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Exploring Writing Products in students with Language Impairments and Autism Spectrum Disorders[i]

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Abstract

Oral language skills scaffold written text production; students with oral language difficulties often experience writing problems. The current study examines the ways in which oral language problems experienced by students with language impairment (LI) and students with autism spectrum disorders (ASD) impact on their production of written text. One hundred and fifty seven participants (M_{age} = 10;2) with LI or ASD completed standardized measures of oral language, transcription, working memory, and nonverbal ability and produced a written narrative text assessed for productivity, grammatical accuracy, and quality. Measures of transcription, productivity, and grammatical accuracy, but not text quality, were poorer for students with LI. Transcription skills accounted for the majority of variance in the writing of the LI cohort. For the ASD cohort, handwriting, oral language and autism symptomatology were significant predictors. When students with ASD also experienced language problems, their performance was equivalent to that observed in the LI cohort.

Key Words: written text production; language impairment; ASD; ; transcription; text generation; learning difficulties

Rationale

Problems in the production of written text are arguably the most prevalent developmental disability of communication skills, a disability that limits communication, academic achievement and employment prospects. Many children struggle to write, and students with developmental and learning difficulties are particularly challenged by the writing process (Graham & Harris, 2009). There is increasing evidence that limitations in oral language skills impact on text production for students with and without learning disabilities (Berninger et al., 2006; Mackie, Dockrell, & Lindsay, 2013; Wagner et al., 2011). The ways in which different aspects of oral language impact on writing products are underspecified (Shanahan, 2006) and are likely to differ according to the way in which written text is examined. The current study explores written text production in students who present with different developmental disorders that impact on the oral language system: those with language impairment (LI) and those with autism spectrum disorders (ASD).

ASD is a disorder characterized by impairment in social interaction and communication and by restricted, repetitive, and stereotyped patterns of behavior. Diagnosis is based on specific behaviors described in the Diagnostic and Statistical Manuals of Mental Disorders (DSM-V, APA, 2013 being the most recent). Communication difficulties of children with ASD have been well documented but little research has focused specifically on their production of written text. Oral language is heterogeneous in ASD, with some individuals showing extremely limited abilities (Ellis Weismer, 2013). While pragmatic impairments are characteristic of the group, syntax is often relatively spared (Kjelgaard & Tager-Flusberg, 2001). By contrast students with LI exhibit problems with expressive and receptive language without an associated diagnosis of ASD or general learning difficulties (Bishop, 2006), and are characterized by significant difficulties with syntax, and to a lesser extent lexical semantics. To address population differences in written text production, and identify the ways in which language difficulties present barriers to written text production, we compared written texts produced by students with LI and ASD in mainstream education and examined the extent to which language and cognitive factors impacted on text production. Given the reported overlap between the two populations in language profiles (Tomblin, 2011) but not cognitive profiles (Taylor, Maybery, & Whitehouse, 2012), we further considered whether participants with ASD who additionally experienced language impairments differed in written text performance compared to their LI peers.

Written text production is a complex process and the written product can reflect different underlying competencies. Early studies of composition in typically developing children identified two dimensions: text quality and productivity (Berninger & Swanson, 1994). These dimensions have been assessed in different ways. Global quality of the text is rated on a single ordinal scale and scales differ in their construction (Williams, Larkin, & Blaggan, 2013). Productivity refers to the amount of text that is produced and has been variously indexed using the total number of words, ideas, clauses, or T Units produced (Nelson & Van Meter, 2007). Recently, researchers have identified other dimensions which purportedly underpin written productions. Although these dimensions vary by age and population tested, they all capture dimensions of productivity, complexity and accuracy (Puranik, Lombardino, & Altmann, 2008; Wagner et al., 2011). In contrast to productivity, accuracy measures examine the correct use of grammatical features (Gillam & Johnston, 1992).

Productivity and quality are uniquely predicted by transcription skills (spelling, handwriting/typing) throughout the elementary grades for pupils learning to write in English (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). The majority of cognitive resources are allocated to transcription until these skills become automatic (Berninger, 2000). Transcription demands a substantial amount of working memory (WM) resources in children, allowing few available resources for sentence construction and content generation (Graham et al., 1997; Olive, Favart, Beauvais, & Beauvais, 2009). As such, WM limitations may underlie children’s difficulties in producing coherent and extended texts due to the competing demands of the transcription process (Adams, Simmons, Willis, & Porter, 2013).

Nonetheless, analyses of the texts produced by young writers highlight processes beyond transcription and WM that relate to text generation.

Text generation is the ability to translate ideas into linguistic representations in working memory that can then be written down (Abbott & Berninger, 1993). This involves the selection of appropriate words for sentences and discourse and the production of grammatically correct sequences of words. Strengths in oral language skills support written text generation in typically developing children where transcription demands are no longer a constraint (Berninger & Swanson, 1994). Writing also involves an awareness of the context of the writing task and the reader and, as such, places demands on the writer's pragmatic skills (Kellogg, 2008). It is to be expected that students who experience difficulties with social communication will also experience difficulties with text production. However, studies of the role of pragmatic skills in students' written text production are limited (Troia, 2011).

