

## Chapter 16: Handwriting Difficulties

### Presenting Concern – Meet Aydin

Aydin is a 9 year old boy who is in his second to last year of primary school in the UK. Next year, the writing that he produces in his English lessons will be formally assessed by his class teacher. In order for Aydin to be working at the expected standard for English (Department for Education [DfE] 2018) he will need to write effectively for a range of purposes and audiences. He will need to select language that shows good awareness of the reader and uses vocabulary and grammatical structures that reflect what the writing requires. His writing should demonstrate his ability to use verb tenses correctly and consistently while implementing a range of punctuation (e.g. inverted commas). In addition, he will need to spell most words correctly and maintain legibility in joined handwriting when writing at speed.

While Aydin is a bright and capable boy, he has significant difficulties with handwriting and spelling driven by his dual diagnoses of developmental coordination disorder (DCD) and dyslexia (see Chapters xx). Aydin is aware that his handwriting is not as good as his peers and it is impacting on his motivation to write. These difficulties are likely to have a significant impact on his writing outcomes, as handwriting and spelling are foundational skills, both of which have been shown to predict compositional quality in school aged children (Limpo, Alves, Connelly, 2017). Aydin's teacher reports that he has difficulty forming his letters (an outcome he should have achieved three years ago) and writing at speed. Looking at his class workbooks, his letters are formed incorrectly and the size of his letters are inconsistent. He reverts to an un-joined style of handwriting when under pressure to either write quickly or generate and produce the content of the text independently. In terms of reading and spelling ability, he is underachieving in comparison to his peers and, in these areas, school-based assessments suggest that he is performing similar to children who are two years behind him. Specifically, Aydin demonstrates insecure phonics knowledge and a difficulty with spellings that contain split digraphs (a digraph is a combination of two letters which represent one sound, e.g., 'ie' representing the long 'i' vowel sound in 'pie'; split digraphs are where the two letters are split between a consonant, e.g., the long vowel sound 'i-e' in 'bike'), initial consonant blends (such as 'bl', 'br') and more complex vowel and consonant digraphs (e.g., 'ai' representing the long 'a' sound; 'wh' in 'what'). His teacher is increasingly concerned about his handwriting performance in particular and is

wondering what can be done to address his writing productivity. She has made a referral to occupational therapy and the school's specialist teacher to see what can be done.

### **Theory: The thinking behind the handwriting.**

Handwriting and spelling are crucial components of the overall task of *writing*. Neuroimaging studies investigating the neural correlates of handwriting are presented with challenges in disentangling the networks recruited specific to handwriting (motor) execution and those that engage the language systems for orthographic selection (see Planton et al., 2013); yet note the left-hemisphere network and the frontal and parietal superior areas to be crucially involved in handwriting tasks. Theoretical models of writing recognise how handwriting and spelling are intertwined and are grouped together as '*transcription skills*', which are the first skills to be learned in young writers (Berninger, Amtmann 2003). These lower level skills in children can be so laboured that they consume substantial working memory resources when writing. As a result, the child has fewer resources available to devote to producing and developing the written text, which impacts not only on the amount of text that they produce but also the quality of the text (i.e., vocabulary used, organisation, sentence structure, cohesion, grammar, punctuation etc) (Berninger, Amtmann 2003).

The learning of spelling and handwriting is complex. The initial stages of learning to spell involve developing an awareness of the sounds within words (phonology), the relationships between sounds and letters (phoneme-grapheme correspondences) and the grammatical units of language (morphology) (Siegel 2008). At the same time, when learning handwriting, children need to be able to map the sounds of a letter to the visual representation (the letter form) followed by retrieving and executing the correct patterns (allograph) from memory (Van Galen 1991). They also need to be able to control the movement of the pen to form the letters, and often to produce letters at speed (ibid). According to The Simple View of Writing model (Berninger, Amtmann 2003) which was developed on 6-15 year olds it is not until these '*transcription*' skills become more automatic that higher level processes can be attended to. Indeed working memory resources are central to the model as it is these resources that are re-directed to higher-level processes once transcription skills are developed. While in most children these skills advance with experience and practice, children with spelling and/or handwriting difficulties may struggle to progress with

their writing.

