

Mouthings in Swedish Sign Language: An exploratory study

Johanna Mesch

Krister Schönström

Sebastian Embacher

Department of Linguistics, Stockholm University

Abstract. This paper deals with the non-manual mouth actions of Swedish Sign Language, *Svenskt teckenspråk* (STS). Based on data from the Swedish Sign Language Corpus and the Swedish Sign Language as L2 Corpus, we compare the use of mouthings in deaf L1 as well as hearing L2 signers. The use, distribution and frequency of mouthings are explored and described quantitatively and qualitatively. The results reveal some similarities as well as differences in the use of mouthings between the groups. Furthermore, the analysis reveals qualitative differences related to the properties of mouthings i.e. full and reduced mouthings among L1 as well as L2 learners of STS. Challenges of the analysis of mouthings will be discussed.

Keywords. Swedish Sign Language, mouthing, reduced mouthing, L1 and L2 signers, corpus-driven study

1. Introduction

This paper deals with mouth actions in sign languages, using Swedish Sign Language (STS) as a case study. As is already known, sign languages use both manual and non-manual articulators to produce meaningful linguistic utterances. Manual articulators consist of one or two hands, which contribute to the main lexical content. Non-manual articulators typically consist of body, head and face movements including mouth actions, that primarily function as grammatical markers. This is the case in particular with respect to the syntax required to mark negation and distinguish between different clause types, and to show prosody, among other functions. Here, we focus on the movements of the mouth i.e. mouth actions, that, apart from having grammatical functions, can also contribute to the lexical information of the signs. Two main categories of mouth actions have been proposed: mouthings and mouth gestures (Crasborn et al. 2008; Boyes Braem & Sutton-Spence 2001). Mouthings are mouth movement patterns based on the visual properties of spoken languages, representing the visual “phonetic” elements based on how words are articulated visually in spoken languages. Mouth gestures on the other hand are sign languages’ own language-specific mouth movements.

The linguistic role of mouth actions has been discussed with regard to the degree of conventionalization as well as the degree of obligatoriness in using mouth actions along with manual signing (see e.g. Johnston, van Roekel & Schembri 2016). This seems to some degree to be language-specific, e.g. in the ECHO corpus (Crasborn et al. 2008), it is shown that the Swedish data compared to other sign languages, British Sign Language (BSL) and Sign Language of the Netherlands, has a high degree of mouthings compared to mouth gesture categories. Mouthings are also suggested to be more robust linguistically due to their contribution to lexical information: in STS (and many other sign languages) mouthings are often the only component that differentiates between ambiguous signs. The linguistic contribution of mouth gestures, on the other hand, is more varied and unclear according to the literature (Bank, Crasborn & van Hout 2016; Johnston, van Roekel & Schembri 2016).

Mouthings is under-studied from a more descriptive and qualitative perspective within the Swedish deaf community. Here we ex-

plore how deaf signers use mouthings, and more specifically the distribution and the varied use of full and reduced mouthings. From previous studies, we know that hearing status as well as linguistic background are two of the factors related to the use of mouthings (c.f. Boyes Braem 2001; Mesch & Schönström 2021). School background may be yet another factor as signers can come from deaf (sign bilingual) schools or mainstreamed schools but also with influence from periods of oral deaf education. Moreover, mouthings is also found to depend on language contact, who a signer is talking to, at home, in the workplace, with relatives or sport peers. In summary, there is language variation within the signing community (c.f. in Norwegian Sign Language, Vogt-Svendsen 1983).

In a previous study on the use and acquisition of mouth actions in L2 signers (Mesch & Schönström 2021), among other things, it was shown that L2 signers had a higher ratio of mouthings compared to the L1 control group. We also found an interesting pattern in how the mouthings were used between L1 and L2 signers, i.e. the use of full and reduced mouthings. We observed that L1 signers use reduced mouthings to a greater extent compared to L2 signers. We also found formal similarities with the E-type mouth actions, i.e. syllabic mouth gestures. However, the study came from an L2 perspective, the L1 data in the L2 study consisted only of a small control group of nine L1 signers and we did not analyze the characteristics of the mouthings in fuller detail; this motivates us to take a step further in the present study. Here we aim to further explore the use of full and reduced mouthings in a larger group of L1 signers using data from the STS corpus. The purpose is to describe the patterns in the use of mouthing among deaf L1 signers, and the characteristics of full and reduced mouthings in more detail.

2. Mouth actions in STS and sign languages – some definitions

Generally, sign linguists have divided mouth actions into two categories: mouthings and mouth gestures. Mouthings are mouth actions whose pattern is based on elements from spoken languages, i.e. (silent) articulation of a word based on its phonological elements. Some sign linguists have labeled this as the M-type. For STS it means the sign DÖV ‘deaf’, which is accompanied by the mouthing of

Swedish word *döv*, would get the mouthings that corresponds to articulating the word Swedish word *döv*. Mouth gestures on the other hand, are genuine mouth actions of sign languages, not related to spoken words. So far, researchers have identified five different sub-categories of mouth gestures: Syllabic mouth actions (E-type), adverbial mouth actions (A-type), imitating “mouth for mouth” gestures (4-type), whole face gestures (W-type) and backchannel interjections (B-type). In this article, we will focus on mouthings (M-type) and their relationship to syllabic mouth actions (E-type).



2.1 Syllabic mouth actions (E-type)

Syllabic mouth actions are a sub-category within the category of mouth gestures. These are inherent mouth movements belonging to sign language’s internal structure (i.e. not derived from spoken languages as with mouthings). Crasborn et al.’s (2008) label for this is the E-type mouth gesture based on its echo-similar properties, i.e. a mouth action follows the movement of the manual component of the sign as a motoric echo (c.f. Woll 2001). Typically, the mouth movement structure of E-type consists of one, two or three mouth segments that can be described using phonetic terms.

In a preliminary study on mouth segments in STS, Bergman and Wallin (2001) arrived at the hypothesis that there is a native pattern of mouth segments determined for what they call “lexically determined mouth gestures”, which falls within this category of E-type mouth gestures. They suggest that there is a limited set of visual mouth segments that can be combined in a limited way, either as one-, two- or three segmental mouth actions, see Figure 1 for a suggestion of such a mouth segment list. Two-segmental mouth actions /bilabial, stretched/ and /bilabial, forward/ are the most frequent in the STS lexicon database.