Writing draws on aspects of oral language including phonological processes (Berninger, Abbott, Whitaker, Sylvester, & Nolen, 1995), vocabulary (Green et al., 2003), oral narration (Cragg & Nation, 2006), and receptive grammar (Mackie et al., 2013). Specifically, productivity, grammatical accuracy and quality are associated with different components of the oral language system. Productivity, the ability to produce words quickly and efficiently, is hypothesized to draw on transcription skills and a well-developed vocabulary (Graham, Harris, & Chorzempa, 2002). By contrast syntactic complexity is likely to be supported by structural language skills such as grammar and morphology (Mackie et al., 2013; Shanahan, 2006). Finally, text quality, it is argued, will be underpinned by transcription and structural language but will also be supported by higher level language skills captured by the pragmatic dimensions of language (Troia, 2011). Further clarity is needed on the precise relationships between aspects of oral language and components of text production, at different developmental time points. Nonetheless, our review indicates strong theoretical and empirical reasons to predict that students who struggle with oral language will struggle with written text production (Dockrell, 2014).

Both students with LI and those with ASD are reported to experience difficulties in the production of written text but the underlying cognitive factors may be different. In relation to LI, difficulties in the production of written text have been reported for children with both transient and persistent impairments, and are present early in development (Puranik & AlOtaiba, 2012), continuing into adolescence (Dockrell, Lindsay, & Connelly, 2009). Spelling errors in LI are frequent, particularly phonological errors (Broc et al., 2013; Mackie & Dockrell, 2004), and studies have supported the view that writing difficulties in this group may reflect a particular vulnerability in using language structure, as evidenced by their grammatical errors (Windsor, Scott, & Street, 2000). Limitations with phonological short-term memory (STM) for children with LI may further compromise the writing process, and elevated error rates, both in spelling and grammar, in the writing of students with LI have been associated with phonological STM over and above their oral language skills (Mackie et al., 2013). In sum, the difficulties experienced in writing by students with language impairments reflect the difficulties they experience with structural language and the impact of WM.

Across studies, the writing performance of students with LI is typically at a level equivalent to either language age or reading age peers (Dockrell & Connelly, 2013; Williams et al., 2013). Processes such as transcription, which have been shown to exert more influence at earlier stages of the developmental process for typically developing writers, continue to exert a significant influence for students challenged by writing at later points in development (Dockrell et al., 2009). This suggests that the constraints experienced by students challenged by writing are consistent with typical developmental trajectories, but that the impact of skills that underpin text production are more pronounced, and their impact is evident for a longer period of time. It is predicted that the language difficulties experienced by students with LI will impact primarily on transcription skills and these difficulties will mar the quality of the text these students produce.

Compared to research on text writing in LI, studies of writing in ASD are fewer in number, include small numbers of older participants, and typically are not driven by models of the writing process; as a consequence, conclusions to date are speculative. Handwriting problems are commonly reported in students with ASD, specifically legibility and letter formation (Kushki, Chau, & Anagnostou, 2011) but these difficulties do not necessarily impact on the written text (Myles et al., 2003). Students with ASD produce briefer, less complex texts with fewer uses of mental state terms in comparison to matched peers (Barnes, Lombardo, Wheelwright, & Baron-Cohen, 2009; Brown & Klein, 2011). Texts are less focused on the main topic, including fewer smooth transitions between ideas (Brown & Klein, 2011). To date, studies of the writing of students with ASD and Asperger syndrome have highlighted limitations in text quality, rather than grammatical or spelling problems (Myles et al., 2003), but the impact of oral language skills on performance has not been explored. Despite the paucity of studies, these data help to further differentiate the barriers to successful text production. These difficulties appear to reflect higher order language skills, consistent with these students' problems in oral language, where significant difficulties in the ability to generate ideas relevant to the context are experienced (King, Dockrell, & Stuart, 2013; Norbury & Bishop, 2003).

1.1 Assessing writing skills

Identifying writing tasks that are appealing to a range of students, and stimulate sufficient written text that can be analyzed for productivity, grammatical accuracy and quality is problematic. This is particularly true for students who are challenged by the writing process. Writing to a short written probe has proved to be a successful approach with a wide range of students (Gansle et al., 2004) and is often used in standardized assessments of writing (Wechsler, 2005). Total words written has been considered the hallmark measure but there is increasing evidence that inclusion of another quantitative measure, the number of correct word sequences (CWS), can provide an indicator of grammatical accuracy (Gansle, VanDerHeyden, Noell, Resetar, & Williams, 2006). Together these measures are argued to be a sensitive index of productivity and accuracy of written text production for students aged between 7 and 12 years and, complemented by qualitative measures of text quality, provide a comprehensive measure that captures the complexity of the student's writing (Espin et al., 2000).

1.2 The current study

We hypothesized that, given the ways in which the language system is differentially impaired in students with ASD relative to students with LI, different difficulties with the writing process would be evident and their written text products would differ in terms of productivity, grammatical accuracy and text quality. Based on the extant literature, and the nature of their language difficulties, we predicted that students with LI would experience greater problems with transcription than those with ASD and these transcription difficulties would be revealed in a time limited writing task by measures of text generation evaluated for productivity (numbers of words produced) and grammatical accuracy (CWS) but not quality (Hypothesis 1). We further hypothesized that for both cohorts the text measures would be significantly influenced by measures of transcription, supported by receptive and expressive oral language skills and nonverbal ability (Hypothesis 2). For students with LI, measures of transcription were expected to explain the majority of variance in all the writing measures, with vocabulary adding additional variance for measures of text quality (Hypothesis 2a). In contrast, given the difficulties experienced by students with ASD, we anticipated that levels of text generation and text quality would be associated with their level of autism symptomatology and with their ability to formulate oral sentences (Hypothesis 2b). Finally, given its importance in the complex task of text generation, we predicted that WM would contribute to models explaining text generation for both cohorts (Hypothesis 3).

