The "Write Stuff": What Do We Know About Developmental Dysgraphia?

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Editor's Note: Catherine McBride had been selected by the Academy to deliver the 2020 Cruickshank Memorial Lecture. That lecture was canceled along with the annual conference.

Abstract

As researchers come to recognize the origins of dysgraphia, we can better suggest optimal approaches to remediation. In defining dysgraphia, we review the writing process, research on the development of writing, and various factors related to either spelling difficulties, visual-motor difficulties, or both, that might interfere in the process of writing. We conclude by exploring some potentially helpful remediation techniques that should be considered as educators, clinicians, researchers, teachers, and parents work together to ameliorate the potentially devastating consequences of dysgraphia.

Keywords: Writing, dyslexia, multiscriptalism, motor skills, visual-spatial skills, spelling, dictation, copying, handwriting, dysgraphia remediation

My (e.g., McBride, 2019) interest in dysgraphia developed gradually. I have taken lessons in Chinese on and off over the years. Each time I do, I try to write the Chinese characters assigned to me clearly and neatly, and every time I fail. My writing of Chinese looks out of proportion and often unclear, writing that might have been done by a child in kindergarten or first grade. I am further compelled to mention that I received the grade of C in handwriting in second grade (age 7). This was lower than most of the other grades I ever received, and I remember feeling shame at this evaluation. At the same time, however, I was quite a good speller, so handwriting and spelling for me were not conflated.

Given my interest in cross-cultural literacy, I came to the research topic of dysgraphia relatively late. What particularly piqued my interest was a former student who did a project on Chinese dysgraphia (see McBride, 2019). The project was well researched, and the student's personal story was even more compelling: He had always had great difficulties in writing but never had problems in reading, in either Chinese or English. Before I got to know him and his story, I had always assumed that dysgraphia was primarily a by-product of the much better understood phenomenon of dyslexia. Now I realize that the phenomenon of dysgraphia is more complicated.

A focus on handwriting per se can help us to identify children with specific learning disabilities, such as dyslexia and dysgraphia. Although those with dyslexia are typically characterized as manifesting pronounced difficulties in spelling and word reading (Lyon et al., 2003), they also have distinctive handwriting characteristics. That is, children with dyslexia often manifest slow and poor-quality handwriting (Gosse & Van Reybroeck, 2020). Compared to those without dyslexia, Chinese children with dyslexia write significantly more slowly, with lower accuracy, greater character size, and more size variability (Lam et al., 2011), whereas children with dyslexia in alphabetic scripts tend to have greater spelling error rates attributable mainly to their impairments in phonology (Sterling et al., 1998). Given these writing-related correlates of dyslexia, it is important to consider more precisely the nature of dysgraphia. What is it, and how can we separate dysgraphia from dyslexia?

McBride, C., & Rui En Cheah, Z. (2021). The "Write Stuff": What Do We Know About Developmental Dysgraphia? *International Journal for Research in Learning Disabilities, 5*(1), 3-12. https://doi.org/10.28987/ijrld.5.1.3

Editor's Note: Due to an editing error, the citation associate with this article should correctly read:
McBride, C., & Cheah, Z. R. E. (2021). The "Write Stuff": What Do We Know About Developmental Dysgraphia? International Journal for Research in Learning Disabilities, 5(1), 3-12. https://doi.org/10.28987/ijrld.5.1.3

In this article, we begin by defining dysgraphia. Conceptualizations of dysgraphia are perhaps even more confusing and variable than are concepts of dyslexia. Nevertheless, it is crucial to settle on a consistent definition as well as to understand how dysgraphia is diagnosed across cultures. We then consider the writing process more generally. In order to understand writing difficulties, we must first grasp how writing progresses in a typically developing child or, indeed, in an adult learning to write in a new script. In reviewing the writing process, we particularly highlight the motoric and visual-orthographic skills required for writing across scripts. Our discussion concludes with a review of some approaches to remediation techniques for helping those with dysgraphia.

