

**Children Challenged by Writing Due to Language and Motor Difficulties**

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Acknowledgements: Thanks to the UK Government Department for Education and the

Leverhulme trust for funding some of the work mentioned in this chapter.

### **Children Challenged by Writing Due to Language and Motor Difficulties**

There has been increased interest in recent years in the writing skills of children with specific learning or developmental difficulties such as dyslexia, specific language impairment and developmental coordination disorder. These diagnoses refer to primary difficulties in specific domains of development, although the child's overall development and intellectual ability are typically within average range. This chapter reviews this recent work and introduces issues in keeping with the goals of this volume—the application of cognitive models of writing development, which have been given insufficient attention in assessment and intervention with these clinical populations. We explain how cognitive models have shaped and influenced our ideas about how these conditions interact with both the process of learning to write and the nature of a child's language or motor difficulties. Moreover, research and clinical practices for both language and motor disorder are increasingly beginning to consider issues related to learning to write within a more complex view integrating developmental models of writing with developmental models of oral language and motor skills.

Writing is a complex task drawing on a range of cognitive, language, motor, and social skills. Not surprisingly, given its complexity, many children struggle with writing (Graham & Harris, 2009). Difficulties in the production of legible, accurate, and coherent text can arise for different reasons including specific patterns of difficulties experienced by the writer, limitations in teaching, or inadequate opportunities to practice producing texts. Complex effects are evident at word-, sentence- and text- levels of language (Graham, 2008; Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002; McArthur & Graham, 1987). An examination of the constraints due to individual differences, teacher variations, or differential experiences, including practice on

written text production, is an essential step in developing and testing theoretical models of writing and in developing evidence-based practice to help those with writing difficulties. Although many children struggle with- text production, there are particular groups of children with clinical difficulties who are especially prone to writing difficulties (see Dockrell, 2009). The difficulties experienced by these children may arise in the processes that support successful text production or the cognitive representations that underpin text generation.

This longstanding interest, in the writing of children with language or motor disorders can be traced back over a hundred years (Ogle, 1867, cited in Hooper et al., 2002). Although children who experience a range of developmental difficulties are at risk of writing problems (Dockrell, 2009), in this chapter we focus on language difficulties, often referred to as specific language impairment (SLI) or language learning disability (LLD) in the literature, specific reading difficulty or dyslexia (DYS), and developmental coordination disorder (DCD). To make the case that the cognitive tradition in writing is relevant to clinical and educational practice for children with language and motor difficulties we will examine the writing of children who have difficulty producing and understanding oral language (children with SLI), children who have problems with spelling (children with DYS, which is a word spelling as well as word reading difficulty), and those with motor problems (children with DCD). Our goal is to provide insight into the difficulties these children face and elucidate the nature of the underlying cognitive, language, and motor processes involved in their written text production (Hulme & Snowling, 2009).

Poor writing is a barrier to educational progress for all children and especially those with SLI, DYS, and DCD.. These children find it difficult to do well in public school exams which are traditionally weighted towards assessment based on producing, often extended, written

responses. Children with language difficulties achieve lower levels of success in these exams than other children (Dockrell, Lindsay, Connelly & Mackie, 2007). Moreover, writing, as a barrier to progress, continues in university students where those with dyslexia do less well in exams than their peers (Richardson & Wydell, 2003; Maughan et al, 2009). See Dockrell, Lindsay & Connelly, (2009) and Scott (1999) for the long running writing problems of students with SLI. See Berninger, Neilsen et al, (2008), Connelly, Campbell, MacLean & Barnes (2006), and Swanson & Hsieh, (2009) for the lifetime of writing problems in those individuals with DYS and see Miller et al, (2001) and Barnett and Henderson (2005) for the writing problems of children with DCD. Previous analyses have focussed on the difficulties experienced by a specific group of children. Such analyses are limited in their ability to inform developmental models of writing, and may imply group specific interventions. An examination and comparison of the patterns of difficulties across these groups of children provides the opportunity to identify barriers which are general and specific and thereby provide necessary data to inform developmental models which can link to targeted interventions. In this chapter we will briefly review and discuss the work related to writing in three populations of children who are significantly challenged by writing (SLI, DYS and DCD).

To contextualise research on these three difficulties we first consider models of writing development and identify some of the methodological difficulties of studying writing in these populations. We use a cognitive model of writing development derived from the work by Hayes and colleagues in an attempt to understand the children's difficulties in writing development including higher-order cognitive and metacognitive processes. We then analyse the development of fluent text production from the perspective of the difficulties experienced by each group of children. The cognitive model is used to inform our understanding of both the children's specific

writing difficulties and the implications of these for writing development in general. We also consider where future research efforts should be directed. The investigation of writing development in these populations is unavoidably complex, with many potential causes of their difficulties. There are a number of methodological challenges which need to be addressed if we are to understand the parameters and causes of the children's difficulties and develop effective treatment approaches, especially regarding their writing difficulties.

### **Cognitive Models and Methodological Issues**

The cognitive study of writing in skilled adult writers is a complex methodological task (see Flower & Hayes, 1994 for a comprehensive overview of difficulties involved). The study of children's writing is even more complex as developmental issues have to be included in the models (see Bereiter & Scardamalia, 1982, and Kellogg, 1994 for further discussions about studying writing development). In writing research, as in many areas of psychology, there is much debate about the definition of terms and reliability of methods used by researchers. For example, terms like fluency and automaticity are frequently used to describe writing performance but these are difficult to operationalise. Do they mean speed of a particular rate or more than this? There has also been debate about the reliability of commonly used measures of text generation in writing research (see a number of chapters in MacArthur, Graham & Fitzgerald, (2006) for more specific discussions).

When studying special populations of children such as SLI, DYS, and DCD, the researcher must also be aware of the methodological issues relevant to this research goal (Hulme & Snowling, 2009). For example, in relation to the populations of children we discuss in this chapter there is much discussion about differential diagnosis and co-morbidity. Children with SLI can present symptoms that can lead them to be classed as children with dyslexia at later

points in development (Bishop & Snowling, 2004). That some of these children share common phonological problems (nonword repetition) presents a serious challenge for researchers in interpreting results and comparing populations. Researchers need clear definitions, not just to design good measures for assessment, but to ensure that the conclusions they draw about difficulties and interventions can be generalised.

There are further complications in carrying out research with children with difficulties. Since developmental difficulties often emerge earlier in development than when children are expected to write in school, the researcher needs to be aware of the methodological debates within, but not restricted to, cognitive psychology and other disciplines with whom psychologists often engage in interdisciplinary research (e.g. speech and language pathology, linguistics, and neuroscience). There is relatively little research linking oral language skills and written language skills in children with and without writing disability (see Shanahan, 2006 for a review). Therefore, interpreting links between general measures of language and general measures of writing is not straightforward.