In Aydin's case we know that he has difficulties in motor skill and spelling and, as such, the mechanisms driving his handwriting difficulties are complex. Van Galen's (1991) psychomotor model of handwriting is a useful theoretical framework for considering Aydin's difficulties. The hierarchical model (Figure 1) outlines the cognitive processes that occur before and during the production of handwriting. According to the model the writer must first activate the intention to write and start to generate ideas about content. They then must translate the ideas into language (semantic retrieval) and construct the sentence (syntactical construction) that they wish to write using the correct grammar/phrases. It is at the next level of spelling where the handwriting processes start to engage as the sounds of the letters are mapped to the visual representations (the grapheme) followed by a set of instructions (allograph) being generated for the letter. It is also at the allograph level where the *style* of handwriting (joined, un-joined) is programmed. Once the set of instructions for the letter are generated they need to be programmed for size (size control) and speed (how fast it needs to be produced). Following this, the command is sent from the brain to the muscles resulting in muscular adjustment and the real time movement of the pen. A difficulty at any one of these levels could impact on handwriting production and it is therefore important to consider whether there is a difficulty at these levels when assessing a child's handwriting. In this case the primary concern is Aydin's handwriting, but any improvement in his handwriting production would likely have a positive impact up the chain in the higher-level processes of writing (ideas and content generation).

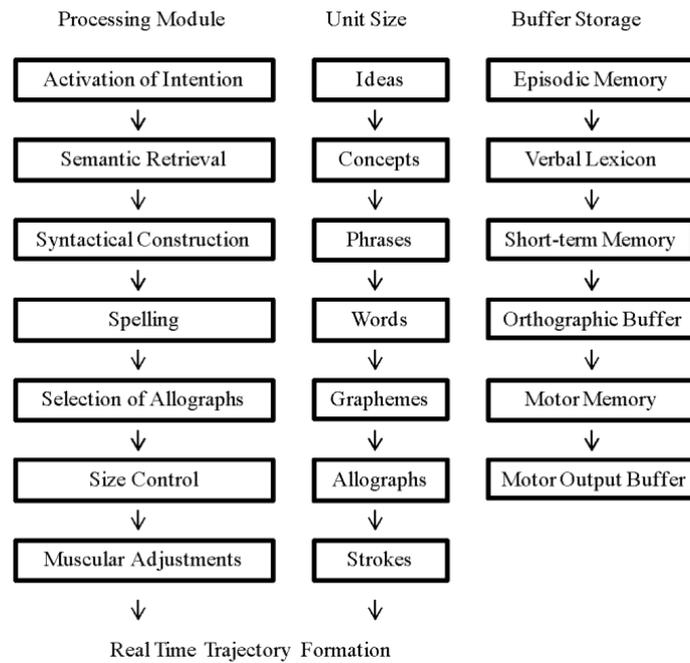


Figure 1. The process modules from Van Galen's (1991) Psychomotor Model of Handwriting

### Assessment of Handwriting

In Aydin's case both his spelling and motor impairment are impacting on his handwriting production and Van Galen's (1991) model serves as a useful framework for considering assessment.

#### *The Level of 'Spelling':*

First of all, we know that Aydin has difficulties with spelling as a result of his dyslexia. Research on handwriting in children with dyslexia has found that spelling difficulties alone can result in slower production of text. For example, Sumner, Connelly and Barnett (2014) examined handwriting production in children with dyslexia who did not have co-occurring motor difficulties. They found that they produced fewer words per minute than their typically developing peers. Using digital writing tablets to examine the real time movement of the pen, Sumner and colleagues (2014) found that the group with dyslexia had a tendency to pause within misspelled words which slowed down the production of handwriting. Figure 2 shows a sample of text from a 10-year-old boy with dyslexia compared to a typically developing peer of the same age.

While the handwriting is readable the red circles on the text illustrate *pauses* during writing (captured by the digital writing tablet technology). The authors argued that the high proportion of pauses observed within-words was an indicator of a lack of automaticity in retrieving and producing spelling information by hand. Note for the typically developing writer (Figure 3) few pauses occur within words which is an indication of skill. While it is beyond the scope of this chapter to cover spelling assessments in great detail, given the impact of spelling difficulties on handwriting, spelling should be considered using observations from class workbooks or administration of informal (e.g., common high frequency words, subject specific word lists, the spelling lists shown in the national curriculum [DfE 2013], etc) or formal (standardised) spelling tests.

