Narrative Writing, Reading and Cognitive Processes in Middle Childhood: What are the Links?

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Abstract

This study investigated the relationship between measures of reading and writing, and explored whether cognitive measures known to be related to reading ability were also associated with writing performance in middle childhood. Sixty-Four children, aged between 8 years 9 months and 11 years 9 months, took part in a battery of writing, reading, and cognitive ability tasks. Reading fluency emerged as having a strong relationship to written language performance, after controlling for age and verbal reasoning. While children with reading difficulties were weak at spelling accuracy, they were otherwise found to produce written compositions of similar quality to typical readers. Boys produced less written text than girls, but did not demonstrate weaker written language abilities. Collectively the results demonstrate that writing skills can be separated into transcription and composition processes, and highlight the need for further research on the relationship between reading fluency and children's writing.

Keywords: writing, reading, children with reading difficulties, gender

1. Introduction

The importance of writing good quality narrative has long been recognised in the field of education (Miller & McCardle, 2011) and although children's written language development is often studied in isolation from their reading development, very little is known about the relationship between children's reading fluency and written language production. Children in UK primary schools are regularly encouraged to engage with and produce narrative compositions, in line with the national curriculum requirements for Key Stages One and Two. The present study therefore seeks to explore the relationship between different aspects of children's reading ability and their performance on a picture prompted written language task, with the aim of enhancing our understanding of how reading and writing interlink in the UK primary school classroom.

1.1 Reading and Written Language Composition

Berninger *et al.* (2002) provided valuable insight by using structural equation modelling to explore the relationships between reading comprehension, reading accuracy, and aspects of written language production. Their findings demonstrated differential pathways whereby single word reading underpinned handwriting fluency and spelling, while reading comprehension contributed to spelling and overall quality of written compositions. Moreover in a longitudinal study of school-age children, Abbott, Berninger, and Fayol (2010) found single word reading related to spelling but not larger components of written language, such as sentences or text. However, neither Berninger *et al.* (2002) nor Abbott *et al.* (2010) included measures of passage reading accuracy or reading fluency. It is possible that single word reading ability, passage word reading, and reading fluency each make distinct contributions to different aspects of the writing process. Other studies have explored the relationship between reading and writing through

writing intervention programmes or by classifying children by writing ability. Bourke and Adams (2010) highlighted early links between reading and writing by demonstrating that children in the first year of schooling could be classified as ‘writers’ or ‘non-writers’ depending on their single word reading and visuo-spatial memory skills.

Comprehension is likely to be involved in the quality of text produced at a number of different levels (Hayes, 1996). One level is that of understanding the text that the writer has just written, another is in storing organised schemas of appropriate writing discourse for a particular topic. In order to establish such schemas, the writer must initially have comprehended text where these topics have been presented. Even if young children do not consistently review their own writing (Kellogg, 2008), they would still need to comprehend the discourse of a story in order to write an effective narrative. Moreover, both Kim *et al.* (2011) and Abbott *et al.* (2010) found reading comprehension to be related to the quality of written composition. The potential importance of reading comprehension for written language production is highlighted further by Cragg and Nation (2006), in a study involving children with specific reading comprehension impairments. The findings suggested that poor comprehenders produced written compositions of a similar length to typical readers, but with significantly poorer ideas and a less coherent story structure.

Very few studies have reported data on the relationship between reading fluency and the quality of written language production. Definitions of reading fluency vary according to different theoretical perspectives (Babayiğit & Stainthorp, 2010). Complex definitions emphasise the automaticity of the reading process and of successful text comprehension, along with the readers’ use of appropriate expression and prosody (see Wolf & Katzir-Cohen, 2001, for further discussion). The automaticity of reading often leads to a freeing-up of processing resources for

higher level cognitive tasks. In practical terms this means that, in order to read fluently, children need to be recognising the majority of the words by sight. Therefore, reading fluency is appropriately indexed through measuring speed or rate. Sight recognition of words is considerably easier in a transparent language such as Turkish compared to the, relatively opaque, English language. Babayiğit and Stainthorp (2011) report a nine month longitudinal study where they explored the processes underpinning reading and writing composition undertaken with a group of eight to twelve year old Turkish children. They found that text reading speed correlated moderately with quality of written content and writing fluency, both concurrently and longitudinally, when the children were retested nine months later. Arguably reading fluency may have an even more important relationship to written language competence in English, as transcription skills will be heavily dependent on having acquired a large store of orthographic spellings in the lexicon. Such an orthographic store could only be established through exposure to written text, which in turn would be facilitated by increased reading fluency. Single word reading fluency and word identification fluency has been assessed in kindergarten children by Kim *et al.* (2011), along with measures of writing. For these beginning writers, there was a significant yet moderate to low relationship between reading fluency and the numbers of words, ideas, and sentences produced in written passages. However, whether the pattern remains for more proficient writers has not yet been addressed systematically by previous literature.

In summary, previous research with typically-developing children seems to indicate that single word reading ability is primarily linked to transcription (including early writing attempts), while reading comprehension skills are also related to the quality of written compositions. Relatively little is known about the relationship between children's reading fluency and their written language skills, which is the primary focus of the present study.

1.2 Written Language Composition and Related Cognitive Skills

There are several key cognitive measures that are known to contribute to reading performance, and are particularly helpful in identifying children at risk of reading difficulties. Arguably the foremost of these measures are phonological awareness and rapid automatised naming (RAN), both of which have been demonstrated to predict children's reading accuracy skills across several different languages (e.g., Babayiğit & Stainthorp, 2010; Chiappe & Siegel, 1999; Ziegler *et al*., 2010). The predictive power of these measures is still significant after controlling for vocabulary knowledge and autoregressive reading effects (Manis, Doi & Bhadha, 1999). Orthographic awareness skills have also been demonstrated to predict children's reading accuracy (e.g., Georgiou, Parrila & Papadopoulous, 2008) and reading comprehension (e.g., Goff, Pratt & Ong, 2005). However, it is currently unclear whether phonological awareness, RAN, and orthographic awareness are also associated with performance on composite written language tasks. Clarifying lower-level cognitive skills that are associated with written language performance has direct implications for educational assessments of children with literacy difficulties, and for formulating structured intervention programmes.

