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# Research in Developmental Disabilities



## Handwriting speed in children with Developmental Coordination Disorder: Are they really slower?



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### ABSTRACT

Handwriting difficulties are often included in descriptions of Developmental Coordination Disorder (DCD). They are cited as the most common reason for referral to health professionals following parent and teacher concerns about slow and untidy writing. The aim of this study was to compare handwriting performance in English children with and without DCD across a range of writing tasks, to gain a better understanding of the nature of 'slowness' so commonly reported. Twenty-eight 8–14 year-old children with a diagnosis of DCD participated in the study, with 28 typically developing age and gender matched controls. Participants completed the four handwriting tasks from the Detailed Assessment of Speed of Handwriting (DASH) and wrote their own name; all on a digitising writing tablet. The number of words written, speed of pen movements and the time spent pausing during the tasks were calculated. The findings confirmed what many professionals report, that children with DCD produce less text than their peers. However, this was not due to slow movement execution, but rather a higher percentage of time spent pausing. Discussion centres on the understanding of the pausing phenomenon in children with DCD and areas for further research.

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## 1. Introduction

Developmental Coordination Disorder (DCD) is the term used to refer to children who present with motor coordination difficulties, unexplained by a general medical condition, intellectual disability or neurological impairment (American Psychiatric Association [APA], 2000). Children with DCD face many barriers to performance in everyday activities, both at home and at school (Mandich, Polatajko, & Rodger, 2003; Missiuna, Moll, & King, 2007; Stephenson & Chesson, 2008). At home, difficulties with dressing can manifest in tasks such as manipulating buttons and zips, where fine motor manipulation and organisational skills are required (Roger, Ziviani, & Watter, 2003). Within the school environment, these difficulties transfer into a range of school activities (Wang, Tseng, Wilson, & Hu, 2009), in particular, handwriting, which is significantly impacted (Miller, Missiuna, Macnab, Malloy-Miller, & Polatajko, 2001). Handwriting difficulties are mentioned in the formal diagnostic criteria for DCD (APA, 2000), are frequently mentioned in parent and teacher reports and are the most common reason for referral to occupational therapy for this population (Asher, 2006). Despite this, surprisingly little research has been conducted to investigate handwriting difficulties in children with DCD, most of which, has been conducted in alphabets outside the Latin base (Rosenblum & Livneh-Zirinski, 2008; Chang & Yu, 2010), with very different demands such as writing from right to left and producing different types of letter-shapes (Hebrew & Taiwanese). This poses considerable barriers when attempting to inform best practice in countries using the Latin alphabet.

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The complexity of handwriting is a particularly important aspect to consider when studying populations with motor coordination difficulties such as DCD, as there are many underlying cognitive factors, which can influence their handwriting performance (Van Galen, 1991). For example, before executing the motor component of handwriting, there are processes that must precede it such as activating the intention to write, generating ideas, retrieving semantics, spelling and selecting the correct allographs (Van Galen, 1991). Handwriting is a very important part of the overall writing process and is therefore recognised as a lower-level component in models of writing (Berninger & Swanson, 1994; Berninger & Amtmann, 2003). When limitations in lower level transcription skills (handwriting & spelling) occur, they can influence the overall writing procedure in terms of the amount of text produced and the quality of written composition (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Berninger, Nielson, Abbott, Wijsman, & Raskind, 2008). According to Berninger (1999) children's ability to compose text is constrained by two important factors; transcription skills and working memory resources. The more automatic a child's handwriting is, the more working memory is made available to focus on the content of the writing (Berninger & Amtmann, 2003; Kellogg, 2008). However, if a child's handwriting is laboured and not yet automatic, the attentional resources available to focus on higher-level processes such as planning will be limited. It becomes even more complex when a child is asked to balance all of the above processes as quickly as possible during an examination. Handwriting speed becomes crucial in an exam environment, as the child needs to be able to transfer their ideas to the page while trying to keep up with their thoughts. Having to write quickly also adds the additional dimension of producing legible text, as there is a crucial trade-off relationship between handwriting speed and legibility (Weintraub & Graham, 1998). For example, when a child writes in their best handwriting, legibility increases while the speed at which it is produced decreases. Similarly, when writing quickly, the legibility will decrease (Weintraub & Graham, 1998). In DCD, the notion of quick movement poses a particular issue, as previous research suggests that children with DCD demonstrate longer movement times than their typically developing peers in a range of fine motor (reaching and/or grasping) tasks (Missiuna, 1994; Plumb et al., 2008; Hyde & Wilson, 2011; Wilmut, Byrne, & Barnett, 2013).