One might find strong links between vocabulary scores and narrative writing scores in children with SLI. Thus, one could hypothesise strong links exist between difficulty in retrieving vocabulary and successful text generation, which would impact on the text produced in this population of children (e.g., Dockrell, et al., 2009). However, there is much debate in the field of language development about the validity of current vocabulary measures. It is not always clear the extent to which current vocabulary measures are tapping the breadth of the children's word knowledge, the depth of their semantic representations, or the efficiency of lexical retrieval (Messer & Dockrell, 2006). Nor are all vocabulary tests measuring the same aspects of vocabulary knowledge; commonly used measures include naming a pictured word, pointing to

one of several pictures portraying possible meanings, completing word analogies and providing written or oral definitions for single words.. Each of these tasks draws on different cognitive, language, executive, and motor functions. Therefore, researchers using special populations have to be aware of wider debates surrounding other related areas of psychology and have to become cognisant of the methods used in those fields as well as those in writing research.

To summarize, there are many pitfalls and difficulties associated with carrying out research with children with difficulties. However, we feel that the benefit of considering developmental difficulties in special populations outweighs these difficulties and, of course, is necessary in order to better meet their educational needs. Models of development and learning provide the basis for generating testable hypotheses (Morton & Frith, 1995). Detailed research undertaken to study children who are challenged by writing can add greatly to our knowledge of writing development by testing hypotheses and challenging widely held but untested assumptions, which ultimately will enhance our understanding of all children's writing development.

### **Research Focus on the Single Word**

Research into the writing of children with developmental difficulties has historically focussed on the spelling of a single word or even the letter level in handwriting (Bishop & Clarkson, 2003; Rosenblum, Weiss & Parush, 2003). Focusing on single-word spelling provides a starting point for research and it is easier to examine difficulties at the single word level because differences, when present, can be more clearly defined and potential interventions more targeted (Bishop & Clarkson, 2003). The spelling of single words has, dominated the majority of research on the writing of children with dyslexia (Jackson & Coltheart, 2001) and most studies of spelling have used dictation methods to examine single real and non-words. Fewer studies have

used dictated sentences to study word spelling in sentence context; and fewer still have examined spelling during text production to evaluate word production in context that is self-generated by the child as a writer. This is slowly changing and several recent studies have also examined the spelling of children with DYS related to composing (e.g., Berninger, Nielsen et al., 2008; Berninger, Winn et al. 2008). In DCD the focus has often been on even smaller units of analysis at the level of letters or strokes within letters (Smits-Engelsman et al., 1994). In SLI the focus has been somewhat wider but there is still a concentration of research studying spelling at the word or subword level rather than text production processes (Fey et al, 2004), but for exceptions, see Scott (Scott, 1999; Scott & Windsor, 2000).

This focus on the single word has achieved much. For example, children with dyslexia do indeed struggle with single words. On average, they are less accurate and slower at reading single words and they are invariably even poorer at spelling the same words (see Hulme and Snowling, 2009). A large and complex literature has shown that the majority of children with dyslexia have difficulties with the phonological aspects of spelling (Kemp, 2009), but a growing literature across languages points to spelling problems related to orthography as well as phonology in DYS and morphology and orthography in SLI . A number of successful educational interventions for reading and spelling have been developed based on research at the single word level (e.g., Johnston, Watson & Logan, 2009). Research on phonology at the word and subword level has contributed to understanding of spelling development in children with and without SLI and DYS (Critten, Pine & Steffler, 2007; Critten & Pine, 2009), as has research on orthography and morphology, especially in morphophonemic orthographies such as English (Nunes & Bryant, 2006, 2009; Pacton et al. ,2001, 2005; Fayol, Zorman & Lete, 2009). However, in order to understand writing problems we need to move beyond single words and

examine how text generation develops in children. This examination must take into account the relationships between text generation and contributory processes such as motor processes, language development and reading skills.

### **Models of Writing Development**

The Hayes and Flower (1980) cognitive process model was a breakthrough in describing how the three key recursive cognitive processes involved in writing (planning, translating and reviewing) interact within the constraints of memory and the task environment. This provided a clear framework for future research in the field. However, this is a model of skilled writing and it is increasingly accepted that models of skilled writing do not account for all aspects of writing development (e.g. Almargot & Fayol, 2006; Berninger & Swanson, 1994; Berninger, Fayol, & Alamargot, expected 2011). While the theoretical factors that underpin writing have been the focus of much discussion over the last 40 years, there is no single model of writing development that provides a comprehensive analysis of all the barriers that may be experienced by children with writing difficulties.

Children's writing, just like that of adults, develops within a limited working memory capacity system (Just & Carpenter, 1992; McCutchen, 2000; Swanson & Berninger, 1996) which also has temporal constraints (Berninger, 1999). Learning to write within a limited capacity system means that children have to gradually automate low level processes (e.g., translation skills such as handwriting and spelling) so that resource can then be freed up for more cognitively demanding and complex processes (Fayol, 1999). Low level skills at the beginning of learning to write are very demanding and need to be taught and practiced many times before automaticity is achieved.

The model in Figure 1 is based on an early intervention study in writing for children who met screening criteria for very low writing fluency (constructing sentences based on provided words within a 7-minute time limit) (Berninger et al., 2002). Children who received transcription training in spelling improved in spelling and children who received text generation instruction (planning, translating, and reviewing/revising) improved in composition. The model is a theoretical framework for integrating the findings of treatment studies: (a) Several studies with at-risk writers in the first three grades (ages 6 to 8) showed that treating transcription transfers to improved text generation (see Berninger & Amtmann, 2003, for review); and (b) a number of studies of self-regulated strategy instruction (planning, translating, reviewing, revising) showed transfers to improved text generation (see Graham, 2006). Thus, this model captures for at-risk writers what prior studies of assessment have shown: text generation is related to transcription (handwriting and spelling) and executive functions (supervisory attention—focus, switch, sustain, update, self-monitor, plan, translate, review, and revise).