Defining Dysgraphia

According to the 5th edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), dysgraphia is categorized as a specific learning disorder (American Psychiatric Association, 2013), with an estimated prevalence of around 7-15% (Katusic et al., 2009). Writing difficulties may be associated not only with dysgraphia but also with other disorders such as developmental coordination disorder (Biotteau et al., 2019), dyslexia (Gosse & Van Reybroeck, 2020), autism (Mayes et al., 2019), and attention deficit hyperactive disorder (Rosenblum et al., 2008). Dysgraphia can appear alone, but it can also co-occur with other developmental disorders (Chung & Patel, 2015). Therefore, to ensure accurate identification, it is imperative for a test used to diagnose dysgraphia to be valid and reliable.

What is the definition of dysgraphia? These are two of the definitions that have been offered in an attempt to describe this difficulty precisely: Hamstra-Bletz and Blöte (1993) defined dysgraphia as a disturbance in the production of written language in relation to the mechanics of writing. In contrast, Chung et al. (2020) defined dysgraphia in a more comprehensive way, describing dysgraphia as a "disorder of writing ability at any stage, including problems with letter formation/legibility, letter spacing, spelling, fine motor coordination, rate of writing, grammar, and composition" (p. S46).

Children have been estimated to spend around 31-60% of their school day performing tasks involving handwriting and fine-motor tasks (Feder & Majnemer, 2007). Although attitudes about handwriting may be changing given the prevalence of computers and cell phones, good handwriting skills remain important (e.g., Askvik et al., 2020; Kiefer et al., 2015). Poor writing and speaking development are related to various negative outcomes, including academic difficulties, as well as social-emotional and behavioral problems (Grigorenko, 2007). As a result, early identification is crucial for children with dysgraphia.

Deuel's (1995) classification of dysgraphia into three categories is potentially useful for a precise diagnosis of dysgraphia (McBride, 2019). This classification focuses on various abilities that contribute to the writing process as a means of identifying the specific difficulties of each individual who exhibits symptoms of dysgraphia. For example, Deuel (1995) focused on four tasks that are used to test for dysgraphia in children; these are oral spelling skills, copying skills, drawing skills, and finger-tapping speed. By focusing on strengths and weaknesses across these skills, one can potentially distinguish across three types of dysgraphia, namely, dyslexic dysgraphia, spatial dysgraphia, and motor dysgraphia.

The three subtypes of dysgraphia distinguished by Deuel (1995) are defined based on strengths and weaknesses of subskills as follows. *Dyslexic dysgraphia* implies struggles related to writing that are caused by corresponding difficulties with spelling. Insecure spellers may write sub-optimally because of confusion around how to represent symbols. However, these children do not have spatial or motor difficulties per se. Rather, their main difficulties have to do with spelling or dictation; such children have difficulties in spelling orally, but their spatial and motor skills are largely intact. In contrast, those with *spatial dysgraphia* have difficulties in the production of writing in both spontaneous and copied written text (Deuel, 1995). Although these children have problems in representing text as well as two-dimensional drawings or other symbols, they do not struggle with motor movements; importantly, they do not have difficulties in spelling when asked to do so orally. Finally, those with *motor dysgraphia*, in addition to manifesting illegible writing in both spontaneous and copied contexts, demonstrate abnormal drawing and handwriting velocity (Deuel, 1995).

A group of researchers has distinguished movements involved in handwriting apart from cognitive-linguistic skills related to spelling or dictation itself. For example, analyzing variables from 42 studies on handwriting movements in relation to dysgraphia, Danna et al. (2013) described the variables as falling into the three main categories of temporal, kinematic, and dynamical.