Method

2.1 Participants

Participants comprised 157 students (M_{age} = 10;2; *SD* = 2;2) with LI (*n* = 93; males 68: females 25, M_{age} =9;10 *SD* = 2;3) or ASD (*n* = 64; males 57: females 7, M_{age} = 10;3; *SD* = 2;1), recruited as part of a larger study with a cross-sequential design. Participants were aged 6, 8, 10, and 12 years at identification and first assessment. Participants were subsequently assessed over a two-year period allowing for longitudinal analyses.

The majority of students in England with special educational needs (SEN) are educated in mainstream schools, Recruitment to the sample was drawn from a screening of five Local Authorities (LAs) in England, which were representative on national indicators namely: a) proportion of students with recorded SEN, and specifically with Speech Language and Communication Needs (SLCN) or ASD, and b) were average for National Curriculum tests taken at age 11. Across LAs, 210 mainstream schools were approached, 74 of which agreed to take part in the study.

All students had SLCN or ASD as their primary SEN, spoke English as a first language and had no history of hearing impairment or uncorrected eyesight; 25% of the participants were eligible for free school meals (FSM), an index of disadvantage, with no significant associations between groups (X^2 (2, *N* = 154) = 0.21, *ns*).

In England, the student level School Census requires schools to identify and notify the UK Government's Department for Education of students with SEN. Schools provide information about type and level of primary SEN following an assessment by a psychologist, pediatrician, speech and language therapist, and the school's SEN coordinator. For SLCN, identification includes a range of clinically and school-ascertained needs and diagnoses relating to language and/or communication difficulties. Students with a classification of ASD received a medical diagnosis via a community or specialist clinical service using ICD-10 (WHO, 1993) or DSM-IV (APA, 2000) criteria for ASD at the time of the study. From students with SLCN, we were interested in recruiting students with oral language impairments. Given the lack of an agreed measure for identifying language impairment (Bishop & McDonald, 2009), we conducted a screening phase.

Students were identified as having LI if they obtained a standardized score that was at least one standard deviation below the mean on either the Recalling Sentences or Word Classes subtest from the CELF-4 UK (Semel, Wiig, & Secord, 2006), at which point the remaining relevant subscales of the CELF-4 UK were administered. We also administered a measure of non verbal ability (Matrices BAS-II; Elliott, Smith, & McCulloch, 1997) and teachers were also asked to complete the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005) as a dimensional measure of autism symptomatology. As shown in Table 1 students with LI scored significantly poorer on measures of receptive and expressive language whereas participants with ASD were significantly more impaired on the SRS.

2.2 Materials

2.2.1 Autism Symptomatology

The SRS (Constantino & Gruber, 2005) was completed by teachers. Respondents are presented with a series of statements relating to autism symptomatology and indicate the frequency of their occurrence. The SRS generates a total score based on measures of social awareness, social cognition, social communication, social motivation, and autism mannerisms. Norms are provided for individuals aged 4 -18 years. A high level of internal consistency was reported using Cronbach's alpha values for teachers (male α=.97 and female α=.96). Correlations between the teacher SRS and the subscales from the ADI-R show high levels of validity (r = .52 to r = .70).

2.2.2 Nonverbal ability

In the BAS-II (Elliott et al.,1997), Participants are presented with an incomplete pattern and are required to select the picture that will complete the pattern from a set of six. The technical manual reports test-retest reliability (*r* =.64) and the correlation (*r* =.47) with the performance IQ scale from the Wechsler Intelligence Scale for Children 3rd edition (WISC; Wechsler, 1991.

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2.2.3 Oral language

Receptive vocabulary

In the British Picture Vocabulary Scale (BPVS-III; Dunn & Dunn, 2009), participants hear a word and select a referent from four alternatives. The BPVS-III provides norms for individuals aged 3-16 years. Reliability is reported as 0.91 and validity with the WISC as *r* = .76.

Receptive Grammar

In the Test for Reception of Grammar (TROG-E; Bishop, 2005), participants hear a series of sentences that increase in grammatical complexity and select a target from one of four alternatives. A computer is used to present items and record responses. The TROG-E provides norms for individuals aged 4 years to adult. High internal consistency is reported (*r* = .88) indicating good reliability; correlation with concepts and directions from CELF-3 (Semel, Wiig, & Secord, 2000) is *r* =.53.

Formulated sentences

In the formulated sentences subtest of the CELF-4 UK (Semel et al., 2006), students are asked to formulate a syntactically and semantically correct sentence in response to an orally presented target word or phrase, with a stimulus picture for reference. . Internal consistency is *r* = .75-.89 and test-retest reliability *r* =.86.

2.2.4 Working memory

In the Automated Working Memory Assessment (AWMA; Alloway, 2007), students complete four subtests which examine verbal and visuospatial storage and processing: digit recall forwards and backwards, spatial recall, and visuospatial STM. Digit recall requires students to recall lists of digits in sequence. In the visuospatial recall task students view pairs of shapes and identify whether they are the same or not. One shape appears with a red dot beside it. After a series of pairs, they attempt to recall the location of the red dot on each shape in the correct order. Visuospatial STM involves a dot matrix task, the child is shown the position of a red dot in a series of 4X 4matrices and has to recall this position by tapping the squares on the computer screen. The position of each dot in the matrix is held on the computer for 2s.

The AWMA provides norms for individuals aged 4 years to adult. Test reliability correlation coefficients range between r = .69 - .90. Mean verbal and visual working memory Z scores were computed for participants.

2.2.5 Writing

Handwriting

In the Detailed Assessment of Speed of Writing (DASH; Barnett, Henderson, Scheib, & Schulz, 2007), students are asked to repeatedly write the alphabet in order for 60 seconds, as a measure of handwriting fluency. The DASH technical manual reports α = . 83 - .89 depending on age, indicating good internal consistency. A significant correlation between the 'words per minute' on the free writing task described by Allcock (2001) and the DASH free writing task is reported (r = .63).