Figure 2 shows some examples of signs using combined syllabic mouth actions that are lexically bound to these signs, in which one of them LYCKAS ‘I finally made it’ is illustrated in fifth example. Syllabic mouth actions /open, airstream/ parallel the movements of the hands for the sign.

Figure 1: Visual phonetic mouth segments and tokens from the Swedish Sign Language lexicon database.

Visual mouth segments	Label	Mouth gesture form	Tokens in STS dictionary	Visual mouth segments	Label	Mouth gesture form	Tokens in STS dictionary
	airstream	[blås]	62		open-stretched	[ä]	19
	bilabial	[m]	407		pursed	[u]	93
	bilabial-closed	[m-together]	109		round	[o]	34
	bilabial-down	[m-down]	38		stretched	[s]	62
	cheeks	[pp]	38		stretched-e	[e]	5
	forward	[y]	37		stretched-i	[i]	60











	labio-dental	[f]	31		tongue	[th]	60
	open	[a]	40		tongue-down	[th-down]	0
	open-tongue-down	[a-t]	23		tongue-out	[th-out]	39
	open-tongue-up	[a-l]	5		tongue-open	[th-open]	1

Figure 2: Examples of signs with syllabic mouth actions (E-type) from the Swedish Sign Language Corpus.

Sign	Phonetic mouth segments	N Segment	Meaning
 LYCKAS-INTE	stretched-i	one	'not succeed'
 TABBA-SIG	bilabial, airstream	two	'lose herself/himself/themselves'



bilabial,
stretched-e
(repeated) two
(repeated) *'not happen'*

HÄNDA-INTE(V)



open,
airstream two *'succeed'*

LYCKAS



open,
stretched-i
(repeated) two
(repeated) *'not succeed'*

LYCKAS-INTE



open
tongue-up,
open,
stretched-i three *'un-
necessarily'*



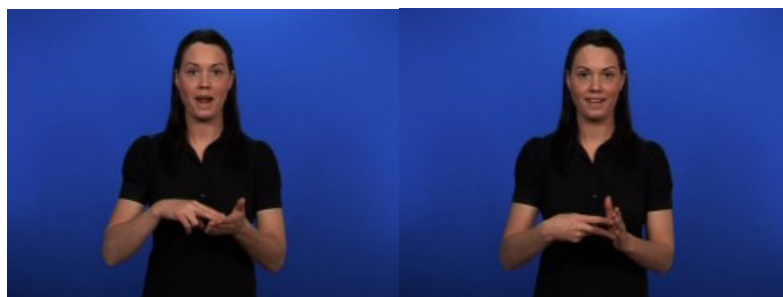
ONÖDAN

2.2 Mouthings (M-/ME-type)

2.2.1 Mouthings (M-type)

Mouthings is a category of mouth actions that is based on a mouth movement with visual elements borrowed from the prototypical mouth articulation of words from spoken language. Following Crasborn et al. (2008), we label this M-type. Mouthings is an outcome of language contact and it adds to the phonological configuration of the sign e.g. the sign for ‘plan’ in STS with handshape “V hand”, down and right, contact with flat hand, right and up, turned left, contact with flat hand, see Figure 3. This sign is ambiguous and can have many meanings through mouthings ‘project’, ‘plan’, ‘actor’, and ‘technique’, and often the only parameter that differs between the signs is the mouthing. However, it is still unclear if mouthings can be counted as an obligatory parameter in the phonological organization of signs, or even as an integral part of a sign language, as sign language researchers have arrived at diverse conclusions on this (see Bauer, 2019 for an overview). Mouthings in STS do not usually include inflections such as Swedish morphemes for e.g. definiteness and number as in *pojke* ‘boy’, *pojken* ‘the boy’, *pojkar* ‘boys’, but there are exceptions, i.e. signers with a stronger connection to Swedish e.g. late signers tend to use inflected mouthing as was found in L2 STS signers (see Mesch & Schönström 2021). Inclusion of inflections in mouthing seem to differ for different sign languages, e.g. Hungarian sign language is reported to frequently include inflections (Racz-Engelhardt 2016), while other sign languages use these less frequently, e.g. German Sign Language (Ebbinghaus & Hessmann 2001).

Figure 3: The sign for PLAN ‘plan’, id 04209 Svenskt teckenspråkslexikon



Crasborn et al. (2008) pursued a comparative study on the mouth actions of three sign languages, NGT, BSL and STS, and concluded that the category of mouthing was most frequently compared to other mouth action categories for all three sign languages. Their statistics show that M-type mouthings for STS are highly frequent, accounting for 57% of all the mouth types, compared to 51% for BSL and 39 % for NGT. However, it should be noted that the participants in these corpuses were experienced storytellers, and they did have preparation time prior to their storytelling, and as a result they may have exhibited higher usage of constructed action, which in turn should affect the use and amount of mouth gestures. Nevertheless, a number of studies on mouth actions in several sign languages consistently report a high prevalence of mouthing (Johnston, von Roedel & Schembri 2016; Bank, Crasborn & van Hout 2016; Ebbinghaus & Hessmann 2001; Bauer 2019).

In a recent study on the use and acquisition of mouth actions in L2 signers using STS as L2 corpus data, we observed qualitative as well as quantitative differences between L1 and L2 signers in using mouthings, i.e. in the use of full and reduced mouthings. In the STS corpus based on L1 control group data, we observed that mouthings occurs mostly in a reduced way, but this was not accounted for in detail. We believe that it is possible that some reduced mouthings is associated with specific signs, just like syllabic mouth gestures (E-type), which will be described further below.