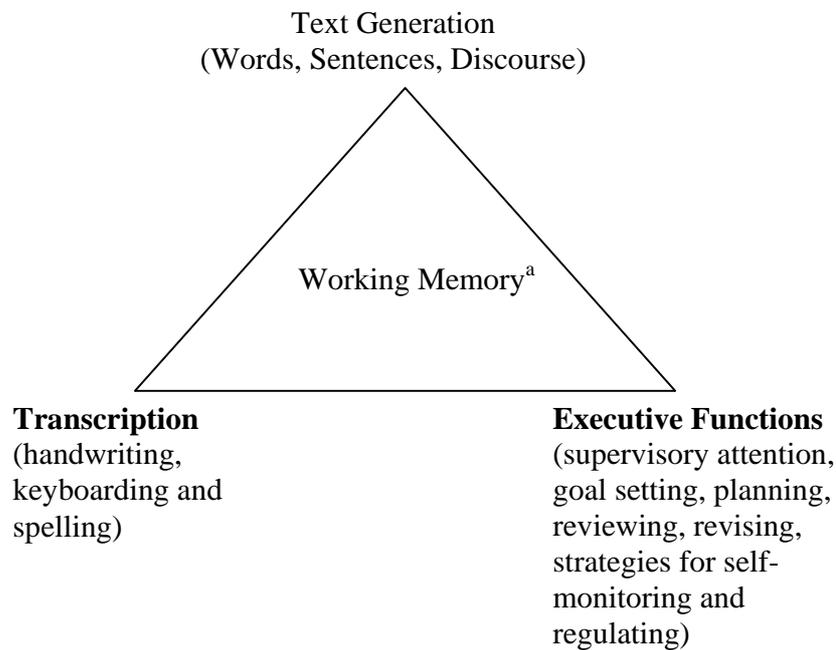


Figure 1. Triangle for the not so simple view of internal functional writing system. Modification of the simple view of writing in Berninger and Amtmann (2003). <sup>a</sup>Activates long term memory during planning, composing, reviewing and revising, and short term memory during reviewing and revising output. Reproduced from Berninger & Winn, (2006) by kind permission.

### **Children with Specific Language Impairment (SLI<sup>1</sup>)**

Children with SLI typically experience problems with the acquisition, processing and production of oral language. The most commonly used core criterion to identify children with SLI is that their language problems cannot be explained in terms of other cognitive, neurological, or perceptual deficits (Leonard, 1998). Language problems are evident by a protracted rate of language development as well as difficulties with subcomponents of the language system. Measurements that tap children's proficiencies with phonological processing, sentence recall,

nonword repetition, and tense marking have all demonstrated high levels of specificity and sensitivity in differentiating children with SLI from their typically developing peers (Conti-Ramsden, Botting, & Faragher, 2001; Ellis Weismer et al., 2000). Although conventionally identified by discrepancy between language levels and non-verbal ability, children with SLI are heterogeneous in their profile of language impairments and in terms of nonverbal ability (Botting, Faragher, Simkin, Knox, & Conti-Ramsden, 2001). Patterns of performance across measures of morphosyntax, vocabulary and semantics in relation to receptive and expressive measures also vary over time (Botting, 2005; Conti-Ramsden & Botting, 1999). Recently Tomblin and Zhang (2006) have argued that much of the variance in standardized measures of language is attributable to a single common linguistic factor with a trend during middle childhood where grammatical abilities and vocabulary abilities become differentiated. By corollary Leonard (2009) has questioned the existence of children experiencing expressive language difficulties alone.

For many young people with SLI, difficulties with spoken communication skills persist into adolescence (Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996; Botting et al.; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998) and adulthood (Clegg, Hollis, Mawhood, & Rutter, 2005; Johnson et al., 1999). Older students continue to experience difficulties with reduced vocabulary levels (Johnson et al. 1999), accurate use of verb morphology (Clahsen, Bartke, & Göllner, 1997), and some syntactic structures (Norbury, Bishop, & Briscoe, 2001).

Reading decoding and comprehension is an area of significant weakness for these children with SLI throughout their school careers (Dockrell, et al., 2009; Dockrell, et al., 2007; Mackie & Dockrell, 2004; Palikara, Dockrell & Lindsay, in press; Reilly, Tolchinsky, &

Wulfeck, 2008; Scott & Windsor, 2000) and continues to be impaired even when oral language narratives become age appropriate (Palikara et al., in press; Reilly, Tolchinsky, Woolpert & Wulfeck, 2006). For many children with SLI spelling is also problematic (Rice, Silliman, Bahr & Peters, 2006). Children with SLI would therefore appear to exhibit problems which would impact on both the text generation and the transcription aspects of writing development.

*Text generation problems in SLI.* Figure 1 makes it clear that the development of good text generation skills is as important as developing good transcription skills. In fact, both transcription and text generation support overall translation and transcription skills are related to text generation skills, as both assessment (Berninger & Swanson, 1994; Graham et al, 1997) and treatment studies have shown (Berninger et al., 2002). Text generation involves the selection of appropriate words, sentences and discourse and so we would predict that age appropriate language skills supported by a deep vocabulary would be related to text generation (Berninger & Swanson, 1994). Therefore, in a population of children with language problems we can expect significant difficulties with text generation, at least in relation to lexical selection and the lexical diversity used in texts.

Many children with SLI have smaller vocabularies than matched peers and can experience difficulties retrieving words that they comprehend (Messer & Dockrell, 2006). A longitudinal study of a group of children with SLI in the UK revealed that at age 16 the two most significant concurrent predictors of their written text production were spelling and vocabulary<sup>1</sup> (Dockrell, et al., 2007; Dockrell, et al, 2009). The continuity of the significant role of vocabulary in relation to text quality throughout adolescence confirms the view that vocabulary provides a building block for text generation processes (Dockrell, et al., 2009). Other work has also

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<sup>1</sup> In this study measures were taken of non-verbal ability, non-word repetition, receptive and expressive grammar and reading in addition to spelling and vocabulary (see Dockrell et al., 2008)

identified limitations in text generation leading to reduced levels of lexical diversity and poorer semantic content as critical limiting factors in the written text of children with SLI (Bishop & Clarkson, 2003; Fey et al., 2004; Scott & Windsor, 2000).

However, as we noted earlier in this chapter, it is not clear the extent to which the vocabulary measure in these studies is tapping the breadth of the children's knowledge, the depth of their semantic representations, or the efficiency of lexical retrieval for text generation. There is increasing evidence that measures of depth and breadth of vocabulary may have differential effects on reading, and so we might predict that similar patterns would be evident in writing (see, e.g., Ouellette, 2006; Tannenbaum et al., 2006).