Spelling

In the BAS-II (Elliott et al., 1997) spelling subtest, students are asked to spell a series of single words. The BAS-II provides norms for individuals aged 5 years to adult. The technical manual reports modified split-half correlation coefficients as a measure of internal reliability (r = .84- .96 depending on age group), and test-retest reliability (r = .64); validity r = .63 with the Wechsler Objective Reading Dimensions (Rust, Golombok, & Trickey, 1993)

Text Measures

Following standard Curriculum Based Measure (CBM) procedures for this age group (McMaster & Espin, 2007), and modeled on the Wechsler Individual Achievement Test (WIAT; Wechsler, 2005), students were asked to write for five minutes about their 'best day at school'. The prompt was presented in a typed format at the top of a page with space for writing, and read to the students. The task was scored for productivity, accuracy, and writing quality. Copying the prompt was classified as not producing written text and therefore not counted in the measures. Productivity was examined by counting the number of words produced, excluding numerals and crossed-out words, irrespective of whether the words were correctly spelled. Accuracy was assessed by counting correct word sequences (CWS), defined as any two adjacent words that were acceptable to a native English speaker (Espin, De La Paz, Scierka, & Roelofs, 2005). End punctuation and beginning capitalization were also taken into account in the scoring of CWSs (Tindal & Parker, 1989). If a participant failed to use a full stop at the end of a sentence this was scored as an incorrect word sequence. Similarly, failure to use a capital letter at the beginning of sentence was penalized. For example the sentence 'I went to the park and it fun' contains six correct word sequences – I went to, to the, the park, park and, and it (see Espin et al., 2000 for further details). To distinguish transcription errors and text generation skills, spelling errors produced in the texts were not penalized. Text quality was assessed using a modification of the WIAT (Wechsler,

2005) paragraph scoring system and scored from 0 to 6 ignoring spelling grammar and punctuation (Appendix A).

Reliability checks were performed on all the anonymized written texts by two raters unfamiliar with the participants but trained in assessing written texts. Intra-class correlations were high: total number of words 1.0, total number of words spelled correctly 1.0, CWS .98, and text quality .86.

2.3 Procedure

All students were assessed individually by a qualified speech and language therapist or psychologist. The first testing session involved the screening measures. In sessions two and three, remaining assessments were completed in a standard order. Text generation was assessed in session two and data from the standardized spelling and handwriting measures were collected in session three.

Results

A significant minority of students failed to produce written text. Thus, differences between students who produced text and those who failed to produce text are examined first (Section 3.1). Section 3.2 describes the performance of the LI and ASD students on the writing measures. Section 3.3 examines the relationships between standardized measures of language, nonverbal ability, and WM, and the measures of written text production, productivity (numbers of words written), grammatically correct production (CWS), and text quality. In Section 3.4 the performance of the LI and ASD+LI groups is compared for measures of transcription, productivity, and accuracy.

Norm-references scores on all standardized measures have been transformed to *Z* scores, to allow for comparisons across the measures.

3.1 Writers and nonwriters

Eighty-one percent of the students wrote in response to the writing prompt ($n = 127$). There were no significant associations between text producers in terms of gender (X^2 (1, $N = 157$) = 0.003, *ns*), eligibility for FSM (X^2 (2, *N* = 157) = 0.97, *ns*) or whether the student had a diagnosis of LI or ASD (X^2 (2, *N* = 157) = 0.54, *ns*). Table 2 presents the mean (*SD*) and significant differences for age, cognitive and language measures for writers and nonwriters. As the table shows, students who did not produce text were significantly younger and had significantly higher scores on the SRS than writers. There were no other significant differences between these groups.

Further analyses are reported only for children who produced written text (ASD *n* = 50; LI *n* = 77). There were no significant differences in age between groups (*t*(125) = -1.75, *ns*). Mean (*SD*) scores for LI and ASD cohorts on cognitive and language measures are presented in Table 3, along with tests of group differences. Both cohorts demonstrated poor performance on the measures of structural language; students with LI were significantly more impaired. In contrast, students with ASD were significantly impaired on the SRS, whereas students with language impairment were not. For these key measures effect sizes were large.

3.2 Transcription and text generation in students with LI and ASD

Independent samples *t*-tests indicated that the transcription performance of students with LI was significantly poorer than that of students with ASD for both spelling (LI: *M* = -0.62, *SD* = 1.14; ASD: *M* = 0.13, *SD* = 1.34, *t*(118) = -3.26, $p < .001$, *d* = .60) and handwriting fluency (LI: *M* = -1.32, *SD* = 0.65; ASD: *M* = -0.84, *SD* = 1.04, *t*(97) = -3.26, *p* =.006, *d* = .55).

On the CBM writing task students wrote a mean of 42 words (*SD* = 29) in the five minute period with fewer CWS (*M* = 33, *SD* = 27). The mean quality rating was low (*M* = 1.7, *SD* = 1.1), reflecting texts which were limited, failed to address the question, or lacked descriptions.