2.2.2 Reduced mouthings (ME-type)

Previous studies have shown that parts of mouthings are reduced and similar to mouth gestures e.g. the E-type (Bank 2015), Schermer (2001; 1990), for NGT, and Bauer (2019), for Russian Sign Language (RSL); furthermore there are claims that reduced mouthings share the same formational patterns as mouth gestures and thus become unidentifiable as those derived from spoken words. Reduced mouthings are found in several sign languages, e.g. German Sign Language (DGS), NGT, and Australian Sign Language (Auslan). Syllables are reduced often in the form of being exclusively expressed by word-final consonants (Bank 2015; Bank, Crasborn & van Hout 2011; Boyes Braem & Sutton-Spence 2001; Johnston, von Roedel & Schembri 2016). Mouthings may be reduced to a single syllable or segment as in the NGT mouthing example ‘see’ from *zien*

to *z* (Bank, Crasborn & van Hout 2015). Reductions are observed to appear in both nouns and verbs (Ebbinghaus & Hessmann 2001), for several sign languages, although some reported more association to nouns (see Bauer 2019 for an overview). Reduced M-type is suggested to be more similar to E-type mouth gesture because of its “syllables” or segments according to Bergman & Wallin (2001), (see also Schermer 2001; Schermer 1990; Bauer 2019). Bergman and Wallin (2001) hypothesized for STS that reduced mouthing conforms to the native pattern of E-type mouth gestures, which motivates us to label it as ME-type; i.e., it has similar structure to the E-type but is based on mouthing of Swedish words.

Prosody varies widely in signers with different backgrounds (Bank, Crasborn & van Hout 2011). It presents a contrast to reduced mouthings, which should conform to the rhythm of the monosyllabic form of the sign (Sandler & Lillo-Martin 2006: 105). Language knowledge seems to affect how speakers control rhythm or emphasize syllables of spoken language, e.g. the prosodic information of spoken Dutch words (Bank, Crasborn & van Hout 2011) and of spoken words from the free-stress language Russian (Bauer 2019). We believe that there is a variation between full and reduced mouthings insofar as mouth articulation, prosodic binding and co-occurring signing are concerned.

In an earlier study focused on adult L2 learners of STS, we demonstrated that reduced mouthings was widely used in the L1 control group (Mesch & Schönström 2021). As the reduced mouthings share the properties from – on the one hand – the M-type (i.e. based on Swedish words), and on E-type (i.e. syllabic) on the other hand, we labeled them as ME-type. Just like the E-type, the ME-type seems to appear in conjunction with a specific set of signs. Mouth action as the ME-type follows the movement of the manual component of the sign, similar to the E-type. The characteristic of the ME-type is when the mouthing of a sign typically contains one or two segments and sometimes three segments, which is reminiscent of the E-type, see Figure 2.

The degree of visible parts of the target Swedish word in the mouthing can vary. It can sometimes be hard to trace the properties of a mouthing to a target word. Some of the mouthings, that seem to be *reductive* at a first glance, may not always be so reductive in relation to the actual articulation of spoken words. There are

mouthings based on one or two segmental mouthing that are representations of short Swedish words such as HA for *ha*. Figures 4–6 show some examples in STS of how signers articulate words in such a way that some parts are not visible or clearly visible, e.g. the signs HA (*h*)*a* ‘have’ in Figure 4, BETYDA *b(et)y(da)* ‘mean’ (the Swedish /by/ with a close front rounded vowel, IPA¹[y]) in Figure 5, and KVAR (*k*)*va(r)* ‘left’ in Figure 6. For example, the one segmental mouthing of HA is based on the word *ha*, where *a* is just visible in the mouthing, as in the articulation of the Swedish word, KVAR with the two segmental mouthing *va*, as in the articulation of the Swedish word *kvar*. To sum, there are words with many consonants e.g. “h”, “k” and “r” for example that are not visible in the vocal articulation of the Swedish word either, and are thus counted as either M-type or MS-type: this is a good example of ambiguity. BETYDA ‘mean’ with the two segmental mouthing *by*, differs from the articulation of the Swedish word *betyda* and is thus counted as ME-type. So, to sum, for the categorization of ME-type we have focused on one-, two- or three-segmental reduced variants of words that usually are articulated longer, as with the mouthing of the sign BETYDA. For the mouthings that have similar formal properties of ME but adhere to short Swedish words as in the signs HA or KVAR, we have labeled them as MS-type, as in short mouthing, see below.

Figure 4: HA (*h*)*a* ‘have’ (SSLC01_161, 00:04:29.282)



1 The International Phonetic Alphabet

Figure 5: BETYDA *b(et)y(da)* ‘mean’ (SSLC01_321, 00:00:06.844)



Figure 6: Two segments from labiodental to open from Swedish word *(k)va(r)* ‘left’ (SSLC01_265, 00:02:31.200)



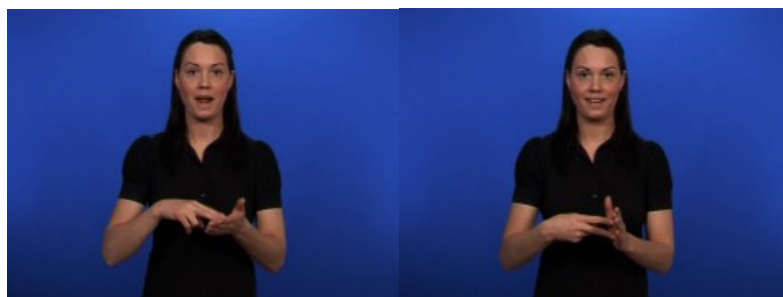
Mesch and Schönström (2021) suggest that L2 sign language learners find it difficult to express manual signs with mouthings and/or mouth gestures, to let manual signs and mouthing cooperate prosodically (right timing for articulating), and to choose which mouth types to use with which signs. Mesch and Schönström (2021) show that L2 signers may struggle with this due to different reasons. We found that the L2 signers use reduced mouthings to a significantly lesser extent compared to L1 signers. We discussed this in the context of the concept of transfer: this may be a case of contact-induced L1 transfer from Swedish, as the mouthings was widely used by L2 signers compared to L1 signers (irrespective of whether it was full or reduced). In addition, these mouthings were often accompanied by Swedish inflections. Due to their current linguistic proficiency stage, signers are not able to distinguish

