibitory area is replaced by an excitatory region. These units are most common in the fusiform/granule cell layer, but are also encountered elsewhere in the DCN. Despite their predominantly inhibitory response to tones, these cells may respond vigorouly to broad-band noise. Unlike the situation usually described for DCN neurons, these units respond more vigorously as a band of noise centered at best frequency is progressively widened. (Supported by NIH).

769 DELAY OF OLIGODENDROCYTE DIFFERENTIATION BY BROMODEOXYURIDINE (BUdR). Linda H. Younkin*, Donald H. Silberberg. Dept. Neur., U Penn Sch Med., Phila., PA., 19174.

Newborn rat cerebellum cultures begin myelination around 10 days in vitro (DIV). When exposed to the thymidine analogue BUdR continuously from explant to as late as 27 DIV they do not myelinate. Pulses of BUdR administered so as to cover the 5-7 DIV "critical" period (corresponding to the peak of DNA synthetic activity) inhibit myelination observed on 15 DIV (Exp Cell Res 76:455, 1973). We report that this inhibition is reversible in continued culture without BUdR, and that myelination occurs with delays which correspond to the length of the BUdR pulse used to induce inhibition. The longer the BUdR pulse (e.g., 1-7 vs. 5-7 DIV), the longer the delay. We suggest that the longer pulse covers more oligodendroglial divisions than the short, resulting in more BUdR containing DNA to be diluted out with divisions after reversal. Autoradiographic evidence from uninhibited cultures shows that oligodendrocytes producing myelin on 15 DIV divide throughout the culture period; further, thymidine enhances the appearance of myelin in reversed cultures. The reversal of BUdR inhibition implies that BUdR does not kill oligodendroglia or prevent their division. The delay in myelination resulting from a BUdR-caused delay of a genetic event in oligodendroglia demonstrates the importance of the state of differentiation of the oligodendrocyte in the timing of myelination. The cerebellar tissue remains competent for myelination many days after the usual time of the initiation of myelination.

770 RAPID REPAIR OF ABNORMALITIES IN THE MYELIN SHEATH INDUCED BY GLYCEROL TREATMENT OF CULTURED SPINAL GANGLIA. Riley Yu* and Mary Bunge* (SPON: H. Burton). Depts. Anat., Univ. Texas Medical Branch, Galveston, 77550, and Washington Univ. Sch. Med., St. Louis, 63110.

Long-term, organized cultures of rat dorsal root ganglia (DRG) were used to study the processes of damage and repair of myelinated nerve fibers found to follow glycerol treatment. Well-myelinated, mature DRG cultures were exposed to regular culture medium containing 10-20% glycerol (1368 to 2736 mOsM) for 24 hours. There was no noticeable change during this period but 30 seconds after the cultures had been reversed to normal medium (300 mOsM), myelin internodes started to swell. As determined by continued light microscopic observation, this swelling process progressed with time, reaching a peak at about 30 minutes after reversal. At this time the reparative phase began, leading to a return to normal appearance often by 3 hours. At the peak of the effect, each internode resembled a string of interconnected beads and nodal regions appeared enlarged. Electron microscopic study revealed that the swelling of myelin was caused by accumulation of fluid between the sheath and the axolemma and also between some of the myelin lamellae in the area of the intraperiod line. In spite of the extensive distortion along the internode and the marked enlargement of the nodal axon, Schwann cell loops retained their contact with the axolemma at the paranodal region. Thus, drastic alterations in the form of the myelin sheath may develop and be repaired in a short period of time. The fairly rapid return to normal may be due, at least in part, to the maintenance of the Schwann cell loop-axolemmal junction; when they are disrupted by trypsin or low calcium treatment, return to normal morphology may be only partial and requires days rather than hours. (Support by Nat. Mult. Scl. Soc.)

771 TENSION OUTPUT FROM MAMMALIAN MOTOR UNITS TO NON-REPETITIVE PULSE TRAINS. F. E. Zajac and J. Young*. Dept. Elect. Engr., Univ. of Maryland, College Park, Maryland 20742

This study investigates the dependence of isometric tension output on the temporal pattern of train intervals in cat medial gastrocnemius units. Single units were isolated from small ventral root filaments and stimulated with short pulse trains consisting of various patterns of interpulse intervals. Tension area was used as a single measure of the unit's output since it is proportional to the average active state of the muscle. The sequence of train intervals $T_1^*, T_2^*, T_3^* \ldots$ which maximizes area output for each unit obeyed the relationship $T_1^* \leq T_2^* \leq T_3^* \ldots \leq T_n^*$ for a train of n pulses. Many sub-optimal trains with intervals close to $T_1^*, T_2^*, T_3^* \ldots$ produced nearly equal tension areas, especially in fast contracting units. Any pulse train with 4 pulses or less with only its first interval optimized to T_1^* caused more tension area than most other sub-optimal trains which were equally long in duration and had the same number of pulses. It was concluded that tension areas of almost maximal value can be attained even with relatively large amounts of randomness in train intervals as might occur during fast locomotion and jumping.