There is some support for each of the three subtypes of dysgraphia considered by Deuel (1995). For example, some researchers have focused on the overlap between dysgraphia and developmental dyslexia (Döh-

la et al., 2018). Döhla and Heim (2016) presented a review showcasing the similarity in underlying cognitive skills across dyslexia and dysgraphia; these include, for example, a phonological awareness deficit and an automatization deficit (Nicolson & Fawcett, 2011). However, some research has found that a central distinction between those with dyslexic dysgraphia and those with dyslexia only is that, typically, students with dyslexic dysgraphia tend to read at grade level, whereas those with dyslexia do not (Brown, 2019). Another distinction between dyslexia and dysgraphia involves differences in language mapping processes. Specifically, Berninger (2008) suggested that dysgraphia is a consequence of an inefficient mapping process involving verbal memory only in the direction of phonological to orthographic, whereas dyslexia results from inefficiency in mapping in both directions, namely, from orthographic to phonological and from phonological to orthographic.

In contrast, spatial dysgraphia is presumably caused primarily by visual-spatial difficulties, which, in turn, contribute to the prevalence of handwriting difficulties (Tal-Saban & Weintraub, 2019). Hécaen and Albert (1978, as cited in Rode et al., 2006) defined spatial dysgraphia according to four main features: (a) right-page preference, with writing often crowded onto the right side of the page; (b) inclination, particularly a failure to produce oblique lines and to write horizontally; (c) broken lines (i.e., leaving unusually large spaces between words leading to fragmentation of lines into small segments); and (d) graphic errors, including incorrect productions of strokes of given letters or characters. Presumably, these features could be generalized to various writing systems, such as Arabic or Persian, in which writing takes place from right to left (see McBride & Mohseni, 2020). Individuals with visual-spatial dysgraphia likely do not manifest oral spelling difficulties, but show distortions in how they copy or draw symbols or pictures.

Finally, dysgraphia is also sometimes associated with poor motor control (Smits-Engelsman & Van Galen, 1997). Smits-Engelsman and Van Galen (1997) found that handwriting movement with dysgraphia produces greater "noise" and that often poor writing is related to failure to obey spatial constraints, resulting in a lack of consistency in handwriting. On the other hand, Nicolson and Fawcett (2011) suggested that dysgraphia may reflect a lack of automaticity at the cognitive level, including an impairment in the cerebellar-motor circuit. Further, adopting a test of tapping ability, Ben-Pazi et al. (2007) demonstrated that some children with poor handwriting quality manifested dysrhythmia.

Other tests of finger tapping or finger succession (touching every finger to the thumb) can distinguish some children with writing difficulties, presumably because these children have specific difficulties with motor control (Berninger et al., 2006; Deuel, 1995). There is still a lot to be learned about dysgraphia across scripts. Deuel's (1995) classification of forms of dysgraphia is helpful, but in practice more research studies on different aspects of dysgraphia are needed.

Some aspects of dysgraphia must also be considered in relation to the individual script. In particular, writing in Chinese is deemed more difficult than writing in English, given that Chinese requires greater visual discrimination of the fine differences in the forms and positions of strokes (Lam et al., 2011). McBride (2016) concluded that learning to both read and write in Chinese demands greater visual skills than in alphabetic orthographies. In addition, the writing styles in alphabetic and non-alphabetic writing systems differ. Alphabetic languages stress the importance of smoothness and continuity in writing (Rosenblum et al., 2003), whereas writing in Chinese often involves sharp turns of strokes and more pen lifts (Tseng, 1998). The differences in both the nature of the scripts and the writing styles in Chinese highlight the importance of research on different scripts in order to shed light on additional issues related to dysgraphia.