Studies have also supported the view that the difficulties of children with SLI in producing written text reflect a particular vulnerability in using language structure, as evidenced by their grammatical errors (Gillam & Johnston, 1992; Mackie & Dockrell, 2004; Scott & Windsor, 2000; Windsor, Scott, & Street, 2000). These errors include both the percentage of written utterances containing grammatical errors (Gillam & Johnston, 1992; Mackie & Dockrell, 2004; Scott & Windsor, 2000) and the total number of verb composite errors. Windsor et al. (2000) carried out a further analysis on data from their cohort and reported that the children with language difficulties made more verb and noun composite errors in the spoken and written narratives than on either their chronological- or language- age-matched peers. Verb composite errors included errors with the regular past tense, third person singular, and copula and auxiliary forms, whereas noun composite errors included the regular plural, articles, and the possessive. The rate of errors in their written narratives was very much higher than that found in the spoken narratives for the children with SLI, but not for the language- and chronological-age matches. The children with SLI made three times as many verbs as noun errors in the written narratives,

but there was no difference between rate of errors in the spoken narratives. Further analysis found that most of this difference was accounted for by verb composite errors on the past tense ‘-ed’ ending in verbs and article errors in noun composites, a pattern which is evident in the children’s oral language at a much earlier age (see Leonard, 2000 for a review of these issues), but there was substantial variability in the children’s performance.

Zero marking of ‘-ed’ in writing was claimed by Windsor et al. (2000) as a clinical marker of the writing of children with language impairment since typical children do not show difficulties with ‘-ed’ beyond the age of 8 or 9 years. However, although omitting ‘-ed’ may be a failure of grammatical awareness, it may also be a failure to spell orthographically. When children are slow in processing language they may experience difficulties in processing sounds with rapid acoustic transitions and/or perceiving phonemes with low phonetic salience (for example, t/d and s/z). These difficulties can affect both the regular past tense (ed) and tense agreement (plurals, for example, ‘plays’; Montgomery & Leonard, 1998). Despite an attempt to account for this complication in their ratings of spellings of words that should have contained ‘-ed’ Windsor et al. (2000) were not able to draw a clear conclusion from the children’s errors. No spelling skill level was reported for the children in the study and it is therefore difficult to disentangle spelling levels and language levels. Therefore, it may be that children with language impairments in this study, although matched on language levels with a comparison group, may have been poorer spellers. Problems with spelling and punctuation, as well as poorer semantic content, were reported by Bishop and Clarkson, (2003) as the most common associated problems with poor writing in children with SLI, rather than grammatical difficulties. Moreover, work by Puranik and colleagues suggested that children with SLI produced fewer ideas in written text than those with dyslexia but showed equivalent proportion of spelling errors (Puranik

Lombardino & Altmann, 2007). Therefore, the impact of poor spelling may have a wider impact on the text generated than simple misspellings.

*Transcription problems – spelling and handwriting in SLI.* Significant proportions of children with SLI also experience phonological difficulties and thus they have spelling difficulties, which influence the transcription of written text both directly and indirectly (Bishop, North, & Donlan, 1996; Briscoe, Bishop, & Norbury, 2001; Gathercole & Baddeley, 1990). In a similar way to children with dyslexia, the text writing of children with SLI contains many spelling errors (Bishop & Clarkson, 2003; Dockrell, et al., 2007; Dockrell, et al., 2009; Mackie & Dockrell 2004). The influence of spelling difficulties is separable from those of vocabulary in the relationships to or effects on text generation (Dockrell, et al., 2007; Dockrell, et al., 2009). Spelling error patterns in SLI can deviate from both chronological- and language- matched peers (Mackie & Dockrell, 2004; Connelly, Dockrell, Critten, Walter & Lindsay, 2010), but differences between children with SLI and spelling-level matched peers are not always found (Silliman, et al., 2006). Further complicating the picture is the prediction that their poor spelling could be influenced by an interaction between patterns of language disabilities and poor literacy skills. As with children with dyslexia and typically developing writers, constraints and interactions may operate at both the word- level and the trans-word level and between the word- and trans-word levels. Thus, poor spelling can have an impact beyond the single-word level and the current evidence indicates that this is the case for children with SLI.

There has been a longstanding concern about the information processing constraints experienced by children with SLI (Ellis Weismer & Hesketh, 1996; Montgomery, 2000), and their reduced performance on tasks requiring quick and accurate performance (Leonard et al., 2007). Measures of speed of writing and reading fluency are both significantly related— either

directly or indirectly—to text production. Children with SLI are reported to have slow handwriting (Dockrell, et al., 2009). Handwriting speed, as measured by a letter writing task, was a significant predictor of writing at age 16 in children with SLI. This finding occurred independent of spelling, which was also a significant predictor of writing performance. The data indicated that shorter texts were associated with reduced levels of handwriting speed. Indeed, the cohort's handwriting speed was equivalent to the average obtained for students some 7 years younger (Graham et al., 1998). This finding is consistent with slow production of text, as evidenced by the few words produced per minute in text generation tasks in the same cohort. The slower handwriting students were also more likely to show decreases in their composition standard scores over time through their teenage years.

There was also a highly significant relationship between reading speed and letter-writing speed in the children with SLI (Dockrell, et al., 2009). This finding suggests that there may be common factors underpinning the two measures that impact on the ability to coordinate and efficiently manage linguistic information. This finding mirrors results for children with dyslexia who exhibited a relationship between speed of naming letters in the RAN task and speed of handwriting (Berninger, Nielsen et al, 2008).

### **Dyslexia (DYS) and Writing**

Dyslexia is often defined as an unexplained difficulty at a word-level with learning to read and spell. Most research to date has been on how individuals with dyslexia fail to learn to read or decode words (Hulme & Snowling, 2009). Theoretically, it is assumed that there is a biological basis for dyslexia related to underlying neurological factors; a comprehensive review of this rapidly growing research literature is beyond the scope of this chapter. There is a general consensus in the field that most individuals with dyslexia have a phonological processing deficit

(Snowling & Hulme, 2008) but the research evidence is growing for other problems as well. Both difficulties in coding phonological information in memory and transforming phonological information into orthographic codes (written words) may be involved. Many individuals with dyslexia also have problems with RAN (Rapid Automatic Naming of items such as letters) (for a recent study in a line of research begun four decades ago, see Jones et al, 2010). However, most researchers agree that the difficulties faced by children with dyslexia when dealing with print have their impact specifically at the word or sub-word level (Jackson & Coltheart, 2001). These word-level deficits may in turn affect processing at other levels of language.