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772 INTERACTION OF L-PROLINE AND GLUTAMATE UPON NEURONS IN THE CENTRAL NERVOUS SYSTEM OF THE CAT. Peter Zarzecki*, Paul Blum and George Somjen. Dept. Physiol. Pharm., Duke U., Durham, N.C. 27710

Van Harreveld and Fifkova (J. Neurochem., 20, 947-962, 1973) have reported that l-proline prevents the glutamate-induced increase in transparency of the isolated avian retina. To test for a comparable antagonism in the mammalian CNS, we have applied proline from multibarreled microiontophoretic electrodes in attempts to modify glutamate-induced excitation of neurons in the cerebral cortex and cuneate nucleus of locally anesthetized, decerebrate or chloralosed cats. Up to 40 na of proline applied for up to 20 min did not alter the spontaneous or glutamate-induced activity of any of 23 cuneate units (relay cells and interneurons) on which it was tested. In contrast, proline reduced or eliminated glutamate excitation of 11 out of 20 cortical cells without modifying the spontaneous activity. This effect has a latency of several min, is reversible and repeatable. The antagonism progresses during the proline application and can sometimes be overcome by increasing the current carrying the glutamate. The effect persists beyond the period of proline application. Current from barrels filled with NaCl at the same pH as the proline solution had no comparable effect. Aspartate-induced excitation is usually reduced along the same time course. These results indicate that the neuronal sites at which glutamate acts in these two regions differ and, therefore, that the function of glutamate may also differ in these regions. (Supported by PHS grants NS 05330 and NS 10507.)

773 INDUCTION OF FEMALE SEXUAL BEHAVIOR BY INTRACRANIAL CATECHOLAMINE ADMINISTRATION. F. P. ZEMLAN* (SPON: C. R. GALLISTEL). Dept. of Psych., Univ. of Penn., Phila. 19104

Intracranial application of dl-norepinephrine (dl-NE) or dl-dopamine (dl-DA) to the ventral midbrain or central gray induced female sexual behavior in rats. Ovariectomized and adrenalectomized females were primed with 5 ug of estradiol benzoate. Females were then tested for lordotic behavior prior to drug administration and ¼, ½, 1½ and 3 hrs afterwards. Maximal lordotic responding occurred 1½ hrs after drug administration with lordosis on 50-60% of the mounts. While dl-NE and dl-DA were effective at the ventral midbrain and central gray placements saline administered to these areas was ineffective. The present investigation and other neurochemical and electrophysiological studies suggest that the diencephalon and the mesencephalon function synergistically to produce motivated behavior.

774 LEVELS OF FOLATE AND S-ADENOSYL-L-METHIONINE IN TISSUES OF ADULT AND DEVELOPING MICE FOLLOWING FOLIC ACID DEPRIVATION. John W. Zemp, L. Ann Blackwell* and Lawrence D. Middaugh. Med. Univ. of S. Car., Charleston, So. Car., 29401; and Wayman Turner* and Elaine Gunter*. Nutr. Biochem. Sec., CDC, Atlanta, Ga. 30333.

Lactating, developing, or adult DBA/2J mice were maintained on folic acid deficient (FAD) diet or folic acid control (FAC) diet ad libitum. Brain and liver S-adenosyl-L-methionine (SAM) and brain, liver, and plasma folate levels were determined. Effects of the FAD diet on activity and reactivity of developing mice were also examined. Dams started on FAD diet at delivery had lower liver and plasma folate levels compared to controls 35 days post partum. The pups, continued on the FAD diet after weaning, had lower brain, liver, and plasma folate levels when sacrificed at 35 days of age. Behavioral measures on these animals at 34 days of age suggest that animals maintained on FAD diet were more reactive to an acoustic stimulus. Adults started on the FAD diet and a 1.0% Sulfasuxidine drinking solution at 42 days of age were compared with controls maintained on FAC diet and tap water for equivalent periods of time. After 6, 8, and 10 week intervals, liver and plasma folate concentrations were lower for animals on the deficient diet. After 10 weeks on the FAD diet brain folate was lowered. This study indicates that a decrease in folic acid content of the brain can be produced in adult mice maintained on a deficient diet plus Sulfasuxidine for long periods of time. The initially lower levels in liver and plasma but not brain indicate a general sparing of brain folate followed by a decline with prolonged deprivation. In the developing animal a decrease in brain folate occurs more rapidly, possibly due to increased demands for folate derivatives during development. SAM levels are not affected by a folate deficiency in any group. Supported by USPHS Grant #ND09471.