Testing for Dysgraphia

Despite a relative lack of consensus on the nature of dysgraphia worldwide, some fairly popular tests of handwriting have been used to diagnose dysgraphia. For example, the Concise Assessment Method for Children's Handwriting (BHK; Hamstra-Bletz et al., 1987), a test of dysgraphia in Latin-alphabet-based writing (Asselborn et al., 2018), can be used to evaluate both quality and speed of writing (Van Waelvelder et al., 2012). The BHK consists of 13 criteria that are believed to provide a detailed analysis of the handwriting profiles of children who are either at risk for reading difficulties or who actually have dysgraphia (Overvelde & Hulstijn, 2011). Another test for dysgraphia in alphabetic writing is the Children's Handwriting Evaluation Scale-Manuscript (CHES-M; Phelps & Stempel, 1988). Handwriting characteristics scored on this test include letter form, spacing, rhythm, and general appearance (Feder & Majnemer, 2003). However, the validity and reliability of the CHES-M have been questioned (Van Waelvelder et al., 2012).

In Chinese, a few diagnostic tests of Chinese handwriting have also been developed, including the Chinese Handwriting Analysis System (CHAS; Li-

Tsang et al., 2013) and Tseng's Handwriting Speed Test (Tseng & Hsueh, 1997). Tests of visual-motor integration (e.g., Beery-Buktenica Developmental Test of Visual-Motor Integration; Beery et al., 1997) may also be used for the diagnosis of dysgraphia (Chung & Patel, 2015). Visual-motor integration skills are related to writing across the different scripts of English (Chung & Patel, 2015), Korean (Lee et al., 2019), and Chinese (Chung et al., 2018).

What Does the Writing Process Entail?

Having reviewed some important diagnostic tools that are sometimes used to evaluate writing difficulties, we must take a step back and consider the skills that are required for writing. Writing is a fundamental component of literacy. Children and adults who struggle to acquire writing skills face multiple impediments to their daily lives in activities such as note taking or providing signatures on documents (McCloskey & Rapp, 2017). In the context of dysgraphia, writing involves both visual-motor skills (i.e., the physical capacity to write) and sufficient orthographic/spelling/dictation knowledge to produce a given word in a given script. These two broad elements of the motoric and visual-orthographic aspects of word writing development and impairment can be considered somewhat separately.

In the research of reading and writing, different models of word writing have been proposed; some of these even extend to writing composition (Bereiter & Scardamalia, 1987; Hayes & Flower, 1980; Kellogg, 1996). One mode of the word writing process comes from McCloskey and Rapp (2017).

In this spelling-to-dictation model (McCloskey & Rapp, 2017), both long-term phonological and orthographic memory are strongly emphasized. For example, when we hear or think of a word (e.g., *buy*), this activates a phonological-grapheme representation in our phonological long-term memory (e.g., /baɪ/), in turn activating our lexical-semantic representation to help us to understand the context of the word (e.g., *buy a snack*). Finally, we retrieve the spelling of the selected word (e.g., *buy*, but not *by* or *bye*) from our orthographic long-term memory (McCloskey & Rapp, 2017). After the retrieval of the abstract letter/grapheme representation in our orthographic memory, both motor planning and production processes are required to produce writing (McCloskey & Rapp, 2017). For example, the abstract letter representation is first converted into an appropriate form of allographs (defined here as variants of a grapheme, such as "A" vs. "a"). Next, the allographic representation activates our graphic motor plans to enact the writing process, including where to begin on the page as well as the direction and movements of the pen (McCloskey & Rapp, 2017). Finally, our motor system executes the graphic motor plans we made and writes the word that we had in mind.

Thus, handwriting is a multi-componential task. It includes perceptual, attentional, linguistic, and motor skills (Asselborn et al., 2018). The production of written words involves both the central and peripheral processes. The central process is responsible for the cognitive processes of retrieving, assembling, and selecting the orthographic representation from the orthographic memory whereas the peripheral process is responsible for the generation of motor actions to produce writings (Delattre et al., 2006; Purcell et al., 2011). The process of motor memory is unique to the entire writing operation (McCloskey & Rapp, 2017).