A critical question for current writing research is the extent to which the written language skills of children with reading difficulties differ from average and above-average readers. A small amount of psychological literature has started to explore this issue in school-aged children, however Berninger (2009) argues that written language skills in children with specific reading difficulties are largely under researched. In a recent study, Berninger, Nielson, Abbott, Wijsman and Raskind (2008) sought to emphasise that factors outside of graphomotor skills contribute to writing difficulties in children with reading difficulties. They found that children with dyslexia

were impaired on spelling, quality of written compositions, and handwriting in comparison to typically-developing controls. Their data demonstrated that spelling was a key contributor to quality of written compositions in the group of children with reading difficulties. In addition, Smith-Locke (1991) found that children with reading difficulties made more morphological errors in their writing than good readers, although Cox, Shanahan and Sulzby (1990) reported a lack of coherence in the written compositions of children with reading difficulties. Research also suggests that children who struggle with early reading skills later become poor writers who struggle to generate story ideas (Juel, 1988). Interestingly, in higher education students with reading difficulties, Connelly, Campbell, MacLean, and Barnes, (2006) found that the main differences in essays were in transcription skills and spelling, while the composition skills were similar to that of typical readers.

1.3 Writing Ability and Gender

An additional issue that warrants consideration in writing research is sex differences in children's writing. There is evidence to suggest that boys in the UK and America underperform compared to girls in English assessments (e.g., Calvin, Fernandes, Smith, Visscher & Deary, 2010; Pajares & Valiante, 2001). Furthermore, previous research has also found males underperform in written language tasks in comparison to females (Berninger & Fuller, 1992). Even though all young writers are likely to find it difficult to consider their audience (Kellogg, 2008), it is possible that females develop meta-cognitive skills at an earlier age, which may impact on their written language skills. Females have been shown to be more advanced than males in false belief tasks (Walker, 2005). Earlier development of theory of mind in girls may result in different organisational and planning patterns between males and females. Knudson

(1995) asked children to write a composition about rainy days, and found that girls were awarded significantly higher ratings of their writing quality than boys. Yet in terms of writing style, Jones and Myhill (2007) suggest the concept of 'differently literate' to describe the writings of boys and girls in their sample of secondary school writing. They considered that both groups often showed equivalent writing patterns, yet also noted that boys were often at the upper and lower ends of the writing indices while girls fell somewhere in the middle. Even where boys appeared to show poorer writing, such as in coherence, this may have been a consequence of their attempts to write longer sentences than girls. Recent studies have also highlighted the potential role of motivation in explaining gender differences in English writing tasks (e.g., Mata, 2011; McGeown, Goodwin, Henderson & Wright, 2011; Parajes & Valiante, 2001).

1.4 The Present Study

The present study aims to improve our current understanding of the relationship between the reading and writing skills of primary school aged children. In particular, the study seeks to contribute to the limited literature that has explored the relationship between reading fluency in children's written compositions. Previous research on children's written language development has used a wide range of written language tasks, which can make drawing comparisons across research studies problematic. Therefore, in line with key recent research papers on typical and atypical written language development (Alamargot *et al*., 2011; Babaygit & Stainthorp 2010, 2011; Bishop & Clarkson, 2003), a picture based written narrative task was used in the present study. For a research measure, providing picture stimuli rather than a written or spoken narrative title has the advantage of reducing the impact of topic knowledge on children's compositions, since their narratives can be based on the stimuli provided rather than exclusively drawing from

schemas in long-term memory. Previous research has also used a variety of different scoring systems to assess transcription skills and quality of written content. The Written Expression scoring framework from the Wechsler Objective Language Dimensions (Rust, 1996) was used in the present study, as it enables scoring of multiple aspects of written language quality, and also provides an overall composite score. Critically, this system assesses quality of written language compositions independently from transcription processes such as spelling and handwriting, and has been demonstrated to be a reliable method of scoring written language production (see Dockrell, Lindsay & Connelly, 2009; Dockrell, Lindsay, Connelly & Mackie, 2007). In order to capture additional aspects of written language performance, measures of text length, lexical diversity, noun usage, verb usage, and the proportion of spelling errors were also assessed.

Although previous studies of writing have covered a range of ages, primary school-aged children provide an opportunity to assess this range of literacy skills and their relationship to writing at a time when they are developing early narrative writing skills. Moreover, children are expected to carry out a considerable number of written language activities at school on a daily basis. Therefore, the present study sought to address four separate research aims in order to build on previous research findings. First, the study aimed to assess the relative contribution of children's reading accuracy, reading comprehension, and reading fluency to performance on a picture prompted narrative writing task. Second, we assessed whether cognitive factors known to predict reading performance (notably rapid automatised naming, phonological fluency, verbal memory, and orthographic skills) also contributed to written language performance. Third, we aimed to explore the written language skills of children with reading difficulties in comparison to age matched controls. Finally, we considered whether there are any differences in the written language skills of males and females.

2. Method

2.1 Participants

Sixty four participants (37 males and 27 females) from a primary school in the East Midlands of the United Kingdom took part in the study. The majority of children have English as a first language at the school but it is considered to be in an area with a low socio-economic status as a third of the children at the school are eligible for free school meals. Moreover, a little over one in ten of the children at the school has a Statement of Educational Needs and this is higher than is typical in the UK. The children in the study were aged between 8 years, 9 months and 11 years 9 months (mean age was 10 years; 1 month and all participants were in Key Stage Two of the UK's National Curriculum). Overall means and standard deviations for the tests used are reported in Table 1.

Insert Table 1 around here

2.2 Reading skill measures

For the reading measures, the raw scores for single word reading accuracy, passage reading, passage fluency, and comprehension were converted to standard scores. These conversions were in line with the information provided by the test manuals, as were the conversions for the writing measures and the measures that involve cognitive and language processes related to reading and/or writing that were subtests of scales.