Results of cross-sectional studies with children in the primary grades (ages 6 to 8) and intermediate grades (ages 9 to 12) showed that child writers are initially constrained by transcription skills (handwriting and spelling) (for review, see Berninger & Swanson, 1994; Berninger & Amtmann, 2003). To transcribe some text that has been generated a number of processes/representations need to be successfully accessed. A key point is that the appropriate spellings for words must begin to be generated. However, accurate and automatic writing also requires the integration of orthographic coding of letters in memory and motor skills for sequencing finger movements to produce the orthographic symbols for letters and words in writing. The child must also be aware of and follow the rules of basic text construction in sequencing words within sentences, capitalizing and punctuating sentences, and creating sentences that have local cohesion across sentences. Thus, there are a number of reasons to predict that children who have been diagnosed with DYS (i.e., with word level learning problems) would experience difficulties with writing, and transcription skills specifically. It is no surprise that they typically produce scripts that are shorter, contain fewer words, and are rated

more poorly in general content and organization than are their age peers without DYS (Berninger, Neilsen et al. 2008).

*Transcription skills – poor spelling.* The word level problems of students with DYS affect spelling as well as reading (Rice, 2004). Children with DYS generally have difficulty with spelling even when their problems in reading words seem to have resolved (Kemp et al, 2009). Poor spelling is clearly reflected in the writing of children and adults with dyslexia (Berninger, Neilsen et al. 2008; Coleman et al, 2009; Connelly et al, 2006; Puranik et al., 2007; Sterling et al, 1998). The essays of children with dyslexia contain many more spelling errors compared to typically developing children of the same age (Hatcher, Snowling and Griffiths, 2002). Berninger, Neilsen et al (2008) found that spelling was a key predictor of overall quality of writing composition in their sample of 122 children with dyslexia, who were on average about 11 years of age (but ranging from 7 to 14). In a recent five-year longitudinal study with overlapping cohorts, spelling was also consistently a predictor of composition across grade levels 1 to 7 (Abbott, Berninger, & Fayol, 2010). Spelling is clearly related to quality of composing in children with and without DYS.

Misspelling has a direct influence on text quality (Berninger et al, 2002; Coleman et al, 2009). Poor spelling leads to confusion and misreading and also confuses and frustrates the writer. Having to concentrate on spelling words takes time and effort away from the purpose of writing and means less text is produced in the equivalent time to those without spelling problems (Coleman et al, 2009; Connelly et al, 2006). In very severe cases the child may struggle to spell and produce twenty to thirty words in as many minutes (Martlew, 1992). Children with DYS produce very much less text, which has a significant impact on what ideas the child can express in writing. There is an increasing link between text length and text quality as children make

progress in writing. Over time, the constraints on writing from transcription exert less influence on text quality in typically developing children and they are able to devote more resource to higher-order cognitive processes (Gregg et al, 2002) but children with dyslexia persist in their struggle with transcription.

There is also evidence that children and adults with DYS produce text with less diversity in vocabulary, probably because they are choosing to use words that they can spell (Sterling et al, 1998; Wengelin, 2007). Lexical diversity is an important predictor of compositional quality when writing (Beard, 1986). It demonstrates that the writer can finely tune text to the reader, which is especially important in expository writing as children progress through school. However, not all studies have found less lexical diversity in children with DYS (Puranik et al., , 2007). As we have argued measurements of vocabulary vary, but it remains a reasonable hypothesis that spelling choice can constrain the precision of the arguments that children, especially some with DYS, make when writing. The effect of poor word choice is to deny the child the opportunity to exploit precise or specialised vocabulary in writing that can lead to clearer meaning (Sterling et al, 1998).

Even adult undergraduates with DYS, who have overcome reading problems to gain access to university, continue to produce more spelling errors in essays than their age matched peers (Connelly et al, 2006). These students, in fact, produced even more spelling errors in their writing than a matched control group equivalent in single-word dictated spelling. However, they were able to overcome their disability in spelling to produce coherent essays that had as many ideas and as good organisation as their age matched peers. This finding illustrates the extra pressure on individuals with DYS when having to co-ordinate all the tasks involved in writing. The individuals in this case were reasonably skilled writers at university and thus were able to

work through their disability to produce good writing, but at the cost of more spelling errors than one would expect.

Other studies have also found that individuals with DYS produce more spelling errors than one would predict when asked to compose rather than just produce a dictated spelling list (Hauerwas & Walker, 2003; Coleman et al, 2009). The extra demands of text generation impact on the ability to retrieve correct spellings, suggesting that the orthographic representations are not well established for these students. These studies also reported that individuals with DYS produced more morphological spelling mistakes when writing sentences or essays than age matched peer groups (Hauerwas & Walker, 2003; Coleman et al, 2009). Morphological spelling components, such as written inflected forms, are complex and take time for children to master; so when working memory demands are high these patterns are more likely to be produced incorrectly or omitted. The problem with morphological spelling is not necessarily a problem with morphology per se. There is evidence that morphological stems are correctly spelled in the same children when presented in a simple single word dictation task that demands less of the limited capacity working memory system (Hauerwas & Walker, 2003).

*Transcription skills – slow handwriting.* A second key component of transcription is handwriting skill. Speed of handwriting is a strong predictor of written composition length and quality in typically developing children (Berninger and Swanson, 1994; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Peverly, 2006). Children with DYS do not necessarily have impaired handwriting but children with DYS experienced difficulties with automatic legible letter writing when writing the alphabet in order, a task which is thought to assess the orthographic loop of working memory (Berninger, Neilson et al. 2008). Some studies have found handwriting differences and others have not for children with DYS (Hatcher, Snowling and

Griffiths 2002; Martlew 1992; Sovik et al. 1987) and any handwriting differences found may not differ from equivalent spelling-ability matched controls (Connelly et al. 2006). A pattern of mixed results is not uncommon in research looking at DYS because there is evidence that many, but not all, children with dyslexia have problems with speeded tasks (Katzir et al., 2006). The RAN task and the alphabet writing task (naming and writing letters automatically/quickly), which are thought to assess the time-sensitive phonological loop and orthographic loops of working memory were correlated in a sample of children with DYS (Berninger, Nielsen et al, 2008). Therefore, the mixed picture regarding handwriting speed could be explained by individual differences in speed of accessing letter forms in memory and integrating those with hand movements to produce letters.

Another explanation for the slow writing and the mixed handwriting fluency results in samples with DYS may be more directly related to spelling. If children with DYS are struggling with spelling, they may show more pauses in writing to try and process the spellings of words. If so, then they slow down the process of transcription, leading to slower writing than would be expected. It has been demonstrated in keystroke logged keyboarded essays that adults with DYS produce more pauses overall and in particular more inter-word pauses than age-matched controls (Wengelin and Stromqvist, 2000; Wengelin 2007). These findings need to be more widely investigated, but do point to spelling having effects on transcription in a number of subtle ways that need to be taken into account when modelling the development of writing.