Poor handwriting sometimes reflects deficits in the central process. Kandel et al. (2017) argued that there is an interaction between the central and peripheral processes such that spelling modulates motor production in children's writing. These researchers suggested that the retrieval of the lexical orthographic representation during spelling continues during the production of handwriting, thus affecting the handwriting process (Kandel et al., 2017). A poor memory for either orthographic representation or motor movements can lead to handwriting deficiencies (Kandel et al., 2017; McCloskey & Rapp, 2017). Importantly, in their study of Chinese handwriting, Zhang and Feng (2017) also found that the central processes of handwriting affect the actual execution of handwriting.

Complexity in Writing

What about the visual- orthographic characteristics involved in writing? Orthographic complexity in an alphabetic script refers to the complications of spelling words when their written representations deviate from the basic one-to-one phoneme-grapheme correspondence (Arfé et al., 2020). The orthography-phonology mapping varies across languages. For example, a transparent one-to-one mapping occurs in Finnish, but a more abstract mapping is found in English (Wang et al., 2009). To elaborate, the less transparent mapping of the phoneme /k/ in the English language might include different spellings such as c in *cat*, ch in *character*, ck in *check*, and k in *kick* (Wang et al., 2009). The inconsistency across orthographies causes differences not only in reading development across languages (Ziegler & Goswami, 2005) but also in writing development. For example, in Chinese, orthographic complexity relates to the number of strokes, number of radicals, and the

spatial composition of the radicals (Wang et al., 2020). When the number of strokes in Chinese characters increases, a person's handwriting is more error-prone and slower at accessing orthographic codes (Wang et al., 2020). Furthermore, individuals require less time to access orthographic codes and hand-write left-right characters than characters with other compositions, such as those that are top-down (Wang et al., 2020) due to the familiarity effect (e.g., 75% of Chinese semantic radicals appear on the left side of the character; Feldman & Siok, 1997).

In conceptualizing dysgraphia in the context of the writing process, we must keep in mind that there are differences in visual complexity and discriminability of visual forms of graphs across distinctive writing systems and that such differences can affect the perceptual learning of grapheme forms (Chang et al., 2018). Grapheme complexity is strongly associated with both learning time and learning difficulty – more time is needed to learn an orthography with higher grapheme complexity (Chang et al., 2016).

Chang et al. (2018) devised a grapheme complexity measure to capture the differences in visual complexity across writing systems. This measure includes four components, namely, perimetric complexity, number of disconnected components, number of connected points, and number of simple features. The authors (2018) compiled an ordering of grapheme complexity across 131 languages, with traditional Chinese script highlighted as the most complex written language, and abjads and alphabets showing equally lower complexity levels. Furthermore, the visual complexity of scripts has an effect on the perceptual load, suggesting that the increasing visual complexity of scripts may increase processing difficulty (alphasyllabry: Rao et al., 2011; abjad: Abdelhadi et al., 2011). Hence, the acquisition of writing skills may be affected by the visual complexity of a given writing system.

The importance of visual-motor skills is particularly highlighted in the acquisition of Chinese. Chinese writing acquisition usually relies heavily on drill-and-practice of writing or copying of each Chinese character over and over (Wu et al., 1999). Chinese learners are required to learn to copy Chinese characters in the correct stroke orders (Wang & McBride, 2017). Moreover, they must rely on fine-grained visual discrimination of the forms and positions of strokes in learning to write in Chinese (Lam et al., 2011). Copying, a primarily visual-motor integrated skill, has been shown to explain unique variance in Chinese word writing skills (Wang et al., 2014), whereas poor visual-motor integration is one of the prominent issues faced by Chinese children with slow handwriting (Tseng & Chow, 2000).

Handwriting consolidates memorization of graphemes (alphabetic: Longcamp et al., 2005; morphosyllabic: Guan et al., 2011; alphasyllabary: Bhide, 2018). Indeed, even novel copying skill is sometimes associated with reading (e.g., McBride-Chang et al., 2011) and word writing (e.g., McBride-Chang et al., 2011; Wang et al., 2014). However, the extent to which copying skills facilitate orthographic learning may be restricted to novice learners (Naka & Naoi, 1995; Vaughn et al., 1992). Given all that we understand about the writing process in the context of dysgraphia and more generally, how can we help children with dysgraphia?