2.2.1 Single word reading accuracy. The single word reading subtest of the York Analysis of Reading Comprehension (YARC; Snowling *et al*., 2009) was used. Participants named aloud a maximum of 60 individual words presented on a sheet, where the items gradually

increased in complexity and the task was untimed. A point was awarded for each correct word read and the sample internal reliability for this measure was .95.

2.2.2 Passage reading accuracy, fluency, and comprehension. Passage reading accuracy, fluency, and comprehension were measured using YARC (Snowling *et al*., 2009). For accuracy, participants were required to read a series of passages of around 100 words, and the number of errors while reading was recorded as a measure of accuracy. The time taken, in seconds, to read aloud the passages was used to calculate the measure of reading fluency and, after reading aloud the passages, the children were asked questions about what they had read as the measure of comprehension. As instructed in the manual, different participants were given different passages to read in line with their chronological age, and this resulted in scores that were not suitable for internal reliability analysis.

2.3 Writing skill measures

For the writing skill measures, the raw scores for spelling were converted to standard scores.

2.3.1 Spelling. The spelling measure was taken from the British Ability Scales II (BAS II; Elliot, Smith, & McCulloch, 1996). Participants were required to spell a series of items that gradually increased in complexity and were read aloud by the experimenter. There was a maximum of 75 words and each correct spelling was awarded one point. The task was discontinued after eight errors in a block of ten. The sample internal reliability was .95.

2.3.2 Written language task. The children were presented, using the class projector, with a sequence of six pictures that made up a series of events about two children building a sand castle and buying ice creams. The children were given two or three minutes to examine the

pictures before the writing task began. The children were provided with writing paper and instructed that they were to write a story based on the sequence. Ten minutes of writing time was provided. At the end of this time, the children were asked to finish the sentence they were writing and the response sheets were collected. The written compositions were coded using the scoring system from the Written Expression scoring framework of the Weschler Objective Language Dimensions (WOLD; Rust, 1996). The WOLD has six elements: (1) Ideas and Development, (2) Organisation, Unity and Coherence, (3) Vocabulary, (4) Sentence Structure and Variety, (5) Grammar and Usage, (6) Capitalisation and Punctuation. Each passage was coded on each of these elements with a score of 1 referring to a poor example of the element and 4 being an excellent example. Half of the passages were coded by the first and second authors and 25% of the passages were coded by both authors with an inter-rater reliability of.93 (Cronbach's alpha). The following written language measures were also recorded: total number of words, lexical diversity (number of unique words in a passage), numbers of verbs and nouns, and the proportion of spelling errors.

2.4 Measures that involve cognitive and language processes related to reading and/or writing.

For the measures that involve cognitive and language processes related to reading and/or writing, the raw scores for verbal memory were converted to standard scores. For matrix reasoning and verbal similarities, the raw scores were converted to T scores.

2.4.1 Verbal memory. Taken from BAS II (Elliot *et al.*, 1996), the verbal memory subscale required participants to complete a forwards digit span task. In early items the strings of digits were short and as the task progressed, the strings became longer. One point was awarded

for each correctly repeated string and the maximum score was 36. The sample internal reliability was .88.

2.4.2 Rapid automatised naming (RAN). The task was designed in line with those of previous RAN studies (e.g. Denckla & Rudel, 1974; Denckla & Rudel, 1976). In the task, participants were presented with a card that had 50 lower case letters (s, d, a, h, f, m, e, c, b, g) in a 5 x 10 matrix. Each letter was presented five times, once in each row of the array, and the letters in the row were in a random order. The time taken for participants to name aloud the array was recorded in seconds.

2.4.3 Matrix reasoning. This task was a subscale from the Weschler Abbreviated Scale of Intelligence (WASI; Weschler, 1999) and was used as a measure of nonverbal ability. On each card, participants were presented with a partially completed pattern and asked to indicate which of five options would complete the pattern. As the task progressed, the patterns became more complex to a maximum of 35 items. The task was discontinued if a participant failed five consecutive items. One point was awarded for each correct answer. The sample internal reliability was .91.

2.4.4 Verbal similarities (vocabulary). The Similarities subscale from the WASI (Weschler, 1999) was administered as a measure of verbal reasoning in that a participant would be required to judge the connections between two verbally presented items and as such draws on vocabulary skills. In the initial task items, participants were provided with pictures of items on two rows and asked to indicate which item in the bottom row was similar to the items in the top row. In later task items, participants were presented with two words and asked to explain how the two words were similar. The task was discontinued if a participant failed five consecutive items. Participants were scored zero or one for early items, and zero, one, or two for later items, in line

with the instruction manual, and there were a maximum of 26 items (maximum score of 48). The sample internal reliability was .84.

2.4.5 Phonological fluency. A phonological fluency task (e.g. Borkowki, Benton, & Spreen, 1967; Harrison, Buxton, Husain, & Wise, 2000) was used to index phonological awareness skills. Participants named as many words beginning with /s/ as they could in 60 seconds. One point was awarded for each correct item named in the time provided.

2.4.6 Orthographic awareness. The orthographic awareness task was taken from the item list in Cunningham, Perry, and Stanovich (2001) where participants were provided with a set of 23 items and for each item, the correct spelling of a word and an orthographically similar but incorrect spelling of the word were presented (e.g., RANE and RAIN). The children were asked to circle the word that had been spelled correctly. One point was awarded for each correct response. The sample internal reliability was .90.

2.5 Procedure

The written language task and the orthographic awareness task were administered on a class-wide basis. The remaining tasks were spilt across two testing sessions and were administered in a one-to-one setting by trained research assistants.