2.2 Mouthings (M-/ME-type)

2.2.1 Mouthings (M-type)

Mouthings is a category of mouth actions that is based on a mouth movement with visual elements borrowed from the prototypical mouth articulation of words from spoken language. Following Crasborn et al. (2008), we label this M-type. Mouthings is an outcome of language contact and it adds to the phonological configuration of the sign e.g. the sign for ‘plan’ in STS with handshape “V hand”, down and right, contact with flat hand, right and up, turned left, contact with flat hand, see Figure 3. This sign is ambiguous and can have many meanings through mouthings ‘project’, ‘plan’, ‘actor’, and ‘technique’, and often the only parameter that differs between the signs is the mouthing. However, it is still unclear if mouthings can be counted as an obligatory parameter in the phonological organization of signs, or even as an integral part of a sign language, as sign language researchers have arrived at diverse conclusions on this (see Bauer, 2019 for an overview). Mouthings in STS do not usually include inflections such as Swedish morphemes for e.g. definiteness and number as in *pojke* ‘boy’, *pojken* ‘the boy’, *pojkar* ‘boys’, but there are exceptions, i.e. signers with a stronger connection to Swedish e.g. late signers tend to use inflected mouthing as was found in L2 STS signers (see Mesch & Schönström 2021). Inclusion of inflections in mouthing seem to differ for different sign languages, e.g. Hungarian sign language is reported to frequently include inflections (Racz-Engelhardt 2016), while other sign languages use these less frequently, e.g. German Sign Language (Ebbinghaus & Hessmann 2001).

Figure 3: The sign for PLAN ‘plan’, id 04209 Svenskt teckenspråkslexikon



between full and reduced mouthings in their signing, as part of the differentiation process in their L2 acquisition.

3. The present study

In our previous study on L2 signers, we had a control group consisting of a limited dataset of 9 L1 signers. In that study, it was shown that L1 signers use the ME-type mostly compared to the M-type in both narrative and conversational data. In this present study, our intention is to take this a step further to investigate a larger dataset consisting of L1 signers. Here the STS corpus was employed to explore the use of mouthings, how full and reduced mouthings are used, and how they are distributed across signs and users. Using corpus-linguistic methodology, i.e. a frequency list, we annotated all mouth actions according to the categories described above and summarized them. Moreover, we provide an exploratory qualitative analysis of the reduced mouthings used.

The purpose is to account for the reduced mouthings variants based on a larger dataset consisting of more participants and more genres as well as individual variation. We also seek to describe the difference between using reduced or full mouthings. We also believe that some ME-types are strongly associated with specific signs, just like with signs with E-types.

4. Analysis of data from two STS corpora

This section describes the STS corpus and the STS as L2 corpus, as well as the analysis of the new sampled data from the STS corpus, and the comparison with previous analyzed data from the STS as L2 corpus, which has been annotated with glosses and mouth types.

4.1 The STS corpora

In this study we take as our point of departure data from two different STS corpora; the STS Corpus and the STS as L2 corpus. The STS Corpus consists of data from deaf signers, based on short personal presentations, one-hour conversations and retellings of the Frog Story, Snowman, cartoons and a short movie clip. In total, the STS corpus comprises 42 signers, aged 20-82, from three regions of Sweden. So far, the entire corpus is not completely gloss annotated,

but this work is in progress. To date, 85% of the STS corpus has been annotated with glosses and 60% with Swedish translations. However, fewer mouth actions have been annotated; so far, 15 texts (56:44 minutes) have been annotated with mouth types for this study. The data consists of a sample of 30 signers (15 male and 15 female), age range 20–82 years, mean age 44.5 years, $SD=17.6$. Age of (sign language) Acquisition ranged 0–7 years with mean 1.97 years, $SD=2.0$. The signers come from different regions in Sweden.

From a previous study (Mesch & Schönström 2021), we have data and results from the STS as L2 corpus based on 16 L2 signers of various linguistic proficiency levels, from beginners to intermediate learners, as well as data from a control group of nine L1 signers. Most of the L1 signers are young signers 20 years old ($N=7$) and most of the signers are female ($N=8$). They were chosen in order to match the characteristics of L2 signers, i.e. young female students studying at a sign language interpreting program at Stockholm university. L1 control group data consists of 50:57 minutes including interviews and retellings. L2 data consists of 2:22:15 hours of data including interviews and retellings from 16 L2 signers (14 female, age range 19–40, mean age 23.6, $SD=5.1$).

There are similarities between the two corpora with regard to discourse genres but there are also small differences. The similarities lie in the retellings, i.e. using the Frog Story as well as cartoons and movie clips (*The Plank*) as elicitation material, although STS as L2 corpus data were only based on one specific retelling data based on the movie clip *The Plank*. The difference lies in the conversation section: in the STS corpus, the participants conversed with each other freely, based on different topics provided. In the STS as L2 corpus, participants were interviewed, and consequently, the style of conversations differs.

4.2 Annotation description

Using the annotation tool ELAN, three tiers were established for annotation of: 1) mouth types, 2) number of mouth segments, and 3) comments. First, the basic annotation of mouth types follows the same procedure as for the previous study (Mesch & Schönström 2021). For this study, the annotation was specifically focused on M-type and ME-type mouthings (see Table 1).

Table 1: Categorization and description of M/ME and E mouth actions (cf. Mesch & Schönström 2021)

Category	Subcategory	Description
Mouthing	M-type	Mouthing with borrowed elements from Swedish
	MS-type	Short mouthing with borrowed elements from short Swedish words
	ME-type	Reduced mouthing
Mouth gestures	E-type	Mouth components, i.e. mono- or polysyllabic mouth actions

First, we identified and annotated the mouth types, which were coded by three deaf annotators, for lexical signs only. Mouthings for depicting signs, compound signs, and pointings were not coded. However, mouthings for the most frequent pointing sign PRO1 *jag* ‘I/me’ were included (only for a part of the STS Corpus in two text types; retellings and conversation). Besides our analysis of the category full mouthings (M-type) the signs with one- or two-segmental mouthings which had counterparts with short monosyllabic and Swedish words with one-, two-, three letters, but also some words with four letters such as *ha* ‘have’, *öl* ‘beer’, *såg* ‘see/saw’, *kvar* ‘left’, were marked with MS.