Dysgraphia Remediation

As mentioned in relation to learning difficulties more generally (McBride, 2019), two overarching remediation strategies should be considered for those with dysgraphia; namely, work around and work through. "Work around" strategies are ways to deal with the problem and accomplish tasks and assignments despite it. Such strategies focus on how an individual with dysgraphia can produce good work in a given domain (e.g., handwriting an essay during an exam within a specified time period) using alternative techniques. The other type of remediation, sometimes referred to as "work through" strategies, consists of techniques by which individuals with dysgraphia can work on their difficulties by focusing on skills related to them. Here, the focus is on skills development, including motor and visual skills, that directly contribute to the process of handwriting.

"Work Around" Strategies

To start with, problems with handwriting can be remediated with the use of assistive technology. Allowing individuals with dysgraphia to present their work in an alternative medium to handwriting can help to free up their cognitive resources to better focus on higher-order skills in writing assignments (McBride, 2019). The speech-to-text function helps to convert the user's speech, produced orally, into text outputs with the usage of voice recognition software (Thiel et al., 2015). The use of speech-to-text technology is particularly beneficial for improving the quality of content, vocabulary, and syntax of the text, as well as contributing to longer and more complex texts overall (Thiel et al., 2015).

Typing using a keyboard is also generally accepted as an alternative form of written communication for children with dysgraphia in the eyes of occupational therapists (Penso, 1990). In survey research, Freeman and colleagues (2004) found that 93% of the

443 occupational therapists in the Canadian Association of Occupational Therapists who responded reported that they frequently recommended typing on a keyboard as a "work around" alternative for clients with dysgraphia. Similarly, Cochran-Smith (1991) noted several advantages of word processing compared to handwriting, including an increase in content quality and quantity, an increase in legibility, and more error-free texts as compared to written work.

Typing and handwriting essentially require distinctly different skills; indeed, there is typically a low-to-moderate correlation between these two writing forms (Rogers & Case-Smith, 2002). Rogers and Case-Smith (2002) found that students who write slowly or with poor legibility demonstrate an increase in both quantity and legibility of text when they adopt typing as their written form of communication. The impact of differing Chinese inputs in relation to typing remediation of Chinese character is relatively unclear, but typing is possible for Chinese as well, particularly using a Pinyin (phonological coding, primarily using Roman alphabet letters) system. Thus, both text-to-speech and typing are simple alternatives to handwriting, and are the clearest "work around" strategies for managing dysgraphia at school or at work.

"Work Through" Strategies

One potentially exciting approach to remediating handwriting difficulties incorporates neurofeedback. Neurofeedback, or EEG biofeedback, is viewed as a potentially useful, though relatively underdeveloped, treatment for several conditions, ranging from developmental disorders to mental illness to problems with physical balance (e.g., Hammond, 2007). The idea behind neurofeedback it to provide real-time audio and visual feedback about brain waves in order to retrain abnormal brainwave patterns to produce healthier patterns through operant conditioning (Hammond, 2007).

This technique has been used in an attempt to alleviate handwriting difficulties (Harandi & Moghadam, 2017; Walker, 2012). With only 5-10 neurofeedback training sessions, Walker (2012) succeeded in normalizing some abnormalities in cortical areas that are significant for handwriting in individuals with dysgraphia. In addition, these individuals' handwriting was also judged to have improved. To date, relatively few studies have been conducted on the utility of the neurofeedback for ameliorating dysgraphia. However, this technique may be worth integrating into future training studies for those with writing difficulties.