3. Results

3.1 The Relationship between Reading and Writing

In order to address the first aim of the study, a series of zero-order correlations were carried out to assess the relationship between reading skills and writing. As can be seen in Table 2, single word reading accuracy was significantly associated with lexical diversity, number of

nouns, number of verbs, and the proportion of spelling errors. Passage reading accuracy was significantly associated with the number of nouns, number of verbs, and the proportion of spelling errors. Reading comprehension showed the fewest significant correlations, only correlating with lexical diversity and the proportion of spelling errors. However, passage reading fluency correlated significantly with all five of the written language measures. There were no significant correlations between the WOLD subscales or the WOLD total score and any of the reading measures. As the age range was across three years, a further series of correlations partialling out chronological age were carried out, and as can be seen in Table 2, the correlation patterns remained similar.

Insert Table 2 around here

Further correlations were carried out to investigate whether variables known to underpin reading ability also correlated with the written language measures. It can be seen from Table 3 that several significant correlations did emerge. In particular, orthographic awareness correlated significantly with all of the written language measures. Moreover, Table 4 demonstrates that this pattern of relationships held after controlling the effect of chronological age.

Insert Tables 3 and 4 around here

A series of hierarchical regression analyses was conducted to assess the second aim: whether each of the reading skills was significantly associated with aspects of written language performance. Throughout all of these analyses, age and verbal similarities (vocabulary) were controlled at the first step of the analyses, and the reading measures were separately entered at the second step of the analyses. Only significant results are reported in full. As the WOLD scores

(ideas and development, organisation, unity and coherence, sentence structure and variety, grammar and usage, and capitalisation and punctuation) did not correlate with any of the reading variables they were excluded from any further analyses. Although several of the written language measures can be considered to index written volume (text length, lexical diversity, number of nouns, and number of verbs), they were still considered to be qualitatively different measures of language production. Therefore predictors of these variables were assessed in turn (where reported in the regression results, *$p < .05$; **$p < .01$).

After controlling for age and verbal similarities, single word reading accuracy, passage reading accuracy and reading comprehension were all non-significant predictors of text length and lexical diversity. Passage reading accuracy accounted for a modest yet significant 6.4% unique variance in number of nouns, $F(3,57) = 3.22$, $MSE = 36.74$, $p = .029$; $\beta = .263$*. Passage reading fluency accounted for a significant 8.3% of the unique variance in text length, $F(3, 57) = 2.75$, $MSE = 688.29$, $p = .051$; $\beta = .299$*, although this should be interpreted with caution since the overall model was only approaching statistical significance. Passage reading fluency also accounted for a significant 10.5% of variance in lexical diversity $F(3, 57) = 3.86$, $MSE = 170.76$, $p = .014$; $\beta = .336$**, and 6.9% of the variance in number of nouns $F(3,57) = 3.33$, $MSE = 36.55$, $p = .026$, $\beta = .271$*. Passage reading fluency accounted for 18.3% of the variance in number of verbs, $F(3,57) = 5.39$, $MSE = 12.86$, $p = .002$; $\beta = .443$**. As expected, both the single word reading accuracy and the passage reading accuracy were strong predictors of the proportion of spelling errors made in the text, accounting for 50.5% of the variance, $F(3,57) = 28.86$, $MSE = .007$, $p = .000$; $\beta = -.782$**, and 52.3% respectively, $F(3,57) = 31.18$, $MSE = .006$, $p=.000$, $\beta = -.750$**. Passage reading fluency also accounted for a substantial 37.7% of the variance in spelling, $F(3,57) = 17.16$, $MSE = 1.54$, $p = .000$, $\beta = -.635$**, with reading comprehension

making a more modest but still significant 10% contribution, $F(3,57) = 4.89$, $MSE = .014$, $p = .004$, $\beta = -.356$**.

In summary, it seems that reading fluency may have a particular association with the amount of written text children produced, and this finding seems to hold regardless of whether the measurement is text length, lexical diversity, number of nouns or number of verbs. A second series of regression analyses was conducted to assess whether the cognitive variables known to be related to reading (phonological fluency, RAN, orthographic awareness and verbal memory) were also significantly predictors of written language performance. Once again, age and verbal ability were controlled by entering these variables at the first step of the regression analyses, and only significant results are reported in full.

Phonological fluency was found to account for 9.4% of the variance in text length, $F(3,57) = 3.07$, $MSE = 6.79.58$, $p = .035$; $\beta = .317$*, 8.1% of the variance in lexical diversity, $F(3, 57) = 3.28$, $MSE = 175.52$, $p = .027$; $\beta = .296$*, and 11.6% of the variance in number of nouns, $F(3,57) = 3.63$, $MSE = 36.07$, $p = .018$; $\beta = .293$*. Orthographic awareness was also a significant unique predictor of text length, accounting for 9.3% of the variance, $F(3,57) = 3.06$, $MSE = 679.81$, $p = .035$; $\beta = 3.18$**. Orthographic awareness accounted for 7.5% of the variance in lexical diversity, $F(3,57) = 3.11$, $MSE = 176.79$, $p = .033$; $\beta = .285$*, and 13.4% of variance in the number of nouns produced, $F(3,57) = 4.09$, $MSE = 35.35$, $p = .011$; $\beta = .323$*. While the analyses indicated orthographic awareness accounted for 7.9% of the variance in verb production, this should be interpreted with caution as the overall model was only approaching statistical significance, $F(3,57) = 2.73$, $MSE = 14.43$, $p = .052$; $\beta = .308$*. Both RAN and orthographic awareness accounted for variance in the proportion of spelling errors participants made, accounting for 13%, $F(3,57)= 5.62$, $MSE = .013$, $p = .002$; $\beta = .364$**, and 41.2%

respectively, $F(3,57) = 19.77$, $MSE = .008$, $p = .000$, $\beta = .668$**.

It appears that orthographic awareness and to a lesser extent phonological fluency are particularly important predictors of written language production, after controlling for age and verbal similarities. Surprisingly, although RAN was a significant predictor of spelling, it contributed little towards the other measures of written language. Similarly, verbal memory accounted for little or no variance in the written language production measures.