775 DEXAMETHASONE TERMINATION OF STRESS-INDUCED PITUITARY-ADRENAL RESPONSES IN THE RAT. E. Zimmermann‡ B. Branch‡ C. N. Pang‡ and A. Newman Taylor. Dept. of Anatomy and Brain Research Inst.,UCLA Sch. Med.,Los Angeles 90024

Corticosteroid inhibition of stress-induced ACTH release in the rat is well documented. However, most experimental evidence of this negative feedback effect represents an action of corticosteroids administered prior to the onset of stress. To determine if corticosteroid feedback inhibits ongoing stress-induced pituitary-adrenal activity, adult male Sprague-Dawley rats were subjected to one of several different stress stimuli at 0900. Fifteen min later, saline or dexamethasone (100 or 400 μg/kg) was injected subcutaneously. Forty-five min after injection, blood was obtained by decapitation and the plasma concentration of corticosterone was subsequently assayed fluorometrically. Nonstressed controls received saline and remained in their cages until decapitation 1 hr later. The results obtained with several different stress stimuli are presented in the following table:

	μg Corticosterone/100 ml Plasma			
Stress	Nonstressed	Stress		
Stimulus	Control	Saline	Dex(100)	Dex(400)
1min Ether	5.1±0.5@	11.3±1.8	12.6±2.3	8.3±1.5
Formalin	5.3±0.8	20.3±1.4	19.5±0.9	20.5±0.6
Morphine (40 mg/kg)	14.0±0.8	30.8±3.3	14.0±4.4**	9.4±1.7**
Cold (6° C)	6.8±0.9	22.8±2.6	17.3±2.9	15.1±2.8*
Restraint w/tilt	4.8±1.1	18.9±1.3	19.0±0.7	18.2±1.6
Restraint w/o tilt	7.7±0.9	25.3±2.1	23.0±1.6	17.8±3.7*

@ mean ± S.E.,5-8 rats/group;*p<0.05; **p<0.01 (t test, vs saline group)

These findings indicate that dexamethasone inhibits pituitary-adrenal activity enhanced by prior exposure to morphine, cold or restraint and this effect appears to be dose-dependent. Further, these results suggest that corticosteroid feedback may terminate ACTH responses to some stresses.

776 INVOLVEMENT OF NIGRO-NEOSTRIATAL DOPAMINERGIC NEURONS IN THE ACQUISITION OF A CONDITIONED AVOIDANCE RESPONSE (CAR). A. P. Zis*, H. C. Fibiger and A. G. Phillips. Dept. Psychiatry, University of British Columbia, Vancouver, Canada

Rats in which the nigro-neostriatal dopaminergic bundle (NSB) had been destroyed bilaterally by local injections of 6-hydroxydopamine (8 μg in 2 μl) into the substantia nigra failed to acquire a one-way active avoidance response or a simple approach response for food reinforcement. If however rats were overtrained (10 trials/day for 13 days) on the avoidance response prior to the nigral lesions, nearly perfect retention of the response was observed in the lesioned animals. Pretreatment with small quantities of L-DOPA (1.5 mg/kg) in combination with a peripheral decarboxylase inhibitor completely reversed the acquisition deficit produced by the substantia nigra lesions. In another series of experiments the dopamine receptor blocking agent, haloperidol (0.15 mg/kg) prevented the acquisition of CAR. Haloperidol did not disrupt the performance of rats which were overtrained on this response (10 trials/day for 9 days) before receiving the drug. If however animals were trained for 2 days (10 trials/day) and then injected with haloperidol (0.15 mg/kg) on the third day substantial deficits in avoidance responding were evident. These experiments point to the special significance of the dopaminergic NSB in the acquisition but not in the retention or performance of learned instrumental responses.

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777 DISCRETE MANIPULATIONS OF HIPPOCAMPAL SUBFIELDS OF THE MOUSE: EFFECTS ON MEMORY. Steven F. Zornetzer and Carl A. Boast* Dept. Neurosci., Coll. Med., Univ. of Fla., Gainesville, Fla. 32610

We have previously shown that the presence of ferric ions (Fe^{+3}) bilaterally in the dentate gyrus of the mouse hippocampus can result in a retention deficit 24 hr. after initial training in the 1-trial inhibitory avoidance task. We have also shown that Fe^{+3} located in other hippocampal subfields (primarily the CA1 region) can result in a retention deficit 15 min. but not 24 hr. after training. The present study attempted to determine whether discrete electrolytic lesions (made by delivering 500μA anodal current through platinum-iridium electrodes to avoid Fe^{+3}) in the dentate gyrus or other hippocampal subfields would mimic the effects produced by Fe^{+3}. Lesioned animals were trained in the step-through apparatus and tested either 15 min. or 24 hr. later. The results were consistent with the data previously reported for Fe^{+3}, that is, bilateral damage to the dentate gyrus resulted in a deficit at 24 hr. but not at the 15 min. test. Damage to non-dentate regions resulted in impaired performance at the 15 min. test but not at the 24 hr. test. The data are interpreted to indicate that a high degree of intrahippocampal specificity exists with respect to information processing.