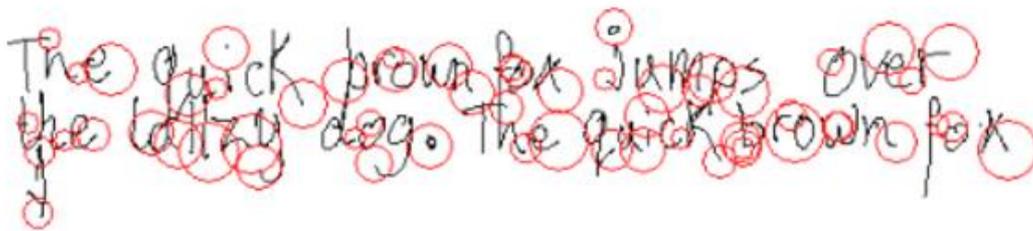


Figure 2 Sample of text from a 10-year-old boy with dyslexia – pauses (red circles) occur within words due to spelling difficulties.

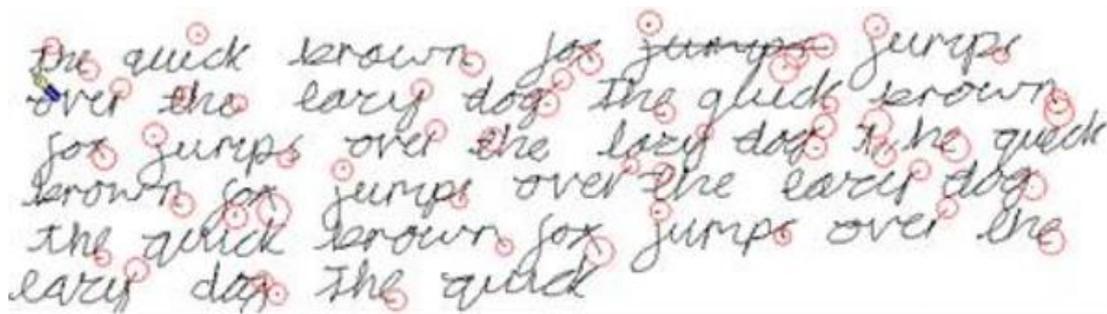
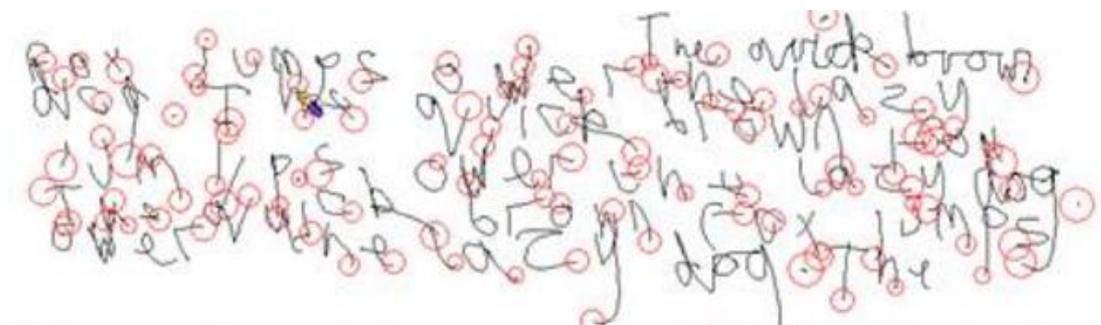


Figure 3 10-year-old typically developing boy: pauses occur between words only indicative of developed writing.

### *Level of the 'Allograph' (letter formation)*

Aydin's difficulties with motor skill pose an additional challenge in the context of his handwriting. Studies on handwriting performance in children with this have revealed difficulties at the level of the allograph. Using similar methods to Sumner et al., Prunty et al. (2013; 2014) examined handwriting performance in children with DCD in the absence of reading and spelling difficulties. Temporal analyses of their handwriting using writing tablet technology revealed that children with DCD have a tendency to pause for a greater percentage of writing tasks compared to typically developing peers (Prunty et al. 2013). In particular, they have a tendency to pause within illegible words (Prunty et al. 2014). Prunty et al. (2017) examined letter formation in children with DCD in detail by replaying the children's handwriting in real time and coding their letters for errors. For example, letters were deemed to have errors in their formation if they started in the incorrect place, were formed with strokes in the wrong direction, were missing strokes, had added strokes or were reversed. The study revealed that children with DCD produced a higher percentage of errors in letter formation compared to the typically developing group (Prunty et al., 2017). The most common errors included incorrect start position and strokes completed in the wrong direction. These letter formation errors indicate difficulties at the *allograph* level. In Aydin's case his teacher has noticed that he tends to produce letters in a way that would not be taught in the school system. This can be assessed through informal observation (watching the child form his letters) or captured using an assessment of handwriting legibility such as the Handwriting Legibility Scale (HLS) (Barnett, Prunty, Rosenblum 2018). Figure 4 illustrates an example of handwriting from a 10 year old boy with DCD.