3.2 Comparisons by Children with Reading Difficulties and Typical Readers

The third aim of the study was to compare two reading ability groups on their measures of written language production. A group with reading difficulties was selected based on having a passage reading accuracy standard score below 85. Twenty-two children met this classification and these children were matched by age and gender to typical children from the remainder of the sample. It was not possible to match one of the children with reading difficulties and so this resulted in 21 children in each group (nine females and 12 males in each reading group). The difference in chronological age ranged between zero months and four months between children in a pair (mean difference = -0.57, months, *SD* = 1.80) and there was no significant difference in age across the two groups (Cohen's *d*, *effect size* = 0.06). Table 5 summarises the group comparisons on the reading and cognitive measures. Although the WOLD scores were not significantly related to the reading measures or the measures thought to contribute to reading and/or writing it was possible that, in comparing children with reading difficulties and typical children, that there might be differences in the patterns of scores between the two groups. As such, analyses of WOLD were included these comparisons.

Kolmogorov-Smirnov tests indicated that passage reading fluency, matrix reasoning, RAN, orthographic awareness, verbal memory, phonological fluency, proportion of spelling errors, number of nouns, and the WOLD scores, had distributions that were outside of normal limits and so the findings from these should be interpreted with caution. As expected, the typical readers had significantly higher scores on the grouping variable of passage reading accuracy (*effect size* = 3.37) along with reading comprehension (*effect size* = 1.08), and single word reading accuracy scores (*effect size* = 1.83). Moreover, typical readers had significantly higher standard spelling scores (*effect size* = 2.13) and orthographic awareness (*effect size* = 1.30). Regarding measures that contribute to reading skills, the typically reading children marginally faster RAN speeds (*effect size* = 1.03), but there was no significant difference in the verbal similarities (*effect size* = 0.34), matrix reasoning (*effect size* = 0.67), verbal memory scores (*effect size* = 0.11), or phonological fluency (*effect size* = 0.48).

Insert Table 5 around here

Comparing lexical measures, summarised in Table 6, there was a significant difference in the proportion of spelling errors (*effect size* = 1.45). However the remainder of the lexical measures were non-significant: lexical diversity (*effect size* = -0.63), number of words (*effect size* = -0.63), number of verbs (*effect size* = -0.60), and number of nouns (*effect size* = -0.46).

Insert Table 6 around here

To compare the WOLD scores, a 2 Reading Group (children with reading difficulties and typical readers) x 6 WOLD scores (ideas and development, organisation, unity and coherence, sentence structure and variety, vocabulary, grammar and usage, capitalisation and punctuation)

mixed ANOVA, Table 7 summarises the results. There was a main effect of WOLD measure, $F(3.77, 150.62) = 4.41$, $MSE = 0.57$, $p < .01$, *partial* $\eta^2 = .10$, (Greenhouse-Geisser), Bonferroni corrected pairwise comparisons indicated that organisation, unity and coherence was significantly higher than sentence structure and variety and grammar and punctuation. However, there was no significant main effect between reader group, $F(1, 40) = 0.01$, $MSE = 3.17$, $p = .92$, *partial* $\eta^2 = .0$ Furthermore, the interaction between Reader Group and WOLD scores was not significant, $F(3.77, 150.62) = 0.37$, $p = .82$, *partial* $\eta^2 = .01$. In a separate analysis, overall WOLD score was also not significantly different between groups, $t(40) = 0.11$, $p = .92$, *effect size* = 0.03.

Insert Table 7 around here

3.3. Comparing Males and Females

The fourth aim of the study was to investigate whether there were any differences in the written performance of males and females. Although gender was one of the matching criteria for the comparison between children with reading difficulties and typical readers, it was possible that gender differences on writing measures may exist in the sample as a whole. Moreover, there was a reasonable split of participants by gender (37 males, 27 females). As with the comparisons between reader groups, WOLD scores were also analysed as there may be differences in the written dimensions between males and females. Kolmogorov-Smirnov tests indicated distributions outside of the normal limits in a number of measures: reading fluency, single word reading accuracy, the matrix reasoning, RAN, orthographic awareness, verbal memory, phonological fluency, number of nouns, proportion of spelling errors, and the WOLD scores. Parametric analyses were used as these are robust to violations of normal distribution, however

these results should be interpreted with caution. Analyses indicated that there were no significant differences between males and females in chronological age, and the measures of reading (passage reading accuracy, reading fluency, single word reading accuracy), matrix reasoning, and spelling (see Table 8). Table 8 also summarises males and females performance on the verbal similarities subtest and the additional cognitive measures. It can be seen that although females had slightly higher verbal similarities scores compared with males, this difference was not statistically significant when a Bonferroni correction was applied to the *t*-test. The two groups were comparable on all remaining measures.

Insert Table 8 around here

In the written language task females outperformed males in terms of lexical diversity (*effect size* = -1.09), text length (*effect size* = -1.03), number of verbs (*effect size* = -0.84), and number of nouns (*effect size* = -0.78). There were no significant differences in the proportion of spelling errors (*effect size* = 0.25). The means and standard deviations are summarised in Table 9.

Insert Table 9 around here

To compare the WOLD scores a 2 Gender (males and females) x 6 WOLD scores (ideas and development, organisation, unity and coherence, sentence structure and variety, vocabulary, grammar and usage, capitalisation and punctuation) mixed ANOVA was carried out. There was a main effect of the WOLD scores, $F(3.71, 222.39) = 4.44$, $MSE = .58$, $p < .01$, *partial* $\eta^2 = .07$ (Greenhouse-Geisser). Bonferroni corrected pairwise comparisons indicated that organisation,

unity and coherence was significantly higher than sentence structure and variety, vocabulary, and grammar and punctuation. There was no significant main effect of gender, $F(1, 60) = 1.17$, $MSE = 2.68$, $p = .28$, *partial* $\eta^2 = 0.02$ and there was no significant interaction, $F(5, 222.39) = 0.24$, $p = .90$, *partial* $\eta^2 = .01$. Moreover, there was no significant difference between males and females on the overall WOLD score, $t(60) = 1.08$, $p = .28$, *effect size* = 0.28, Table 10 summarises the descriptive measures.