*Impact on writing skills beyond transcription.* As already mentioned, there may be an impact of spelling on vocabulary choice in writing and in pausing during writing for children with DYS. However, there is some evidence that their difficulties with writing go beyond the consequences of their transcription difficulties. Puranik et al., (2007) carried out an exploratory

study to investigate this matter. They compared children with DYS to those with SLI and an age-matched control group. The children with DYS did not differ significantly from age matched peers in the amount of ideas produced in a text (Puranik, et al., 2007), but were less skilled at producing complex sentences. Puranik et al (2007) linked their results with some recent studies showing differences in grammatical skills related to morphology in DYS populations. However Connelly et al (2006), found no difference in ratings of expository essays for “ideas and development”, “organisation, unity and coherence”, sentence structure and grammar for their sample of university students with DYS compared to age-matched controls. However, as mentioned previously, university students may be more capable and the measures used in this study were global and may have missed subtle grammatical differences. In addition, there may be individual differences on this aspect of writing among those with DYS.

There has been relatively little research into links between the reading and writing difficulties in DYS. Altemeier, Abbott, and Berninger (2008) did find that executive functions (for switching attention during automatic integration of orthographic and phonological name codes) uniquely predicted integration of reading and writing in children with DYS; but more research is needed on this topic. There is also the issue of reading for planning and revising and to date we know of very little research on populations with dyslexia. Recently, in a writers workshop, children with DYS were taught planning, translating, reviewing, and revising strategies and were able to apply them to a second draft after reading and reviewing the first draft and setting goals for the revision (Berninger, Winn et al., 2008; Study 1) but again more in depth investigation is required to follow up this promising work. The advent of eye tracking software linked to digital writing tablets has made online processing studies of reading while writing

possible and could open a whole new area of research linking reading to writing (e.g., see Wengelin, Leijten & Van Waes, 2010).

### **Developmental Coordination Disorder (DCD) and Writing**

Developmental Coordination Disorder (or DCD) is defined by the DSM-IV as a ‘marked impairment in the development of motor coordination’ (APA, 2000 p.56) that cannot be explained by a sensory, neurological or general intellectual impairment. In the past, children with DCD have been described as ‘clumsy’ or ‘physically awkward’, drawing attention to the main feature of this condition, which is difficulty in the performance and learning of everyday movement tasks and very often includes specific difficulties with handwriting. Most children with DCD have difficulty with a wide range of motor tasks including those which require fine manipulative action of the hands, gross body movements requiring balance and locomotion and various other tasks which have precise timing and spatial demands (e.g. catching or striking a ball). Such tasks are included in tests of general motor competence such as the Movement ABC-2 (Henderson, Sugden & Barnett, 2007) and Bruininks-Oseretsky Test of Motor Proficiency-2 (Bruininks & Bruininks, 2005), which are commonly used as part of the diagnostic process. The nature of the difficulties varies with age but it is now well recognised that the motor difficulties often persist into adulthood (Cousins & Smyth, 2003). The lay term ‘dyspraxia’ is in common usage in the UK and is often used in a more general way than DCD to include children who also have difficulties with planning and organization. Interestingly, recent work suggests that these higher level or executive control problems seem to be most prominent in adolescents and young adults with DCD (Kirby et al., 2008).

*Transcription skills – poor handwriting.* One aspect of writing is the fine motor component of physically holding the pen (sometimes referred to as pencil grasp) and

manipulating it to form letters and words on the paper (orthographic-motor integration). Since handwriting involves fine motor control and coordination, it is hardly surprising that difficulty with this particular skill is noted as a common feature of DCD in the DSM-IV entry for this condition. Although some tests of general motor competence (e.g. the Movement ABC-2, mentioned above) include a pencil control (tracing or tracking) task, these are not designed to specifically assess handwriting skill. Practitioners may therefore find it useful to also use a separate test of the speed and/or quality of handwriting, a variety of which are available (see Rosenblum, Weiss & Parush, 2003 for a review).

Reports of handwriting performance in children with DCD by their teachers and parents often mention poorly formed letters and words which are difficult to read. These observations are supported by more objective measures of handwriting quality or legibility (Hamstra Bletz et al., 1987; Smits-Engelsman & Schoemaker, 2010). Slow handwriting and reduced output compared to typically developing peers is also commonly reported (Geuze et al., 2001), although when measured formally there have not always been significant group differences in speed of performance (Smits-Engelsman & Schoemaker, 2010). However, most research studies and clinical reports describe handwriting difficulties in this population, with parents and teachers noting handwriting as an area needing support from early childhood and children with DCD often choosing handwriting as a task that they themselves wish to improve in intervention programmes (Geuze et al, 2001; Mandich et al., 2003; Miller et al., 2001). Furthermore, adults with DCD note the persistence of handwriting difficulties into later years (Cousins & Smyth, 2003).

Although it is widely recognised that handwriting difficulties can lead to low self-esteem and academic underachievement, there has been very little systematic study of their exact nature and the best ways of improving this skill in children with DCD. However, some studies have focussed on a more specific group of children, those with 'dysgraphia', referred to in the DSM-IV as a 'disorder of written expression' (APA, 2001). Although different types of 'dysgraphia' have been described in the literature, here we focus on children who have difficulty with the motor aspects of writing (Hamstra-Bletz & Blote, 1993). Such children may have other fine motor control difficulties, including difficulties with the fine manipulation of small objects and producing sequential finger movements (Berninger, 2004). However, they would not perform poorly in all areas when assessed on a test of general motor competence and would not meet the formal diagnostic criteria for DCD. Interestingly, recent findings show similarities in the nature of graphic skill difficulties in children with DCD and those with dysgraphia, suggesting perhaps that these groups can be considered together (Smits-Engelsman & Schoemaker, 2010).

There has been extensive work to try and identify the mechanisms underlying the general motor difficulties in DCD. To date there is a consensus that these children experience information processing deficits across a range of perceptual modalities (visual, kinaesthetic and cross-modal) and that of these deficits, problems in processing visuo-spatial feedback seem to be the most pronounced (Wilson & McKenzie, 1998). However, in relation to handwriting, Smits-Engelsman et al. (1994) argue that current theories of motor control place less emphasis on feedback than before and that in handwriting, sensory feedback plays only a minor monitoring role. Therefore, to understand this specific motor skill, attention has turned to a more focused model of motor control and the particular processes involved in handwriting. This work in the

field of DCD and dysgraphia could inform modelling of this aspect of the transcription process and contribute more “granularity” to future models of writing development.