Measures from the text generation task were transformed into Z scores from the sample to allow comparisons between the measures across the cohorts and are presented in Figure 1. A mixed repeated measures ANOVA with cohort (LI, ASD) as the between subjects factor and writing measure (words written, CWS, and text quality) as a within subjects factor revealed a main effect of cohort, *F*(1, 125) = 10.96, *p* = .002, η_p^2 = .08, but not writing measure, *F*(2, 250) = 0.27, *ns*. The predicted interaction between cohort and writing measure was significant *F(*2, 250) = 6.04, *p* = .003, η_p^2 = .05. As Figure 1 shows, this interaction reflected the poorer scores of the LI cohort on productivity and CWS and the ASD cohort's relatively poorer performance on the text quality measure. Moreover, the performance of the ASD participants on text quality did not differ significantly from that of the LI cohort (*t*(125) = -1.47, ns) whereas both productivity (*t*(79.31) = -3.28, *p* =.002, *d* = .62) and CWS (*t*(73.96) = -3.51, *p* =.001, *d* = .67) were significantly poorer in students with LI.

3.3 Relationships between language, cognition and text generation

We considered the relationship between text generation and writing quality measures and scores on standardized measures of non-verbal ability, language, and WM controlling for participants' age. Table 4 presents bivariate correlations, controlling for age, among the writing measures for the LI cohort above the diagonal and for the ASD comparison cohort below the diagonal and using a Bonferroni corrected level of *p =*.005. Nonverbal ability was not significantly correlated with any writing measures for either cohort. Whereas both measures of WM were significantly correlated, WM was not associated with text production for participants with ASD. As predicted, for students with LI, writing measures were correlated with spelling, handwriting fluency, and WM. In contrast, whereas spelling and handwriting fluency were associated with some of the measures of written text for the students with ASD, there were also significant correlations with structural language and autism symptomatology for CWS and the writing quality measure.

For each cohort we examined whether age, language levels or autism symptomatology predicted productivity, accuracy, and quality of writing using linear regression. Given the significant correlations between receptive vocabulary and receptive grammar measures, a composite score for receptive language was computed. Formulated sentences were used as the measure of expressive language. All predictor variables were entered simultaneously. As Table 6 shows, significant models emerged for each writing measure but the models differed between cohorts and across measures. For each LI model, transcription featured as a significant predictor. In contrast, transcription was only significant for the ASD cohort when CWS was the dependent variable. The SRS was a significant predictor for the ASD cohort but only when text quality was the dependent variable. In contrast, the expressive language measure predicted CWS for both cohorts. Verbal WM was not significant in any of the models but, unexpectedly, spatial WM was significant for the LI cohort when text quality was the dependent variable.

3.4 Comparison of the LI and ASD+LI students

To address questions about the overlap between ASD and LI, we identified those participants with ASD whose language levels were commensurate with the participants with LI. These students with ASD had either receptive grammar or receptive vocabulary scores more than 1.5 SD below the mean and a score on formulated sentences that was also 1.5 SD below the mean. This combined set of problems was taken as evidence of difficulties with structural language. Twenty-three of the 50 participants with ASD were classified as ASD+LI. Independent samples *t*-tests indicated that there were no significant differences between the ASD+LI and LI cohorts on measures of transcription, text accuracy or text quality (see Table 6).

Discussion

The writing skills of students with LI and ASD were examined on measures identified to reflect current understanding of written product analyses (Wagner et al., 2011). Standardized measures of oral language, autism symptomatology, nonverbal ability, and WM were used to explore relationships with the participants' writing performance.

To understand barriers to written text production it is important to analyze data from both writers and nonwriters. A significant minority of students did not produce written text, a phenomenon rarely recorded in studies of emergent or early writing. These students were both younger and had significantly higher scores on the measure of autism symptomatology than writers but, unexpectedly, did not have significantly lower levels of performance on measures of transcription. Recall that these nonwriters were on average eight and half years old, an age when typically developing children are producing extended texts. Given The delays in writing that are experienced by children with learning difficulties it is, perhaps, not unexpected that the younger children were significantly less likely to produce text in response to a probe. By contrast, these children attempted single word spelling and handwriting tasks, despite performing poorly on both measures. More intriguing was the relationship between autism symptomatology and writing refusal. It is possible that the social challenges experienced by these children meant that they did not understand the task demands. Alternatively, there may have been difficulties related to failure to generate ideas (Norbury & Bishop, 2003). There is emerging evidence to indicate that children with ASD struggle with talking about events (King et al., 2013) and this may impact on their written texts.

As predicted, of the participants who produced written text, students with LI had significantly poorer performance on standardized measures of transcription than participants with ASD. Students with LI also demonstrated marked difficulties with productivity and accuracy in their written narratives, as measured by words produced and CWS (Hypothesis 1). In contrast, students with ASD performed significantly better on measures of productivity and accuracy but scored poorly on measures of text quality, and these scores did not differ significantly from the scores of students with LI.

Different patterns across the measures and between the cohorts were evident (Hypothesis 2). Bivariate correlations established that nonverbal ability was not related to any of the writing measures, for either cohort. Regression models for the participants with LI accounted for between 40% and 56% of the variance and transcription measures were the significant predictors for all the writing measures, with the expressive oral language measure of formulated sentences additionally predicting CWS (Hypothesis 2a). This pattern of results is similar to those found for younger writers (Puranik & AlOtaiba, 2012). Regression models for the participants with ASD revealed a different pattern. For these participants between 24% and 31% of the variance of the writing measures was accounted for. Although handwriting fluency was a significant predictor for CWS it accounted for less variance than the expressive oral language measure of formulated sentences. In contrast for participants with ASD structural language supported both productivity and CWS while, as we predicted, the measure of autism symptomatology accounted for significant variance in text quality (Hypothesis 2b).

Using the participants' performance on standardized measures of language, we identified a subgroup of students within the ASD cohort that had significant difficulties with structural language (ASD+LI), levels of difficulty that were commensurate with their LI peers. Participants with LI and ASD+LI did not differ significantly on any of the writing measures, reflecting the oral language difficulties experienced by some children with ASD (Kjelgaard & Tager-Flusberg, 2001) and demonstrating how these impact on written text production.