It is possible that the girls' slightly higher verbal ability could be responsible for the gender differences seen in written language production. Therefore, to assess whether verbal similarities performance contributed to the differences in lexical measures, a series of one way ANCOVAs were carried out for the written language measures with verbal similarities T scores as the covariate. The pattern of differences remained the same.

Insert Table 10 around here

4. Discussion

The overarching aim of this study was to explore the relationships between different aspects of reading, particularly reading fluency, and writing in primary school children. In addition, we aimed to assess whether cognitive measures that are known to underpin reading also contribute to written language production and explored differences in written language skill in relation to reading ability and gender.

With the exception of Babayiğit and Stainthorp (2011) and Kim *et al.* (2011), who studied Turkish children and kindergarten children respectively, links between reading fluency and writing quality have been unexplored in the psychology literature to date. We found that

reading fluency accounted for substantial amounts of variance in multiple measures of writing in a conservative analysis controlling for verbal ability and chronological age. Specifically, reading fluency was significantly associated with text length, lexical diversity, number of nouns, number of verbs, and proportion of spelling errors. With the exception of spelling, all of the outcome variables that were significantly associated with reading fluency are indexing the amount of information children are able to transcribe on the page. Therefore reading fluency seems to be linked to the transcription processes of writing rather than the higher order processes impacting on quality of content. In particular, reading fluency reflects the automaticity with which participants are able to access lexical representations. Rapid access of orthographic and semantic information is also likely to facilitate children's ability to transcribe their ideas on to paper. We can hypothesise that this link between reading fluency and transcription processes is likely to increase in importance as children grow older, and they are frequently required to produce written text either under time restrictions in the classroom or in formal examinations. For instance, Connelly *et al.* (2006) highlighted that, in higher education students with reading difficulties, it was their transcription processes rather than their composition skills that set them apart from typical readers. Further studies are now needed to investigate this link across different age groups, and over time, in order to model the developmental relationship between reading fluency and writing more clearly. Both passage reading accuracy and single word reading accuracy were found to be significantly associated with spelling performance in the written compositions once age and verbal similarities (vocabulary) had been taken into account, and therefore these reading measures were more related to transcription rather than higher level processes or the children's text generation. The link between reading and spelling development is

well documented at the single word level (e.g. Frith, 1985), but this is one of the few studies that extends this relationship to children's written narratives.

In contrast to previous research (e.g., Berninger *et al*., 2002; Cragg and Nation, 2006) no relationship was found between reading comprehension and the quality of written compositions, which may in part reflect the nature of the written language task used in this study. The children were asked to produce a written narrative based on pictures, therefore they did not have to generate the ideas for their narrative from long term memory. Through reducing the impact of topic knowledge and written language schemas acquired through reading comprehension skills, a non-significant relationship between reading comprehension and written language production is not surprising in the present study. We anticipate that a stronger relationship between reading comprehension and writing would emerge if the children were given an essay based writing task, without visual stimuli. In future studies administering multiple measures of writing skill with varying types of prompt and stimuli may be advantageous. Moreover in contrast to some of the previous research (e.g., Olive, Kellogg, & Piolat, 2008), verbal memory made little contribution to the writing measures, which again may be explained by the picture based written language task. Providing pictures for the children to write about is likely to have reduced the load on verbal memory, as the children had the visual stimuli present throughout the writing task, and they could refer to the pictures as often as they liked.

Researchers, teachers, and practitioners know a considerable amount about the lower level cognitive skills that underpin reading development, but relatively little about the processes underlying writing. Our data shows that phonological skills and orthographic awareness are key variables that have links to measures associated with the text generation aspect of writing. Phonological fluency was linked to number of nouns, the text length, and lexical diversity, while

orthographic awareness and phonological fluency were linked to the number of nouns produced in the written text. Both RAN (Savage, Pillay, & Melidona, 2008) and orthographic awareness (Stanovich & West, 1989) are known predictors of single word spelling and, in this study, these abilities are also found to be associated with spelling ability within the context of the written text.

Children with reading difficulties underperformed compared to typical readers on a range of reading-related skills in this study, including spelling ability in the written narrative task. However, the two groups were comparable on all other written language measures. This emphasises the striking separation of transcription processes, in this case spelling, and higher order processes related to written language content. In particular, there was no difference between the two groups on their WOLD scores, indicating that the quality of the compositions produced by children with reading difficulties was comparable to the typical readers. The findings suggest that reading and spelling difficulties are distinct from more general writing difficulties and the findings are broadly in line with Connelly *et al*., (2006), who demonstrated a similar pattern of findings in university students. Children with reading difficulties and the typical control children in this study were matched closely by age and gender and were differentiated only by their reading accuracy and comprehension. However, previous research would also lead to an expectation that verbal ability, phonological ability (Kirby, Desrochers, Roth, & Lai, 2008), and possibly nonverbal ability (Catts, Hogan, & Fey, 2003) would differentiate the two groups. However, these cognitive measures showed non-significant differences in our sample, even though the trend was for typical readers to have higher scores in these measures than children with reading difficulties and the effect sizes were moderate. There are two possibilities, the first is that, although the groups were closely matched, the smaller

sample size meant there may have been insufficient power in these analyses for significant effects to emerge between the groups on these cognitive variables. A second possibility is that some of these differences are more evident in younger children rather than children in late primary school.

The sample as a whole had a large range of reading ability, from a number of children with below 85 in their standard score on the reading measures to several children well above 115. Overall, the mean for the standard scores were below 100. It is likely that this is related to the lower SES of the area that the school was situated in and the proportion of children with SEN statements who attended the school. The findings might be generalizable only to some particular educational contexts but do highlight a number of the challenges that many schools face in the UK in addressing the requirements of Key Stage Two. However, the finding in relation to reading fluency and writing ability does support the aim in Key Stage Two of integrating writing into other linguistic activities and that writing itself should not be seen in isolation to other linguistic skills.