*Figure 4* 10-year-old boy with DCD: many pauses within words due to poor & incorrect letter formation.

### *Level of Size Control & Speed*

*Size control* is the second mechanism at play in the handwriting of children with DCD. It seems that when children with DCD are required to speed up or handwrite while generating content, the size of their handwriting increases. Figures 5 and 6 illustrate this during two copying tasks. In Figure 5 the boy with DCD copied the sentence in his best handwriting (Copy Best Task from the Detailed Assessment of Speed of Handwriting (DASH) (Barnett et al, 2007). In this case the handwriting is joined (he programmes joined letters at the allograph level) and his handwriting is even and consistently sized. However, in Figure 6 he copies the same sentence again but this time as quickly as possible (Copy Fast Task from the DASH). Here his handwriting is no longer joined (he programmes un-joined letters at the allograph level) and his size is distinctly different. Size of handwriting can be considered using an assessment of handwriting legibility.

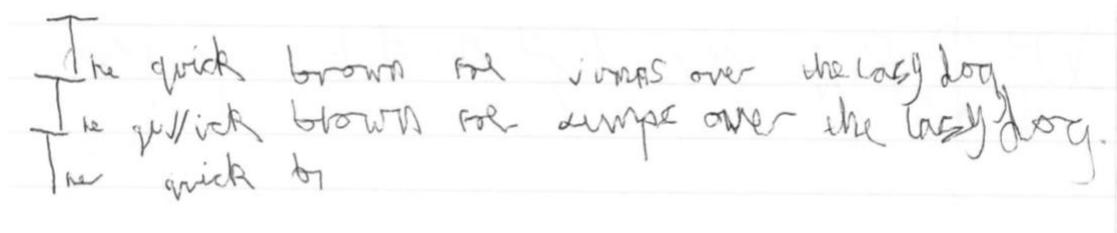


Figure 5 10 year old boy with DCD - Copy Best Task from the Detailed Assessment of Speed of Handwriting (DASH)



Figure 6 10 year old boy with DCD - Copy Fast Task from the DASH

*Handwriting speed* in Van Galen's (1991) model refers to the speed of the pen when it is in motion. This is not a contributor to handwriting difficulties in children with dyslexia or DCD as they are able to move the pen just as quickly as their typically developing peers (Sumner et al. 2013; Prunty et al. 2013). However handwriting speed by way of the amount of text a child can produce (usually measured on a

timed task where the number of letters or words produced per minute is recorded) is particularly important for Aydin as he approaches the end of primary school. Indeed the number of words a child can produce per minute has been shown to predict not only text length but also the quality of written composition (how good the text is) (Puranik & Alotaiba, 2011). This underpins many models of writing including Berninger and Amtmann's (2003) Simple View of Writing model described in the section on theory where *transcription* (spelling ability and handwriting speed) skills predict compositional quality. As such, the ability to write at speed is a very important component of handwriting skill.

Several tests of handwriting speed are available including the Detailed Assessment of Speed of Handwriting (DASH) (Barnett et al. 2007) which considers handwriting speed using a variety of different tasks (copying, writing the alphabet from memory and free writing) and conditions (best handwriting versus writing at speed). Figures 5 and 6 illustrate the importance of looking across tasks when assessing a child for a handwriting difficulty as there is an obvious difference in legibility between them. However, in the context of speed, looking across tasks can yield important information. For example, if a child can copy a sentence at speed but cannot write quickly during a free writing task then this may indicate difficulties with combining handwriting speed with higher-level writing processes (idea generation, language etc). Equally, if a child cannot write the alphabet quickly from memory but can copy a sentence at speed this may indicate difficulties in retrieving letterforms independently without a visual prompt. By looking across a range of tasks, a comprehensive picture of the child's handwriting speed can be formed. This will enable a more person centered plan for intervention.

## **Intervention**

While explicit support and on-paper practice is essential for improving handwriting, these strategies alone will not improve handwriting in the classroom particularly when there is a spelling difficulty involved, as linked to the Van Galen model. In Aydin's case his handwriting is also impacted by difficulties with spelling (see previous sections) and so careful consideration should also be given to this. In a meta-analysis on spelling instruction, Graham and Santangelo (2014) demonstrated that increasing the amount of spelling instruction above what is typically offered in the classroom has a positive impact on spelling development. Harris and colleagues (2017) suggest that spelling instruction may focus on the systematic study of spelling