WM scores were within the normal range but the associations between WM measures and oral language and transcription varied between the groups. Verbal WM was significantly correlated with receptive grammar for the language impaired participants but unexpectedly there were no other significant correlations (Montgomery, Magimairaj, & Finney, 2010) (Hypothesis 3). By contrast, for participants with ASD verbal WM was significantly correlated with all the standardized measures of oral language and transcription suggesting that for these participants the impact of these WM measures were domain general. Contrary to our expectations, the WM measure did not correlate with any of the text production measures for the participants with ASD. In contrast for the participants with LI there were significant relationships between verbal WM and handwriting fluency and text generation as would be predicted from previous research (Mackie et al., 2013), visual WM was only associated with text quality. It was only the relationship between visual WM and text quality that remained significant in the regression analyses. This is an unexpected relationship which requires further investigation (Olive et al., 2008).

The results of the current study provide further evidence of the pervasive influence of structural language abilities on writing and the importance of profiling these skills when examining text production. Importantly, by including a sample of participants with difficulties with social aspects of communication, those participants with ASD, it was possible to elucidate the ways in which pragmatic aspects of the language system may impact on written text quality. This has been a hitherto under-investigated feature of text production (Troia, 2011). Communication difficulties were related to the production of coherent and cohesive text and this was evident in quality ratings, supporting the view that discourse level skills add to the overall quality of written composition. Similar results have been reported for the oral narratives of students with ASD difficulties (Capps, Losh & Thurber, 2000; King et al., 2013).

The study raises further questions about the ways written texts should be evaluated to capture writing performance and writing predictors. Different aspects of the text were related to different aspects of oral language and transcription, highlighting the importance of capturing these dimensions in students' writing. This could further elucidate developmental models of writing and also inform teaching and interventions (Troia & Graham, 2003). CWS was a sensitive marker of text production at this point in development; a marker that we argue captures grammatical accuracy. For both groups of participants, performance on this measure was predicted by the oral language measure of formulated sentences. Thus at this point in development, for children challenged by writing, being able to produce sentences orally supports text generation, but not transcription. The study also questions the ways in which differences in text production should be conceptualized. Overall, the LI group had greater difficulties with transcription and, as with younger children, it was these skills that predicted their written language performance. In contrast, the ASD group presented a more variable profile of skills and written language performance that was underpinned by a range of skills. It remains to be ascertained whether these different patterns of performance reflect different phases of development in written text production or qualitatively different barriers to producing written text. However, the similarity in performance between the LI and the ASD+LI groups suggests that until these basic skills are mastered there is limited scope for other cognitive variables to impact on writing.

Implications for theory and practice

The current study demonstrated the ways in which students with LI and ASD are differentially challenged by the writing process, suggesting that the roots of the pupils' writing difficulties varied. We found no relationships with nonverbal ability on any of our writing measures. This result emphases the importance of focusing on the specific areas of weakness rather than identifying pupils on the basis of a discrepancy between nonverbal ability and writing performance (Saddler & Asaro-Saddler, 2013). The current results provide an indication of where to focus attention. For children with language impairment, at this point in development (Broc et al., 2013), difficulties in transcription are the main barrier to text production, whereas for those participants with ASD barriers were related to their oral language skills and handwriting fluency (see also Kushki, et al., 2011).

The dimensions of text production were consistent with current models of writing development (Wagner et al., 2011) and point to the importance of using evidence informed interventions to target the pupils' writing (Graham, 2008). There is emerging evidence that these approaches can be effective for students with autism (Asaro-Saddler & Bak, 2012; Pennington & Delano, 2012). However the considerable overlap between students with LI and ASD indicates that approaches to interventions need to profile students' strengths and weaknesses on these dimensions and texts should be analyzed with a range of measures to capture the challenges experienced (Myles et al., 2003; Nelson, & Van Meter, 2007).

The regression analyses identified a specific relationship between oral formulated sentences and CWS, indicating that intervention at the sentence level may be required (Datchuk & Kubina, 2013). Work on sentence combining may be particularly beneficial for these struggling writers (Saddler, Behforooz, & Asaro, 2008) and serve as an important skill to scaffold more complex text production at later points in development once basic transcription skills have been mastered (Olive et al., 2009).

The children who refused to write raise different challenges. Importantly their noncompliance could not be explained by differences in oral language or transcription skills. The association with impaired social responsiveness found in the current study is suggestive of a difficulty to engage with the task. Thus some children with writing challenges may need to be provided with explicit instructions in how to respond to writing probes and the role of immediate reinforcements may be particularly important for these pupils (Pennington & Delano, 2012). *Data from the current study suggest that evaluating writing for educational decision making requires a multi-faceted approach capturing both quantitative and qualitative measures including handwriting, spelling, sentence construction, and prose.*

Study limitations

A narrative probe was chosen as these texts tend to be produced earlier and are longer than texts to other probes. However, a focus on narrative texts may limit our understanding of the participant's strengths and difficulties in written text production (Beers & Nagy, 2011). Similarly, the potential moderating effect of literacy skills has not been addressed. Reading skills appear to be more strongly related to composition quality than composition productivity (Abbott & Berninger, 1993) and word reading accuracy, not oral language, is associated with spelling performance (McCarthy, Hogan, & Catts, 2012). It will be important in further studies to address the impact of both reading decoding skills and reading comprehension on written text performance given the differences experienced by students with LI and ASD on these measures (

Nation, Clarke, Wright, & Williams, 2006). Only one measure of handwriting was used and future studies should consider more detailed assessment of handwriting given the difficulties experienced by students with ASD (Hellinckx, Roeyers, & Van Waelvelde, 2013) and the significance of handwriting in the regressions models.