Furthermore, we annotated the number of mouth segments in ME-types. The number of mouth segments is between 1-3 segments, representing the pattern of ME-type mouthings. After that, we identified and counted visible articulated parts of a targeted contact word that was used, e.g. *fö(rklara)* ‘explain’. This part of the analysis was not uncomplicated, as there are words in which the articulation of several consonants (like k, h and r) is usually invisible, also in vocal articulation of these words, and therefore merely falls within the M or MS category. So, the identification of ME types and the tracking of invisible of spoken words could be complicated sometimes. That is why the marking of mouthing originated in short words i.e. MS are important in order to control for the proper identification of corresponding words.

Third, in the comment row, we added comments about what segments of the mouthings were visible, in order to make the analysis of mouth segments transparent and accessible for other annotators and future analysis.

5. Results

In this section, the results are presented. First, we will show the frequency and distribution of mouth categories in STS corpus (5.1) and STS as L2 corpus (5.2). Later the structure of reduced mouthings and its frequency and distribution are presented (5.3).

5.1 Distribution of mouth categories in STS corpus

Below is the distribution of mouth categories based on conversation and retelling data from the STS corpus (Table 2). In line with previous results found for STS (Crasborn et al. 2008; Mesch & Schönström 2021), mouthings is the most frequent category regardless of discourse genre. For retellings we also see a larger number of mouth gestures such as whole face gestures (W-type) and adverbial mouth gestures (A-type) compared to conversation data, which are to be expected from the nature of narratives, i.e. use of constructed actions etc.

We also see a pattern within the mouthing category i.e. for M/MS/ME-type. In line with previous findings, mouthings as a category is most frequently used, and ME-type as well as M-type account for a considerable part, especially in conversations. In retelling, there is 11.9% and 15.5% use of mouthings for ME-type and MS-type respectively, compared to 28.0% for M-type, and in conversation 20.1% and 13.2% for ME-type and MS-type respectively compared to 30.3% for M-type, see Table 2. These results confirm earlier findings shown in Crasborn et al. (2008) for STS, i.e. mouthings together stand for 58.3% of the mouth actions also in the STS corpus (compared with 57% in Crasborn et al. (2008))

Table 2: Frequency and distribution of mouth actions by category. Retelling data (n signers=5) and Conversation data (n signers=10).

Category	Retelling		Conversation		
	n mouth	Percent of distribution	n mouth	Percent of distribution	of distribution
M-type	382	28.0%	1,350	30.3%	
MS-type	212	15.5%	591	13.2%	
ME-type	163	11.9%	897	20.1%	
E-type	52	3.8%	270	6.1%	
A-type	66	4.8%	43	1.0%	
W-type	103	7.5%	90	2.0%	
B-type	0	0.0%	41	0.9%	
4-type	7	0.5%	14	0.3%	
No action	381	27.9%	1,165	26.1%	
Total	1,463	100.0%	4,461	100.0%	

5.2 Distribution of mouth categories in STS as L2 corpus

Table 3 shows the frequency and distribution of mouth actions by category based on data from the STS as L2 corpus (Mesch & Schönström 2021). Data is based on sign language production of 16 L2 signers of various proficiency levels (first-year and second-year sign language interpreter students). The subjects participated in a longitudinal data collection which includes tasks of retelling a short movie clip (*The Plank*) and dialogue in which a L1 signer interviewed the L2 signer on various topics mostly related to personal experiences and personal life. In addition, there is a control group consisting of 9 L1 signers.

Table 3: Number and percentage of mouth actions by category in retellings and interviews in L2 and L1 signers (based on data from Mesch and Schönström (2021)).

	L2 (N=16)				L1 (N=9)			
	Retellings		Conversations		Retellings		Conversations	
M-type	1,699	71.9%	7,685	89.3%	245	21.1%	1,510	51.0%
ME-type	27	1.1%	25	0.3%	264	22.8%	573	19.4%
E-type	19	0.8%	106	1.2%	24	2.1%	178	6.0%
A-type	69	2.9%	58	0.7%	89	7.7%	47	1.6%
W-type	138	5.8%	62	0.7%	31	2.7%	9	0.3%
B-type	4	0.2%	66	0.8%	5	0.4%	30	1.0%
4-type	6	0.3%	3	0.0%	2	0.2%	1	0.0%
No action	402	17.0%	601	7.0%	500	43.1%	612	20.7%
Total	2,364	100.0%	8,606	100.0%	1,160	100.0%	2,960	100.0%

As can be seen from Table 3, the patterns for mouthing and other mouthing categories differ in L1 and other groups with regard to frequency and distribution. A striking difference is shown by no use of mouth action, i.e. “no action”, and there are also differences in use of for example A-type and E-type. For the mouthing category, i.e. M (including MS) and ME types, L1 signers clearly use ME types to a greater extent compared to the L2 signers. It was also found that L2 signers frequently add Swedish inflections to their mouthings.

A comparison of the L1 control group data from the STS as L2 corpus with STS corpus data (Table 3) shows some similarities in distribution with regard to no action, E-type and A-type in both text

types. However, the STS corpus shows a somewhat higher rate of mouthing compared with data from the control group in STS as L2 corpus, at least for the retelling part. We can only speculate why this is so; we guess that is a matter of 1) age differences (the L1 control group are younger signers), 2) differences in stimuli design generating different data.

5.3 Structure of reduced mouthing (ME-type)

A closer study concerning reduced mouthing (ME-type) in two discourse types shows that two segments are most used in reduced mouthings (64.4% in retellings compared to 59.9% in conversation) (see Table 4). Next is one-segment mouthings with 34.4% and 38.8% respectively. The three-segment reduced mouthings are rarely found in the data, and are linked to very few signs, e.g. PERFEKT *pe(r)f(ekt)* ‘perfekt’.

Table 4: Number of mouth segments for ME-type.

Retellings			Conversation	
1 segment	56	34.4%	354	38.8%
2 segments	105	64.4%	528	59.9%
3 segments	2	1.2%	12	1.3%
	163	100.0%	887	100.0%

5.3.1 Qualitative examples of ME and MS mouthing

As noted above most of the ME mouthings are one or two segments. Table 5 shows the top 20 signs that are accompanied by ME mouthings. ROLIG ‘funny’ and BARA ‘only’, for example, are represented by Swedish words *ro(lig)* and *ba(ra)*, but are reduced to one- and two-segmental mouthings, see Table 5. Note that SEDAN could be represented by the Swedish short version of *sedan* i.e. *sen*, but we have included this in the ME category. We also see that mouthings of SEDAN vary greatly between users.