patterns that the child needs to learn. Strategies could include weekly spelling lists, contrasting/different spelling patterns in the weekly word lists, tracing and visualisations, practice, repetition and generalization, or word study (morphology – understanding the root word and how the word changes once prefixes/suffixes are added). In the case example, Aydin demonstrates insecure phonics knowledge, therefore specialist support with teaching systematic phonics would be appropriate alongside spelling instruction. Spelling activities designed around detecting all phonemes within words and identifying their corresponding letter(s) would be useful (e.g., initial consonant blends: ‘bl’, ‘br’), as well as developing Aydin’s awareness of alternative ways of spelling phonemes (e.g., split digraphs, alternative long /a/ sounds; ‘ay’, ‘ai’, ‘ae’). While strategies to support spelling for children with literacy difficulties have been reported by Brooks (2016), for someone with Aydin’s profile both handwriting and spelling would need to be considered together in order to support development in both. Using spelling practice to inform and compliment handwriting practice would be a useful strategy in this case.

#### *Individual Differences:*

In order to implement the most effective intervention to support Aydin, it is essential to assess his handwriting for both speed and legibility (as outlined above) as a focus on only one aspect of handwriting could mean that a difficulty with the skill goes undetected. Studies have looked at variability in the handwriting profiles of children with DCD by looking across measures such as legibility, speed, percentage of pausing and letter formation errors (Prunty et al. 2017; Prunty et al. 2019). They found that while most children in the DCD group had difficulties with global legibility, others had difficulties with speed only, while others struggled with letter formation. These individual differences are key informants when it comes to selecting appropriate assessments and interventions.

#### *Intervention for Handwriting:*

In order to address Aydin’s difficulties with handwriting, pen-on-paper practice is essential (Hoy et al. 2011; Santangelo, Graham 2016). The international clinical practice recommendations for DCD advocate a focus on ‘activity’ based interventions rather than trying to remediate the underlying motor difficulties (Blank et al. 2019). However, while pen-on-paper practice is crucial, it also needs to be accompanied by specific instructions for handwriting. Children with DCD are able to learn motor skills

but it takes them longer to learn and they require explicit instruction. In particular, interventions that involve self-evaluation and problem solving have been shown to be effective and therefore recommended (Blank et al. 2019) (i.e the Cognitive Orientation to Daily Occupational Performance (CO-OP), Polatajko, Mandich 2004). By helping the child problem solve their difficulties with handwriting it engages them in the process of letter formation (i.e it makes them think through the steps involved in producing a letter) in a way that they will remember.

One way of engaging the child in problem solving is to avoid 'telling' them how to form a letter at the level of the allograph. Instead, the therapist/teacher could prompt the child through the use of questions. For example, rather than telling Aydin to place his letters 'on the line' the therapist/teacher could rephrase this in the form of a question such as "I noticed that your letter 'a' is floating off the line, what could you do differently to ensure it is placed on the line next time?". This engages the child in thinking about what they could do differently when forming the letter rather than being told what to do by the therapist/teacher. The evidence suggests that the child should be encouraged to think for themselves and self-evaluate as much as possible when working on an activity such as handwriting (Blank et al. 2019). In terms of teaching strategies for use in the classroom, the use of technology (digitising writing tablets to provide feedback on letter production) and demonstrating/modelling correct letter formation have both been found to be effective strategies for improving handwriting (Santangelo, Graham 2016). These interventions target the level of the allograph as research has shown that difficulties at this level (correct letter formation) in children with DCD has an impact on fluency of writing and ultimately speed (Prunty et al. 2017; Prunty et al. 2019).

### **Outcome**

One school term later Aydin is making progress with his letter formation. Explicit teaching surrounding correct letter formation and additional input on spelling has meant that Aydin is able to maintain correct letter formation within sentences that are easy to spell. When asked to speed up or produce more difficult spellings, Aydin still resorts to some of his old habits. However with practice combining both handwriting and spelling his new letter formations will become more stable.

### **Summary**

Children have difficulties with handwriting for all sorts of reasons. In this chapter, Van Galen's (1991) model was used to illustrate how impairments in attention, language, spelling or motor skill can all impact on handwriting production in their own way. The model serves as a useful tool for considering handwriting difficulties in children as it can serve as a framework for clinicians to consider the possible mechanisms at play. This chapter focused on a boy with a dual diagnosis of DCD and dyslexia and as such, it outlined why a focus on the handwriting difficulty in isolation would not be enough to improve production. Indeed the difficulties with spelling would also need to be addressed given the role of spelling in the writing process. For more information and resources for handwriting visit the National Handwriting Association's website <https://nha-handwriting.org.uk/> or [www.Canchild.ca](http://www.Canchild.ca)

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