Finally, all the participants were being educated in English mainstream schools where there is a national curriculum which provides explicit guidance about the teaching and assessment of writing. However we collected no measures of classroom activities, monitoring of progress or specific interventions. As such we are unable to relate writing profiles to learning contexts.

Conclusions

Evaluating writing for educational decision making requires a multifaceted approach capturing both quantitative and qualitative measures including handwriting, spelling, sentence construction, and prose (Saddler & Asaro-Saddler, 2013). Screening on these measures will help professionals develop targeted interventions to support written text generation skills. When students experience oral language difficulties they are at risk of specific problems in transcription and text generation. Both structural and pragmatic language skills may impact on written text production. As such both students with LI and those with ASD are at risk of difficulties in the production of written text, but the patterns of difficulty they experience may differ. The differential effect of these dimensions of oral language may only be evident once students learning an opaque orthography, such as English, have begun to master transcription skills.

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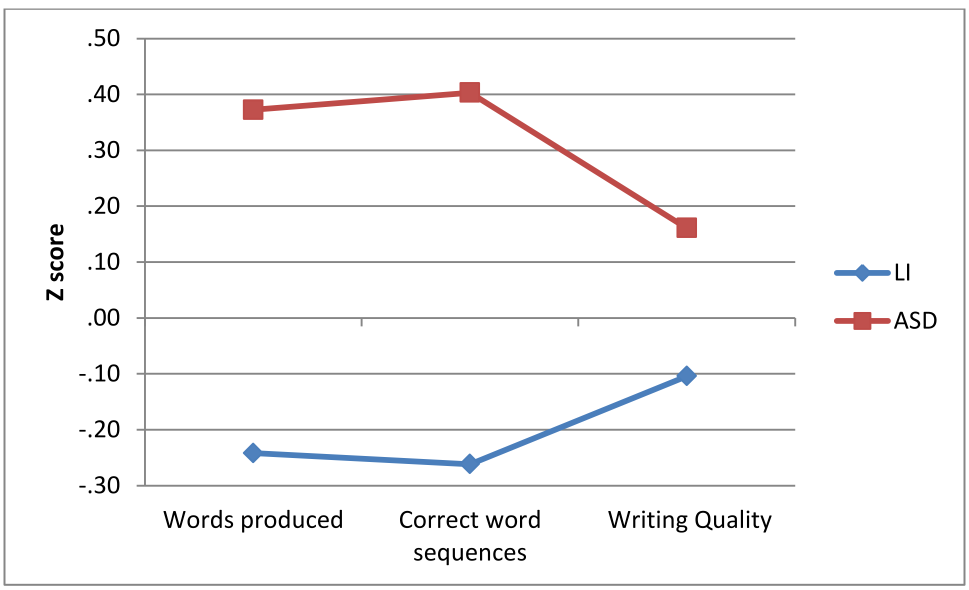

Figure 1 Mean *Z* score for LI and ASD students for words produced, correct word sequences and writing quality

Table 1. Means (*SD*s) for LI and ASD participants on screening measures

	Screening *Z*-score		*t*	*p*	Cohen's *d*
	LI = 93 *M*(*SD*)	ASD *N*= 64 *M*(*SD*)			
BAS Matrices	-0.52 (1.17)	-.12 (1.27)	*t*(154) = -2.03,	.04	0.33
CELF-4 Recalling sentences	-2.06 (.73)	-1.19 (1.38)	*t*(152) = - 4.61	< .001	0.80
CELF-4 Word classes receptive	-1.38 (.95)	-.66 (1.34)	*t*(154) = -3.68	< .001	0.62
Social Responsiveness Scale	0.64 (1.02)	1.73 (1.19)	*t*(144) = -5.98	< .001	0.98

Table 2. Means (*SD*) for age, cognitive and language measures for writers and nonwriters.

Domain	Measure	Writers *N* = 127 *M*(*SD*)	Non writers *N*= 30 *M*(*SD*)	*t*	*p*
Age in months		124.65 (27.92)	107.00 (24.59)	*t*(155) = 3.18	.002
Cognitive measures Z-score					
	BAS Matrices	-0.30 (1.23)	-0.56 (1.22)	*t*(154) = 1.04	*ns*
	Verbal working memory	-0.79 (.86)	-0.90 (1.0)	*t*(152) = 0.61	*ns*
	Spatial working memory	-0.64 (1.13)	-0.57 (1.22)	*t*(142) = -0.31	*ns*
Language measures Z-score	Formulated sentences CELF-4	-1.94 (1.16)	-2.25 (.98)	*t*(133) = 0.40	*ns*
	BPVS	-1.24 (.95)	-1.45 (.80)	*t*(154) = 1.07	*ns*
	TROG	-1.38 (1.17)	-1.80 (1.04)	*t*(150) = 1.75	*ns*
Transcription Z-score					
	Handwriting fluency DASH	-1.12 (.87)	-1.06 (.99)	*t*(113) = -0.28	*ns*
	BAS Spelling	-.33 (1.27)	-0.54 (1.37)	*t*(146) = -0.28	*ns*
Autism Symptomatology Z-score	Social Responsiveness Scale	0.97 (1.23)	1.54 (1.05)	*t*(144) = -2.33	.02

Table 3. Z-score means (*SD*) for cognitive and language measures for writers: LI and ASD.