Van Galen (1991) has proposed the most complete model of handwriting, which he considers as a multi-stage process, organised in a hierarchical manner. The initial processes in this model include intentions, semantic recovery, syntactic construction and spelling. The remaining processes are psycho-motor in nature and therefore particularly relevant when considering the handwriting of children with DCD and dysgraphia. These motor processes involve (a) Motor planning/programming, or the retrieval of the action pattern for letter forms (allographs) from long term memory; (b) Parameterization, or the setting of tempo, force and size variables of the motor programme and finally (c) Muscular Initiation to recruit the necessary motor units to produce an appropriate movement given the particular context. Van Galen and colleagues have used this model in an attempt to identify processing constraints underlying difficulties in the production of handwriting. Employing a series of writing tasks, they have compared the performance of children with and without handwriting difficulties under careful experimental manipulation of task demands (Smits-Engelsman et al., 1994). Using this approach they found that the two groups did not differ in terms of letter form retrieval or size control. It was in tasks designed to tap the peripheral muscular initiation process that clear group differences emerged. The poor writers had a more ballistic style, characterised by higher movement velocities and fewer final adjustments. They displayed irregularities in movement control and were particularly sensitive to increased spatial accuracy demands, showing poor error correction. A detailed analysis of the movement velocity signal (van Galen et al., 1991) revealed significant differences between the good and poor writers in the higher frequency components of the velocity signal, showing a higher degree of neuromotor ‘noise’. Smits-

Engelsman and van Galen (1997) suggest that in an attempt to control their distal movements within this noisy system, poor writers use the arm or wrist rather than the fingers when writing. This difference in engagement of the motor system may explain the inconsistent and poorly controlled writing so often reported in this group (Wann & Kardirkamanathan, 1991; Schoemaker et al., 1994).

The aim of this systematic approach described above is to identify specific difficulties, leading to a better understanding of DCD/dysgraphia and ultimately to interventions designed to improve handwriting performance levels in this group. However, certain limitations to this work have been identified, relating both to the theoretical model and to the experimental tasks employed. Research on handwriting production in children and adults reveals that higher-order linguistic units actually modulate the timing of handwriting movements (Kandel et al, 2009). It is argued, for example, that the orthographic representations activated during handwriting production are not single, linear letter strings as assumed by van Galen's model but that letters are grouped into "linguistically coherent units, such as graphemes, syllables and morphemes" (Kandel et al, 2009). This insight suggests that the model should include additional intermediate linguistic processes that have a direct impact on motor programming (this is similar to comments originally made by Abbot & Berninger, 1993).

Rosenblum and Livneh-Zirinski (2008) also argue that the brief experimental writing tasks employed in much of the research by van Galen and colleagues lack ecological validity and that the results may not be directly applicable to longer classroom writing tasks. Although the work has provided valuable information on aspects of the quality of individual letter formation, it has not addressed aspects relating to the speed of production of whole words, sentences and longer texts.

Selecting children with handwriting difficulties who also met the diagnostic criteria for DCD, Rosenblum and Livneh-Zirinski (2009) examined both the final handwriting product (in terms of writing speed and letter formation) and measures of the 'on line' movement characteristics while writing in Hebrew. In contrast to findings on short experimental writing tasks, they found a clear slowness of movement in their DCD group compared to typically developing controls, even in very familiar tasks such as writing their name. Although there were no significant group differences in overall stroke length and letter height, global spatial arrangement and legibility were significantly worse for the DCD group. More letters were also erased or over-written in the DCD group. In terms of the 'on-line' process of writing the DCD group spent more time both with the pen on the paper and in the air ('in-air' time). These pauses in the flow of writing have also been noted in clinical reports (Benbow, 1995), although it is not clear what they represent. These findings could reflect difficulty in visualizing the letters, difficulty retrieving motor memories for letter forms and/or slow movement execution per se. General slowness of movement and difficulties with temporal control have been reported in DCD across other movement tasks (Barnhart et al., 2003; Missiuna et al., 2003), but we have yet to gain an understanding of the underlying mechanisms within the context of handwriting. However, closer examination of 'in-air' samples by Rosenblum et al (2003) revealed that these were not static pauses but "motion tours" whereby the pen is moved in a rather haphazard way over the page. This invokes explanations at a higher level, perhaps relating to attentional, motivational, or executive function mechanisms.

There has been very little work that has considered the impact of slow and illegible handwriting in this group more widely. For example, it is not known whether the text generation skills of children with DCD are adversely affected by their poor handwriting. There has also

been debate about the phonological, spelling and reading skills of children with DCD but this has been inconclusive due to issues with co-morbidity of samples (O'Hare & Khalid, 2002; Hulme & Snowling, 2009).

### **Conclusions and Questions for Future Research**

#### *Delayed writing – not Different?*

What then can we say about the writing of children with SLI, DYS, and DCD who have challenges with either transcription or text generation or both? Can we say their writing is delayed and may improve to within the limits of the normal range? Can we say their writing is different and may develop but not in the usual ways?

Measures of writing of children with dyslexia, SLI and DCD certainly suggest that their performance is poor in comparison to their age matched peers and that there are similar constraints to development. The transcription and text generation constraints that hold back typically developing children are fundamentally the same constraints that hold back the writing development of children with dyslexia, SLI and DCD. Poor motor skills constrain the development of handwriting in children with DCD and lead to poor transcription directly effecting their writing development. Poor spelling skills in children with dyslexia also have an impact on transcription skills, which feeds through into their pattern of constrained writing development. Children with SLI, meanwhile, struggle with both a text generation constraint as well as a spelling problem. As a result, children with SLI have a constraints impacting on both text generation and transcription. This is reflected in the very poor writing this population produces and in direct comparisons with children with DYS their writing is more impaired (Puranik et al, 2007). However, to describe performance as 'delayed' we must be sure that it is similar in nature to that of younger children. There is evidence that that on many measures

performance is similar to younger children matched on target variables e.g. language or spelling. However, more fine-grained analysis of performance is lacking and it is not yet possible to differentiate between delayed or different patterns of development across the groups' performance.

*Separable Processes in Writing Development- Transcription and text generation.*

Our review of children facing challenges also brings us to the second conclusion which is that the constraints on writing development identified by Berninger and Swanson (1994) are separable; as has been shown for typically developing writers (ages 6 to 12) using a structural equation study of handwriting, spelling, and composing ( Abbott & Berninger, 1993) Transcription and text generation processes have separable effects on writing development, as the contrasts discussed between children with DYS and SLI make clear. However, we would caution that more work is required in this area as the separation of transcription and text generation skills does not mean that they are not functionally integrated during on-line writing in real time and real world writing in the classroom. Children with DYS show impairments in spelling and thus transcription skills, but these may in turn have an effect on text generation. The evidence we have presented shows a direct effect of the number of spelling errors contained within text and in the number of words produced in a text. The evidence we have reviewed demonstrates that difficulties with spelling also impact on wider text generation skills through having a more limited written vocabulary to draw upon and struggling to retrieve spellings thereby affecting overall writing speed and thus ideas presented. In sum, the spelling problems have a downstream effect on the other processes required to produce text. These effects are not yet well understood beyond the prediction that a limited working memory capacity system will

impact on managing multiple tasks that require much processing effort. This wider effect of poor spelling skill explains why the compositions of children with dyslexia are shorter, poorer in content, and rated as less adequate than peers.