The M-variant in the table refers to the sign variants that include full mouthing i.e. explicit full mouthing of the whole Swedish word. Such variants can be related to the signer’s linguistic background within the deaf community, i.e. late signers or signers with a strong language connection to Swedish (cf. Boyes Braem 2001). However, ME-variants are most apparently used in the STS corpus. Our

preliminary observations of some signers show that full mouthings tend to be used when introducing new referents or information (e.g. names) and when any of this is repeated in the discourse, we believe that M-types typically transform to ME-types. We also noted that full M-variants can be used in situations when the signer wants to emphasize something.

Table 5: Top 20 signs with ME mouthing.

Gloss	Swedish word, English translation	Reduced form	ME-variant	M-variant	No mouth-ing	Total	% ME
BETYDA	<i>betyda</i> 'mean'	by	25	1	0	26	96%
ROLIG	<i>Rolig</i> 'fun'	o	23	4	0	27	85%
BARA	<i>bara</i> 'only'	ba	24	2	0	26	92%
MÅSTE	<i>måste</i> 'have to, must'	må	19	0	1	20	95%
NÅGON	<i>Någon</i> 'someone'	å	14	6	4	24	58%
SEDAN	<i>Sedan</i> 'later'	se	12	16	17	45	27%
INTE	<i>inte</i> 'not'	i	16	10	2	28	57%
SITTA	<i>sitta</i> 'sit'	i	11	3	5	19	58%
TYCKA	<i>tycka</i> 'like'	y	16	0	3	19	84%
BRUKA	<i>bruka</i> 'used-to'	bu	12	0	3	15	80%
GÖRA	<i>göra</i> 'to do'	ö	13	3	5	20	60%
MYCKET	<i>mycket</i>	my	10	2	2	14	73%

OLIKA	<i>'much'</i> <i>olika</i> <i>'different'</i>	o	12	2	0	14	86%
STYRELSE	<i>styrelse</i> <i>'board'</i>	y	10	1	0	11	91%
KÄNNA	<i>känna</i> <i>'feel'</i>	kä	9	3	2	14	64%
FÄRDIG	<i>färdig</i> <i>'finished'</i>	fä	8	1	2	11	73%
FÅGEL	<i>Fågel</i> ' <i>bird</i> '	få	8	9	1	18	44%
TÄNKA	<i>tänka</i> <i>'think'</i>	tä	9	4	6	19	47%
VIKTIG	<i>viktig</i> <i>'important'</i>	vi	7	0	0	7	100%
Total			255	67	53	375	68%

There are several examples of one- or two-segmental mouthings based on longer Swedish words, for example the two-segmental BETYDA, *betyda* 'mean', which is a homonym either functioning as a coordinating conjunction or as a verb 'mean/meaning', OMÖJLIG, *omöjlig* 'impossible' which is two-segmental (see Figure 7). This movement is similar to that of the sign BRY-INTE 'ignore' (Figure 8), which usually comes with the E-type mouth movement.

Figure 7: (*o*)*mö(j)lig* 'impossible' (SSLC01_003)



Figure 8: *b(r)y(inte)* ‘ignore’ (STS Dictionary id 1757)



Moreover, MS types were represented of short monosyllabic Swedish words, e.g. signs (with equivalent Swedish words in italics within parentheses); PRO1 (*jag* ‘I/me’), HA (*ha* ‘have’), VARA (*vara* ‘be’), HUR (*hur* ‘how’), MEN (*men* ‘but’), PERF (*har* ‘have’), POSS1 (*min* ‘my’), MED (*med* ‘with’), TYP (*typ* ‘kind of’). And VARA (mostly represented by Swedish inflected irregular forms of *vara* i.e. *är* or *var*).

5.4 Qualitative note on variation of mouthings in compound signs and signs with merged negation

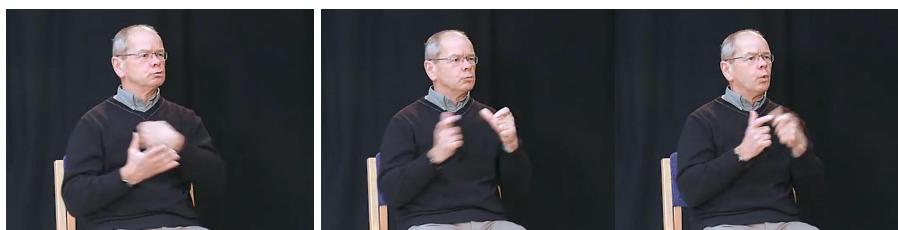
In our analysis, we found further interesting patterns in the use of mouthings related to compound signs, sign constructions and signs with merged negations that were analyzed briefly in this study, but that would be valuable to include in future analysis. Compounds, usually loan words from Swedish, were not included in the quantitative result of this study, due to difficulties in comparing with other categories because of their mixed properties. As part of gloss and mouth annotation, compounds were also observed and annotated in the data of the STS corpus. Compounds seem to allow a certain amount of variation between different combinations of different mouthings e.g. M[^]ME, versus ME[^]M, or both words M[^]M or ME[^]ME. In Figure 9, the signer fingerspells and has full mouthing for a fingerspelled word *vice* ‘vice’ and expresses the next sign ORDFÖRANDE ‘president’ with visible mouthing parts ‘o’ and ‘f’, *o(rd)f(ör)ande*. Figure 10 is a type of ME[^]ME. Compounds are not very frequent in this study, only 2.0% in retellings and 3.2% in conversation.

Figure 9: Compound with M[^]ME-type (*vice*[^]*o(r)f(örande)*)
 VICE[^]ORDFÖRANDE ‘*vice president*’ (SSLC01_161, 00:02:35.928)



However, most compounds consist of a combination of M[^]M, which is understandable because most compounds are basically loan signs i.e. borrowings from the Swedish language. All these M- and ME-types are borrowings from the Swedish language even though they vary between M end ME. Some of them have become clearly ME-types. The result shows that retellings (N=5) have 31 signs with two mouth types and interview (N=10) have 155 signs with two mouth types.