By gender, one of the key patterns to emerge was that males and females had very similar profiles across the standardised measures of reading ability, the skills that contribute to reading, reading comprehension, and spelling. In contrast to the predictions based on the previous literature, higher level measures of writing, as indexed by the WOLD, were comparable between the two groups. Where differences emerged in written language skills was in the lexical diversity, numbers of nouns and verbs, and the length of compositions. Moreover, these differences were not accounted for by the superior verbal ability of the female participants. Previous studies have also shown differences in the nature of writing by males and females (Jones & Myhill, 2007; Knudson, 1993), what is striking about the current findings is that these

differences can be found in primary school aged children who have only begun to write fairly recently, and where males and females are comparable on reading and related cognitive skills. The findings here contribute to the argument put forward by Jones and Myhill (2007) that it is not males' underlying skills in reading and writing that result in less writing ability nor, as measured by the WOLD scores, that males have poorer quality ideas or organisation. Rather, the differences may be due to the approach that males and females have to free writing, such as the task in this study. It may be that teachers equate 'more' with 'better' in assessing writing quality. In addition, we need to consider the possible impact of motivational factors on writing production (Mata, 2011; Parajes & Valiante, 2001; McGeown, Goodwin, Henderson & Wright, 2011). Both boys and girls appeared to be engaged with the written language task, but it is possible the topic of the narrative was more appealing to girls than boys.

As the focus of the study was on reading skills, one transcription aspect not investigated was the role of handwriting. As Graham, Berninger, Abbott, Abbott, and Whitaker (1997) noted, research has not always shown handwriting fluency and quality contribute to written composition. Yet in their structural equation modelling of handwriting fluency they found a direct relationship to the fluency of children's writing and to, a lesser extent, the quality of children's writing; findings supported by Stainthorp and Rauf (2009) and Medwell, Strand, and Wray (2007). However, the within grade relationships between written composition and writing fluency in Abbott *et al.*, (2010) suggested that handwriting fluency may have implications for younger writers but not necessarily those of writers in middle childhood. Nevertheless, further exploration of fluency in future studies would allow an investigation of transcription aspects of writing in tandem with spelling.

4.1 Conclusion

In conclusion, this study has built on previous findings into the links between writing and reading, and provides clear directions for future research. In the data set as a whole, links between reading and writing existing at the transcription level rather than the compositional level. Furthermore, both the comparison analyses also suggest that the transcription processes of writing are separable from the composition processes. Males compose their narratives as equally well as females and spell their written work competently, but they transcribe their compositional ideas using fewer words, nouns, and verbs. Children with reading difficulties have compositional abilities that are comparable to typical readers, yet their spelling sets their written work apart. Finally, this study has drawn attention to the relationship between reading fluency and written language production in primary school children. Further longitudinal research is now needed to assess the direction of this relationship and to see whether reading fluency becomes an increasingly important predictor of written language as children develop.

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Table 1. Means and standard deviations for the background measures and age (N = 64)

Measures	Mean	SD
Age in months	120.92	9.21
Single word reading accuracy raw score	37.03	12.21
Passage reading accuracy standard score	94.70	17.06
Passage reading fluency standard score	92.33	16.61
Reading comprehension standard score	93.97	9.56
Spelling standard score	94.68	14.76
Verbal memory standard score	50.46	9.32
RAN seconds	31.06	13.65
Matrix reasoning T score	42.09	11.29
Verbal similarities T score	41.32	12.12
Phonological fluency raw score	10.19	3.94
Orthographic awareness raw score	21.52	3.08

Table 2. Bivariate correlations (above the diagonal) and partial correlations controlling for age (below the diagonal) between reading measures and written language measures (N = 64)

	1	2	3	4	5	6	7	8	9
1. Single word reading accuracy	-	.757**	.384**	.704**	.209	.259*	.289*	.313*	-.770**
2. Passage reading accuracy	.831**	-	.327**	.767**	.163	.245	.304*	.275*	-.700**
3. Reading comprehension	.451**	.319*	-	.395**	.184	.260*	.157	.250	-.309*
4. Passage reading fluency	.768**	.765**	.390**	-	.322*	.373**	.313*	.457**	-.599**
5. Text length	.197	.171	.195	.329*	-	.934**	.887**	.813**	-.264*
6. Lexical diversity	.262*	.249	.267*	.377**	.935**	-	.858**	.880**	-.312*
7. Number of nouns	.276*	.315*	.171	.322*	.887**	.859**	-	.732**	-.325**
8. Number of verbs	.314*	.281*	.259*	.462**	.812**	.880**	.731**	-	-.336**
9. Proportion of spelling errors	-.746**	-.763**	-.366**	-.651**	-.254*	-.317*	-.314*	-.336**	-

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

Table 3. Bivariate correlations between cognitive measures and written language measures (*N* = 64).

	Phonological fluency	RAN	Orthographic awareness	Verbal memory
Text length	.345**	-.158	.344**	.163
Lexical diversity	.328**	-.171	.315*	.184
Number of nouns	.340**	-.214	.366**	.209
Number of verbs	.307*	-.259*	.329**	.207
Proportion of spelling errors	-.065	.393**	-.698**	-.278*

*$p < .05$, **$p < .01$

Table 4. Partial correlations, controlling for age, between cognitive measures and written language measures (N = 64)

	Phonological fluency	RAN	Orthographic awareness	Verbal memory
Text length	.338**	-.151	.337**	.157
Lexical diversity	.328*	-.168	.315*	.182
Number of nouns	.330*	-.205	.356**	.202
Number of verbs	.303*	-.255*	.326*	.203
Proportion of spelling errors	-.009	.374**	-.682**	-.262*

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

Table 5. Descriptive scores for age, YARC and cognitive measures comparing typical (n = 21) and poor readers (n = 21)