In the available research on handwriting in children with DCD, on-line handwriting performance has been investigated using digitising writing tablets, which measure the temporal characteristics of handwriting. It has been reported in the literature that children with DCD demonstrate a distinct slowness (produce less text and take longer to produce letter strokes) across a range of handwriting tasks, including copying (Rosenblum, Parush, & Weiss, 2003; Rosenblum & Livneh-Zirinski, 2008; Chang & Yu, 2010), writing from memory (Rosenblum et al., 2003; Chang & Yu, 2010) and the habitual task of writing ones name (Rosenblum & Livneh-Zirinski, 2008). However, it is not known to what extent these findings can be applied to the Latin based alphabets. Furthermore no study to date has examined speed of performance in the task of free writing, which is perhaps the most common in the classroom and the most demanding in terms of cognitive load. It is also not known whether the slow performance relates to slower movement time in the actual movement of the pen to form letters on the page or whether it actually reflects longer pauses between the formation of letters and words.

In other developmental disorders handwriting has been studied across a range of writing tasks. For example it has been reported that children with dyslexia (poor reading and spelling) produce fewer letters/words per minute both on the alphabet task and in compositional writing tasks (Sumner et al., 2012). This is important in relation to DCD, which is known to sometimes co-occur with dyslexia (Chaix et al., 2007). Surprisingly however, literacy skills such as reading, spelling and vocabulary have not previously been examined in studies of handwriting in children with DCD, even though these may have an impact on performance. The main aim of this study was therefore to assess the speed of handwriting performance in children with DCD in English using a range of writing tasks including free-writing. Measures of the handwriting product were supplemented with more detailed temporal aspects (process measures) of performance to understand the nature of any slowness in production. Finally, reading and spelling skill was also assessed, as these may have an impact on performance as well as the motor difficulties associated with DCD.

## 2. Methods

### 2.1. Participants

Thirty children with DCD were initially recruited (28 boys, 2 girls) ranging from 8 to 14 years. Two were excluded due to non-compliance and difficulties with attention (1 girl, 1 boy). Subsequently, 28 children with DCD (27 boys, 1 girl) and 28 age (within 4 months) and gender matched typically developing (TD) controls were included in the study.

#### 2.1.1. DCD group

The children with DCD were recruited from a database of children previously assessed and who met the formal diagnostic criteria for DCD from the DSM IV (APA, 2000). The children had significant motor difficulties, with performance below the 10th percentile (24 were below the 5th, 4 below the 10th) on the Movement Assessment Battery for Children 2nd edition Test (M-ABC-2; Henderson, Sugden, & Barnett, 2007). These difficulties had a significant impact on their activities of daily living, as reported by their parents and evident on the M-ABC-2 Checklist (Henderson et al., 2007). A developmental, educational and medical history was taken from the parents, which confirmed that there was no history of neurological or intellectual impairment and no medical condition that might explain the motor deficit. The British Picture Vocabulary Scale 2nd edition (BPVS-2, Dunn, Dunn, Whetton, & Burley, 1997) was used to give a measure of receptive vocabulary, which correlates highly with verbal IQ (Glenn & Cunningham, 2005). This was in at least the average range for all children. The

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