Figure 10: Compound with ME[^]ME-type (*(st)y(relse)*[^]*mö(te)*)
 STYRELSE[^]MÖTE ‘*board meeting*’ (SSLC01_161, 00:01: 20.520)



With regard to signs with merged negations, it was interesting to observe that most of all glosses for negation have no mouthing. In Figure 10, the signer has a visible part *a* for merged sign HAVE*NOT in form of invisible and visible parts of mouthing (*h*)*a* (*inte*), see Figure 11. The other variant we found parts of the negation are part of the mouthing i.e. the second segment in Figure 12.

Figure 11: *(h)a (inte)* HAVE*NOT ‘have not’ (SSLC01_281)



Figure 12: *o(rka) i(nte)* ORKA*INTE ‘can not nope’ (SSLC01_390, 00:01:32.330)



Johnston, van Roekel & Schembri (2016) have explored such an overlapping of mouthings and signs cross-linguistically and cross-culturally, and their findings are in good agreement with the Swedish data.

6. Discussion

This paper presents a first corpus-driven analysis on mouth actions and specifically on mouthings in STS, following the preliminary study of Bergman and Wallin (2001). Due to the amount of time required for annotation of corpus data, mouth data analyzed here is still confined to a subset of the entire corpus, and thus somewhat limited in this way. Further detailed descriptions on mouthings based on a large-scale study would be desirable, in order to increase the vocabulary size of data as well as including more deaf signers to make a stronger frequency list. Larger datasets would also open the possibility for making sociolinguistic studies on the variation of mouth actions among the signers according to their diverse backgrounds (age, gender and linguistic background etc.) However,

in our exploratory study of the STS corpus, we found that deaf signers clearly produce reduced mouthings on a regular basis. The reduced mouthing was mostly characterized by one or two segmental mouth patterns. Three segmental mouth patterns were very rare in our data. This confirms earlier results found by Mesch & Schönström (2021) in which data was based on L1 control group data. Furthermore, we also showed that reduced mouthing was differently used in terms of number with respect to discourse genre. In narrative tasks M and ME mouthings were less used compared to conversation data.

A look at the qualitative patterns of the mouthing category revealed that most of the reduced mouthings are one- or two segmental, which is not surprising. Further, we observed that some of the signs with ME mouthings were also produced with M mouthing variants, so there is a variation in the signers as well, especially for some of the signs. Below we discuss this variation further and share our perspective on that variation. A considerable part of the mouthing category comprises one- or two segmental mouthing of short Swedish words, i.e. MS mouthing, which are similar to the form of ME mouthings, but not per definition reduced. To differentiate between MS and ME mouthing was the most challenging part of the analysis.

The combinations of mouthing in compound signs as well in merged signs adds interesting aspects as well. Most compound signs are loan words from Swedish, and in signing, these mouthings are apparently used as ME, e.g. ME^ME, while mouthing is mostly M-type in signs containing fingerspelling as first or second element in the compounds.

Signers seem to use full mouthing in presenting something for the first time or with emphasis, while some ME-types are independent of the manual sign. This was illustrated with the sign FÅGEL ‘bird’ in Table 5, in which we observed several examples where the sign FÅGEL was emphasized and full mouthing was used. This could be a subject for future studies, i.e. studying mouthing (as well as mouth actions in general) from a pragmatic perspective. Here we provide a further example of the pragmatic use of mouthings. In Figure 13 below, various mouth types are used in the utterance: MS-type for a short word (*n*)*u* ‘now’, no action for pointing PRO1, ME-type for *b*(*eh*)*öv*(*a*) ‘need’ (the /*ö*/ vowel is IPA [œ]), progressive

spreading of ME-type mouthing for *behöva* rightward over PRO1, and M-type mouthing for *ett år* ‘one year’, while depicting with the index finger PEK-RUNT ‘around’ from the non-dominant hand and back to the same point describing the time. The signer’s non-dominant hand with holding movement depicts a time period meaning ‘until’. This depicting sign was used instead of the lexical ÅR ‘year’, which usually is only accompanied by one-segment mouthing, i.e. *å(r)* ‘year’ (the /å/ vowel is IPA [ɔ]). Closer study is needed concerning all mouthing types at an integrated view of the interplay of the syntactic and pragmatic levels.

Figure 13: Example on a sign sequence with various mouth types used.



Mouthing:	<i>(n)u</i>		<i>b(eh)öv(a)</i> -----		<i>ett år</i> -----
Mouth type:	MS-type	No action	ME-type	ME-spr	M-type
Glosses DH:	NU	PRO1	BEHÖVA	PRO1	PEK-RUNT
Glosses NonDH:	tid-framåt-till@hd-----				
Eng. glosses DH:	NOW	PRO1	NEED	PRO1	PT-ROUND
Eng. glosses NonDH:	time-until@hd-----				
Swedish translation:	'Jag behöver vara fri ett år.'				
English translation:	'I need to be free for one year.'				
STS Corpus code:	(SSLC01_161, 00:04:09.860)				

Another source of the variation in the use of mouthing categories relates to sign language proficiency. In Mesch & Schönström (2021), it was shown that L1 signers have a preference for reduced mouthing in comparison to L2 signers. It seems that L2 signers are influenced by their L1 Swedish, which affects the use ratio of ME, as part of their L2 acquisition. This has implications for sign L2 teaching, i.e. to make the L2 signers conscious of the difference between the use of M and ME and which signs should be used with M versus ME. However, any certain conclusions from this study are still limited, except for the statistics from the top 20 signs for ME and several signs where it is clear that there is a preference for ME mouthing over M mouthing, which should be interesting for L2 teaching.

For future research it would also be interesting to study deaf L2 learners of STS, with little or no contact with Swedish, and compare their mouthing with that of L1 signers as well as L2 signers.

Sign fluency is another interesting topic for continuing studies on the ways in which sign prosody affects mouthing, which makes the mouthing pattern move towards ME-type. The switching between M-type and ME-type seems to be variable mostly with older signers but also for pragmatic purposes. Higher signing speed “gives” more ME-types than M-types. Language learners have less sign fluency because of proximity, sign speed, and “searching” signs. Also, with the learning process, sign duration increases and signing rate decreases. Further study about sign fluency and disfluencies is needed in the future.