Measures	Typical reader (n = 21)		Poor reader (n = 21)		Group Comparisons (Bonferroni correction $p < .004$)
	Mean	SD	Mean	SD	
Age in months	121.05	8.82	121.62	9.26	$t(40) = 0.21$, $p = 0.84$
Single word reading accuracy raw score	42.62	7.02	25.24	11.95	$t(40) = -5.75$, $p < .004$
Passage reading accuracy standard score	104.67	11.21	75.19	6.30	$t(40) = -10.51$, $p < .004$
Passage reading fluency standard score	101.67	13.13	77.1	11.83	$t(39) = -6.28$, $p < .004$
Reading comprehension standard score	101.05	7.31	90.52	12.14	$t(40) = -3.4$, $p < .004$
Spelling standard score	101.7	12.06	80.19	8.18	$t(39) = -6.71$, $p = .004$
Verbal memory standard score	48.85	8.81	47.76	10.58	$t(39) = -0.36$, $p = 0.72$
RAN seconds	26.00	7.03	39.05	18.28	$t(40) = 3.05$, $p = .004$
Matrix reasoning T score	46.29	9.58	39.1	11.89	$t(40) = -1.75$, $p = 0.09$
Verbal similarities T score	42.4	14.6	38.05	11.02	$t(39) = -1.08$, $p = 0.29$
Phonological fluency raw score	11.2	4.43	9.38	3.19	$t(39) = -1.52$, $p = 0.14$

Orthographic awareness raw score	22.65	0.67	19.33	4.43	$t(39) = -3.31$, $p < .004$

Table 6. Descriptive scores for lexical measures of writing compared by reader group

Measures	Typical Readers (n = 21)		Poor Readers (n = 21)		
	Mean	SD	Mean	SD	Group Comparisons (Bonferroni correction $p < .004$)
Text length	57.90	20.88	52.24	27.08	$t(40) = -0.76$, $p = 0.45$
Lexical diversity	38.10	11.55	30.9	11.46	$t(40) = -2.03$, $p = 0.05$
Number of nouns	12.62	5.56	10.05	5.61	$t(40) = -1.49$, $p = 0.14$
Number of verbs	9.29	4.06	7.10	3.21	$t(40) = -1.94$, $p = 0.06$
Proportion of spelling errors	0.07	0.08	0.23	0.14	$t(31.73) = 4.62$, $p < .004$

Table 7. Descriptive scores for WOLD measures of writing compared by reader group

	Typical Readers (n = 21)		Poor Readers (n = 21)	
WOLD Measures	Mean	SD	Mean	SD
Ideas and development	2.29	1.06	2.33	1.02
Organisation, unity and coherence	2.38	0.92	2.48	0.87
Sentence structure and variety	2.00	0.89	1.86	0.79
Vocabulary	2.05	0.80	2.24	0.83
Grammar and usage	1.95	0.97	1.86	0.96
Capitalisation and punctuation	2.24	1.09	2.29	1.01
Total WOLD score	12.90	4.50	13.05	4.21

Table 8. Descriptive scores for males and females on age, YARC reading tasks and cognitive measures

Measures	Male (n = 37)		Female (n = 27)		Group Comparisons (Bonferroni correction $p < .004$)
	Mean	SD	Mean	SD	
Age in months	120.38	10.05	121.67	8.06	$t(62) = 0.55$, $p = 0.59$
Single word reading accuracy raw score	36.14	12.30	38.26	12.21	$t(62) = 0.68$, $p = 0.50$
Passage reading accuracy standard score	93.62	15.89	96.16	18.75	$t(62) = 0.58$, $p = 0.56$
Passage reading fluency standard score	90.47	15.92	94.81	17.49	$t(61) = 1.03$, $p = 0.31$
Reading comprehension standard score	94.27	11.31	97.56	10.55	$t(62) = 1.18$, $p = 0.24$
Spelling standard score	92.27	14.19	98.12	15.13	$t(61) = 1.57$, $p = 0.12$
Verbal memory standard score	49.38	10.29	52.00	7.66	$t(61) = 1.1$, $p = 0.28$
RAN Seconds	30.38	15.39	32.00	11.05	$t(62) = 0.47$, $p = 0.64$
Matrix reasoning T score	41.00	10.67	43.59	12.12	$t(62) = 0.91$, $p = 0.37$
Verbal similarities T score	38.54	12.17	45.27	11.11	$t(61) = 2.24$, $p = 0.03$
Phonological fluency raw score	10.03	3.98	10.42	3.95	$t(61) = 0.39$, $p = 0.7$

Orthographic awareness raw score	21.22	3.21	21.96	2.90	$t(61) = 0.94$, $p = 0.35$

Table 9. Descriptive scores for males and females on the lexical measures of writing

Measures	Gender				
	Male (n = 37)		Female (n = 27)		
	Mean	SD	Mean	SD	Group Comparisons (Bonferroni correction p < .004)
Lexical diversity	29.22	13.32	42.46	11.01	$t(61) = 4.16$, $p < .004$
Text length	44.89	26.23	69.69	22.13	$t(61) = 3.93$, $p < .004$
Number of verbs	7.08	3.88	10.15	3.39	$t(60) = 3.24$, $p < .004$
Number of nouns	9.97	5.76	14.65	6.31	$t(60) = 3.03$, $p < .004$
Proportion of spelling errors	.13	0.12	.09	0.13	$t(60) = 1.00$, $p = 0.32$

Table 10. Descriptive scores for WOLD measures compared by gender

WOLD measures	Gender			
	Male (n = 37)		Female (n = 27)	
	Mean	SD	Mean	SD
Ideas and development	2.28	0.91	2.12	0.91
Organisation, unity and coherence	2.42	0.77	2.35	0.94
Sentence structure and variety	2.00	0.83	1.73	0.78
Vocabulary	2.14	0.83	2.00	0.63
Grammar and usage	2.14	0.99	1.85	0.97
Capitalisation and punctuation	2.22	1.07	2.04	1.00
Total WOLD score	13.19	4.15	12.08	3.81