Connelly et al (2006) showed that the handwriting fluency of students with dyslexia was not slower than spelling matched controls but that their spelling in a writing task was poorer. This finding is consistent with that reported for a family genetics study in which the individuals with DYS had spelling impairments but varied as to whether they also had associated handwriting (automatic alphabetic writing) problems. There are clearly close links between spelling and handwriting. Recent research has shown in typically developing children that handwriting and spelling are indeed very closely interlinked with both acting together in a cascaded function during transcription (Kandel et al, 2009), yet some children have handwriting only and not spelling or spelling but not handwriting problems. Spellings seem not to be fully constructed before writing begins and therefore the motor processes for handwriting are closely regulated by spelling knowledge access and may influence it. On-line access to the spellings of words could be disrupted at the word-, syllable-, morpheme-, and grapheme- levels while the word is being transcribed onto the page. More work on this aspect of the model is needed in order to demonstrate whether slow handwriting of children with dyslexia can be attributed to difficulties with spelling.

At the same time, there is a paucity of detailed research on handwriting in children with DCD. There should now be a focus on research in this population based on models of motor development that include, but transcend, serial finger movements and language development for orthographic coding of letters and written words as well as phonology and morphology. That would allow researchers to examine difficulties in motor function in the context of oral and

written language development, and then link those findings with knowledge from the motor control literature.

Text generation processes in children with SLI are a major constraint on their writing development. There are powerful reasons to predict that oral language underpins the processes of text generation and that difficulties with oral language will constrain the development of written text production as we have shown. Specific relationships between oral language competence and the production of written text have been reported both for children with continuing language problems and those with resolved language problems, showing that the development of writing skill is especially sensitive to oral language influences (Bishop & Clarkson, 2003; Fey, et al., 2004). Vocabulary appears to provide a critical building block for written language (Green et al., 2003) and is a key mediator in the performance of children with SLI (Dockrell, et al., 2007; Dockrell, et al., 2009), whereas syntactic difficulties constrain the production of grammatically accurate written text (Scott & Windsor, 2000). Thus, the text generation processes of children with SLI are severely impaired with respect to their typically developing peers.

However, a large number of children with SLI also have concurrent difficulties with the phonological processes involved in written language. This difficulty impacts directly on the children's spelling and thus their transcription skills are also impaired (Bishop & Clarkson, 2003; Dockrell, et al., 2007; Dockrell, et al., 2009; Mackie & Dockrell 2004). This highlights the separable effects of text generation and transcription on the production of written text.

#### *Beyond Writing Processes to Look at Links with Writing Foundations*

The study of children with dyslexia, SLI, and DCD shows how different difficulties in aspects of cognitive and motor development can impact directly on the development of the writing. Text generation and transcription skills that operate within working memory and are

guided by other cognitive and metacognitive processes (e.g., Berninger and Swanson, 1994) need to be mastered during the beginning and developing stages of learning to write. We have seen how problems with vocabulary, phonological knowledge and graphomotor skills all have an impact on transcription and text generation. Writing processes are intimately linked with wider cognitive, linguistic, and motor abilities. We need more research into the specific ways in which these more general abilities affect the writing processes for children with specific problems. Studying these children allows us to begin to examine relationships between writing processes and more general cognitive, motor and linguistic abilities in ways that inform both typical writing development and writing development in those children with challenges in learning to write.

These wider abilities have been classed as writing foundations as distinct from writing processes (Singer & Bashir, 2004). These writing foundations fall into four distinct categories, cognitive-linguistic (linguistic knowledge, meta-awareness, working memory, processing speed, conceptual ability), text production (graphomotor skills, mode of output, speed of output), social-rhetorical and beliefs and attitudes (self efficacy, goals and affect). It is hypothesised that if any of these foundations are weak then the writers capacity to meet the demands of the processes involved in composing (translation, text generation etc) will also be weakened (Singer & Bashir, 2004). That certainly is what we have found in our review of the writing development of children facing challenges such as dyslexia, SLI and DCD.

We need to now take forward these ideas into further research with children who experience writing difficulties. We need to probe more deeply into the relationships between writing foundations and writing processes. For example, difficulty manipulating the phonological parts of language leads to non-fluent and inaccurate spelling within texts. This inaccurate

spelling has an impact on writing beyond single words that we still do not yet fully understand. Online studies using new tools such as digital tablets may allow us to begin to see how links between writing foundations and writing processes play out in real composing time. Do children who struggle with spelling, struggle with most words or only those they do not know how to spell? What might their pattern of pauses or a linguistic analysis of spelling choices tell us about how foundations are linked to writing processes? For some initial ideas about links between pauses and online writing processes, see Wengelin et al, (2010). These and related issues now need to be specified. What impacts do writing foundations have on writing processes at the word, sentence and text level? Do they have different impacts as Hayes (2009) predicts? How does online reading impact on writing processes as a writing foundation skill? Rijlaarsdam and colleagues make a strong argument for how reading impacts on writing processes on typical populations, but for children with DYS and SLI this very important and as yet largely unanswered question deserves investigation (Rijlaarsdam et al, 2009).

Writing researchers also have to reach into other disciplines and use the tools and techniques other disciplines such as linguistics have used to investigate the effects of difficulties in writing foundations on writing processes (See Hancock ,2009) and Myhill,(2009 for work using linguistic tools to investigate writing processes). Some exciting work on the links between writing foundation, general cognitive abilities, and online writing processes is also taking place using brain imaging to capture processes related to writing foundations in typically developing writers and compared to them and those with dysgraphia or dyslexia (Berninger et al, 2009; Richards, Berninger, & Fayol, in press). As we move further ahead in this area we can begin more confidently to develop, drawing on multiple disciplines, theoretically driven, conceptually appropriate, evidence based assessments and interventions that can target the different

constraints and challenges to writing development that these children face every day of their life within our very literate world.

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#### *Notes*

<sup>1</sup>We use the term specific language impairment to reflect the most common usage in the research literature for this population.