Further, a multisensory approach linking aspects of visual, auditory, and kinesthetic-tactile skills (Abdulkarim et al., 2017) has been recommended as a general remedy to handwriting problems in children (Amundson, 1992). The interaction of different modalities is believed to help students with dysgraphia to recognize cues that are provided by many different sensory channels in order to facilitate learning (Tafti & Abdolrahmani, 2014). Examples of multisensory modalities and activities used in remediation of handwriting problems include "sky writing" letters in the air, finger writing using finger painting, and finger writing in sand or rice (Woodward & Swinth, 2002). A multisensory approach has proved to be beneficial for students with dysgraphia; for example, researchers have documented some improvement in writing performances, writing expression, and spelling, as well as reduced social-emotional problems in students with dysgraphia (Abdulkarim et al., 2017).

At a general level, children with dysgraphia may also require early therapy in basic processes related to writing (for a review, see McBride, 2019). For example, some children benefit from exercises intended to strengthen their hands and fingers or focused on improving fine-motor movements. In addition, it is important that children establish a handedness preference. Children should be encouraged to favor one hand over the other for holding a pen to write; such dominance indicates a specialization of one hemisphere of the brain over the other in writing activities. Forcing children who are naturally left-handed to write with their right hand can cause difficulties (for a review, see McBride, 2019).

Another potentially useful focus for children with specific writing difficulties involves coordination between the hands to ensure optimal bilateral integration. For example, if one hand easily writes and the other easily holds the paper in place to facilitate writing, that collective, coordinated process makes the handwriting process easier. Finally, simply getting children interested in the writing implement, whether it is a pencil, pen, or marker, can be helpful for those with dysgraphia. Thus, one boy's interest in a beautiful pen his mother gave him paved the way for his renewed practice and ultimate mastery of writing (McBride, 2019).

Perhaps the act of copying graphemes itself can additionally help in ameliorating handwriting problems. As children with dysgraphia may purposely avoid writing tasks given the frustration such tasks can cause (Rahim & Jamaludin, 2019), they may lack general practice in handwriting. The act of handwriting practice through repeated direct and delayed copying of letters and words can lead to a more automatic graphomotor control in handwriting (Beeson, 2004). Furthermore, copying tasks can be used to improve both spelling production and handwriting. For example, the copy and recall treatment (CART) paradigm requires individuals to copy a target

word repeatedly and then try to recall the spelling in a written picture-naming format (Beeson et al., 2003). CART has been found to facilitate spelling, which, in turn, helped to ameliorate dysgraphia (Beeson et al., 2003). Interestingly, individuals with dysgraphia may show differences in impairment between writing styles. For example, some are impaired in print writing but not in their ability to write in cursive (Hanley & Peters, 1996; Ingles et al., 2014). Research has also focused on the idea of using cursive writing as an intervention strategy for dysgraphia (Indira & Vijayan, 2015; Nalpon & Chia, 2009). While teaching cursive writing to children appears to improve handwriting skills (Indira & Vijayan, 2015), it does not improve reading and spelling performance in children with dysgraphia (Nalpon & Chia, 2009).

Conclusion

This has been an overview of an important but under-studied learning difficulty. It is critical to understand the writing process in its entirety in order to establish what specific difficulties might interfere with that process, causing dysgraphia. Dysgraphia is, after all, extreme difficulty in the normal but very complicated process of writing. As technology progresses and children engage in more typing and less handwriting, dysgraphia may become less consequential and devastating for those who have it. However, handwriting remains important at least in some domains, and understanding this difficulty is helpful for teachers and parents worldwide.

Given the different scripts that are used globally and the varying demands of each, dysgraphia is a particular learning problem that may glean critical understanding from cross-scriptal, cross-cultural comparisons. In addition, from our observations and experience, we view the topic of dysgraphia as incorporating many disciplines of study. Those in computer science, neuroscience, education, psychology, and occupational therapy, among others, all contribute important understanding of dysgraphia We look forward to critical research globally on this topic in the years to come.

Acknowledgments

This research was supported by a General Research Fund of the Hong Kong Special Administrative Region Research Grants Council (14600818) to Catherine McBride.

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