Cognitive and Language Variables	*Z*-score		*t* *p*	*Cohen's d*
	LI *N* = 77 *M* (*SD*)	ASD *N* = 50 *M* (*SD*)		
BAS Matrices	-0.52 (1.16)	0.20 (1.27)	*t*(124) = -2.54, .02	0.44
Verbal working memory	-0.93 (.71)	-0.55 (1.02)	*t(*123) = -2.44, .02	0.44
Spatial working memory	-0.72 (1.06)	-0.52 (1.24)	*t(*115) = -0.92, *ns.*	
BPVS	-1.57 (.58)	-0.73 (1.18)	*t(*64.43) = -4.70, < .001	1.16
TROG	-1.59 (.99)	-1.04 (1.42)	*t(*71.90) = -2.33, .02.	0.61
Formulated sentences CELF-4	-2.37 (.74)	-1.28 (1.37)	*t(*60.86) = -4.85, < .001	1.25
Social responsiveness scale	0.48 (.90)	1.71 (1.30)	*t(*73.49) = -5.62, < .001	1.31

Table 4. Correlations controlling for age between writing, language and cognitive measures for LI above the diagonal and for ASD below the diagonal.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Words produced	-	.85***	.54***	.14	.25*	.18	34**	.37**	.02	.01	.13	-.07
2. Correct word sequences	.93***	-	.64***	.17	.24*	.18	.52***	.48***	.10	-.01	.17	.01
3. Writing Quality	.49***	.,47***	-	.21	.20	.28*	.49***	.20	-.07	.09	.07	-.02
4. Non-verbal ability	.10	.15	.10	-	.13	.15	.15	.18	.08	.26*	-.01	.07
5. Verbal working memory	.04	.15	-.02	.26	-	.34**	.30**	.20	.11	.14	.09	-.02
6. Visual working memory	.19	.23	.23	.34*	.33*	-	.16	.02	.07	.23*	-.01	-.13
7. Spelling	.17	.36**	.07	.40**	.48***	.-.02	-	.50***	.05	-.05	-.06	.07
8. Handwriting fluency	.27	.39**	.29*	.30*	.48***	.24	.59***	-	-.03	.03	-.03	-.01
9. Receptive vocabulary	.26	.31*	.18	.31*	.39**	.23	.50***	.26	-	.36**	.13	-.02
10. Receptive grammar	.34*	.38**	.26	.25	.52***	.36*	.34*	.29	.81***	-	.06	-.10
11. Formulated sentences	.24	.32*	.23	.01	.29*	-.02	.29	.00	.53***	.62***	-	.16
12. Social responsiveness scale	-.31*	-.39**	-.36*	-.11	-.34*	-.17	-.44**	-.14	-.30*	-.36*	-.33*	-

Note. Values greater than .30 are significant at the Bonferroni corrected level p = .005

* p<.05, ** p.<.01, *** <.001,

Table 5. Regressions predicting written text measures for LI and ASD.

	Predictor	*B*	Std error	Beta	*t*	Sig	Model	Adjusted R^2
Number of words produced								
LI	Chronological age	.31	.09	.39	3.66	<.001	F(2,76)= 25.87, p <.001	.40
	Handwriting fluency	.57	.18	.34	3.24	=.002		
ASD	Receptive language	.48	.12	.51	4.06	<.001	F(1,49)= 16.46, p <.001	.24
Correct word sequences								
LI	Spelling	.39	.09	.44	4.20	<.001	F(3,76)= 28.49, p <.001	.52
	Handwriting fluency	.40	.16	.27	2.59	=.01		
	Formulated sentences	.35	.15	.19	2,32	=.02		
ASD	Handwriting fluency	.62	.18	.39	3.41	<.001	F(2,49)= 16.08, p <.001	.38
	Formulated sentences	.92	.25	.42	3.67	<.001		
Text quality								
LI	Spelling	.02	.01	.43	4.45	<.001	F(3,76)= 32.55, p <.001	.56
	Age	.01	.01	.31	3.06	= .003		
	Spatial working memory	.01	.01	.18	2.05	= .05		
ASD	Age	.02	.01	.49	4.15	<.001	F(2,49)= 11.80, p <.001	.31
	Social responsiveness scale	-.01	.01	-.30	-2.65	= .01		

Table 6. Comparison between LI and ASD+LI on written text measures

	LI	ASD	
Measure	*M*(*SD*)	*M*(*SD*)	*t*
Handwriting fluency	-1.32 (.65)	-0.83 (1.16)	*t*(20.48) = -1.71, *ns*
Spelling	-0.62 (1.14)	0.06 (1.44)	*t*(94) = -1.90, *ns*
Number of words produced	35.45 (22.80)	39.04 (25.77)	*t*(98) = -.64, *ns*
Correct word sequences	26.16 (20.14)	30.43 (24.23)	*t*(98) = -.85, *ns*
Text Quality	-0.10 (0.98)	-0.30 (0.94)	*t*(98) = .91, *ns*

APPENDIX A

Quality scoring criteria for the written texts.

Score	Operational criteria
0	Unintelligible text or too few words to judge the content of the text or text which was irrelevant to the target prompt
1	Response which included a list of school based activities but did not indicate why this reflected ‘ the best day’
2	Included information which indicated why it was a special or best day. Could either be an extensive list with no elaboration or single event or thing with some descriptive details about that event or thing.
3	Ideas (events or things) are related to each other or to the main idea and additional descriptive information or detail provided.
4	Generally well written engaging the reader with ideas clearly related to each other with the addition of clarifying descriptive detail
5	Presents a substantial amount of descriptive and varied detail of the topic. The ideas and details are clarified with several descriptions or thorough elaboration.