To sum up our findings, reduced mouthings seem to conform to the linguistic pattern following sign language “native” features similar to that of E-types (mouth gestures), but with traces to spoken Swedish, at least with STS as an example, as was suggested by Bergman & Wallin (2001). This study gives a clue as to the construction of lexical items (including mouthings) for the STS dictionary, where lexical items are presented in isolated and demonstrated conditions. This invites us to critically consider the structure of the STS dictionary where some ambiguous signs in the STS dictionary are presented as separate lexical items with full mouthings, e.g. PLANERA that can vary in mouthing depending on contexts as ‘to plan’ (in verbal contexts) or as ‘plan’ (in nominal contexts).

Acknowledgements

The results from this article is based on the data from the projects “Swedish Sign Language Corpus“ funded by Riksbankens Jubileumsfond (RJ) (In2008-0276-IK, PI: J. Mesch) and “From Speech to Sign – learning Swedish Sign Language as a second language” funded by Riksbankens Jubileumsfond (RJ) (P16-0371:1, PI: K. Schönström). We also would like to thank Ylva Larsson and Josefin Bark for assisting us in mouth annotations of the data from the STS Corpus, and Thomas Björkstrand and Nikolaus Riemer Kankkonen for assisting us with the mouthings in the STS Dictionary. Finally, the anonymous reviewer for the valuable comments on the paper.

7. References

- Bank, Richard. 2015. The ubiquity of mouthings in NGT: A corpus study. *Sign Language and Linguistics* 18(2). <https://doi.org/10.1075/sll.18.2.05ban>.
- Bank, Richard, Onno Crasborn & Roeland van Hout. 2011. Variation in mouth actions with manual signs in Sign Language of the Netherlands (NGT). *Sign Language and Linguistics* 14(2). 248–270. <https://doi.org/10.1075/sll.14.2.02ban>.
- Bank, Richard, Onno Crasborn & Roeland van Hout. 2015. Alignment of two languages: The spreading of mouthings in Sign Language of the Netherlands. *International Journal of Bilingualism* 19(1). 40–55. <https://doi.org/10.1177/1367006913484991>.
- Bank, Richard, Onno Crasborn & Roeland van Hout. 2016. The prominence of spoken language elements in a sign language. *Linguistics* 54(6). <https://doi.org/10.1515/ling-2016-0030>.
- Bauer, Anastasia. 2019. When words meet signs: A corpus-based study on variation of mouthing in Russian Sign Language. In Anastasia Bauer & Daniel Bunčić (eds.), *Linguistische Beiträge zur Slavistik, Specimina philologiae Slavicae* 198, 9–35. Frankfurt am Main: Peter Lang.
- Bergman, Brita & Lars Wallin. 2001. A preliminary analysis of visual mouth segments in Swedish Sign Language. In Penny Boyes Braem & Rachel Sutton-Spence (eds.), *The Hands are the Head of the Mouth: The Mouth as Articulator in Sign Language*, 51–68. Hamburg: Signum-Verlag.
- Boyes Braem, Penny. 2001. Functions of the mouthings in the signing of deaf early and late learners of Swiss German Sign Language (DSGS). In Penny Boyes Braem & Rachel Sutton-Spence (eds.), *The Hands are the Head of the Mouth: The Mouth as Articulator in Sign Languages*, 99–132. Hamburg: Signum-Verlag.
- Boyes Braem, Penny & Rachel Sutton-Spence (eds.). 2001. *The Hands are the Head of the Mouth: The Mouth as Articulator in Sign Languages*. Hamburg: Signum-Verlag.
- Crasborn, Onno, Els van der Kooij, David Waters, Bencie Woll & Johanna Mesch. 2008. Frequency distribution and spreading behavior of different types of mouth actions in three sign languages. *Sign Language and Linguistics* 11(1). 45–67. <https://doi.org/10.1075/sl&l.11.1.04cra>.

- Ebbinghaus, Horst & Jens Hessmann. 2001. Sign language as multidimensional communication: Why manual signs, mouthings, and mouth gestures are three different things. In Penny Boyes Braem & Rachel Sutton-Spence (eds.), *The hands are the head of the mouth: The mouth as articulator in sign language*, 133–151. Hamburg: Signum-Verlag.
- Johnston, Trevor, Jane van Roekel & Adam Schembri. 2016. On the conventionalization of mouth actions in Australian Sign Language. *Language and Speech* 59(1). 3–42. <https://doi.org/10.1177/0023830915569334>.
- Mesch, Johanna & Krister Schönström. 2021. Use and acquisition of mouth actions in L2 sign language learners. *Sign Language & Linguistics* 24(1). <https://doi.org/10.1075/sll.19003.mes>.
- Racz-Engelhardt, Szilard. 2016. Morphological properties of mouthings in Hungarian Sign Language (MJNY). Unpublished PhD dissertation. Hamburg: University of Hamburg. <https://doi.org/10.1075/sll.00016.eng>.
- Sandler, Wendy & Diane Lillo-Martin. 2006. *Sign language and linguistic universals*. Cambridge: Cambridge University Press.
- Schermer, Trude. 1990. In search of a language: Influences from spoken Dutch on Sign Language of the Netherlands. Delft: Eburon.
- Schermer, Trude. 2001. The role of mouthings in Sign Language of the Netherlands: Some implications for the production of sign language dictionaries. In Penny Boyes Braem & Rachel Sutton-Spence (eds.), *The Hands are the Head of the Mouth: The Mouth as Articulator in Sign Language*, 273–284. Hamburg: Signum Verlag.
- Vogt-Svendsen, Marit. 1983. Positions and movements of the mouth in Norwegian Sign Language. In Jim Kyle & Bencie Woll (eds.), *Language in sign: An international perspective on sign language*, 85–96. London: Croon Helm.
- Woll, Bencie. 2001. The sign that dares to speak its name: Echo phonology in British Sign Language (BSL). In Penny Boyes-Braem & Rachel Sutton-Spence (eds.), *The hands are the head of the mouth: The mouth as Articulator in sign languages*, 87–98. Hamburg: Signum-Verlag.