

Assessment, Evaluation, and Treatment of Dysgraphia: Applications to Education and the Workforce

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Dysgraphia represents a learning disability, affecting a person's ability to write and transcribe written materials, that may be present in clients receiving services through vocational counselors. The present article offers a framework for diagnostic criteria, educational and worksite accommodations, and treatment modalities for individuals with dysgraphia. Particular attention is directed towards accommodations, including laptop computers, audio-recording devices, and adaptive word processors.

Keywords: dysgraphia, Individualized Education Plan, worksite accommodations

Dysgraphia represents a learning disability that gained the attention of psychologists in the 1930s. The etymology of dysgraphia is the base word *graph*, meaning the hand's function in writing as well as the letters being formed by the hand, the prefix *dys-*, meaning impairment, and the suffix *-ia*, meaning to have a condition. The combination of these elements defines dysgraphia as the condition of impairment of the hand's ability to write and form letters (Berninger, 2008). The definition of dysgraphia has varied little over the years. O'Hare and Brown defined dysgraphia in their study as the "retarded development or an acquired loss in the skill of writing," (1989, p. 2). O'Hare and Brown also categorized types of dysgraphia into three main groups: abnormalities in penmanship, difficulties with spelling, grammar and punctuation, and abnormal written content (1989). Presently, according to popular literature, dysgraphia is defined as a specific learning disability dealing with how easily children develop written language skills and how well they are able to use those skills to express their thoughts in writing (Berninger, 2008). The National Center for Learning Disabilities, 2010, defines dysgraphia as a learning disability that affects writing, which requires a complex set of motor and information processing skills. The National Center for Learning Disabilities defines it as a learning disability that affects writing, which requires a complex set of motor and information processing skills. Crouch and Jakubecy used the definitions used by Richards and Meese in their studies to define dysgraphia (2007,

p. 3). Richards defined dysgraphia as "a problem with expressing thoughts in a written form" (1999, p. 3), and Meese defined dysgraphia as "handwriting problems, specifically, a partial inability to remember how to make certain alphabet or arithmetic symbols" (2001, p. 3).

Diagnosis & Assessment of Dysgraphia

A diagnosis of dysgraphia may be offered by someone knowledgeable about disability foundations, and education and training of individuals with disabilities. Individuals with backgrounds in medicine, educational psychology, clinical psychology, or counseling may be appropriately trained. However, at present the literature does not explicitly state, indirectly or directly, whom is best qualified to diagnose dysgraphia. It is important to note, dysgraphia is a learning disability that continues to occur across the lifespan; however it may be diagnosed at different stages, and the signs of it differ slightly across these stages. For instance, the National Center for Learning Disabilities, 2010, lists warning signs for children in pre-K to second grade (e.g., trouble coloring within the lines), in third to eighth grade (e.g., trouble with writing in print and/or cursive), in ninth to twelfth grade (e.g., trouble with transferring thoughts and ideas into written form), and in college students and adults (e.g., trouble with writing organization). Additionally, comorbidity with other learning disabilities, such as dyslexia, is not un-

common in those with dysgraphia, and vice versa (Berninger & Richards, 2010).

In order to properly develop a diagnosis of dysgraphia, the evaluator may evaluate the person with dysgraphia via a battery of selected tests and assessments. The literature suggests that it is common practice to evaluate handwriting samples as part of formulating a diagnosis. This can be as informal as collecting handwriting samples from school assignments (Berninger & Richards, 2010), however more formal approaches to handwriting analysis have also been developed. For example, the classic BHK Handwriting Scale assesses both the quality of writing and production speed (Hamstra-Bletz, 1993). A more recent technique to formally evaluate handwriting samples is via the Signal-to-Noise velocity peaks difference (SNvpd), which focuses more on handwriting fluency and “localiz[ing], in both space and time, the occurrences of undesirable velocity peaks” (Danna, Villagrán, & Velay, 2013, p. 4382).

An intelligence test or other academic assessment may be used to rule out any other neuropsychological disorder or learning disability. A test battery, such as the Process Assessment of the Learner Test Battery of Reading and Writing (PAL-RW) may be used to help attain a diagnosis of dysgraphia. Specifically, the PAL-RW Copying Tasks A and B and the PAL-RW Alphabet Writing Task may be used to assess handwriting legibility and handwriting automaticity, respectively. Additionally, the Wechsler Individual Achievement Test may be used to assess potential writing deficiencies, such as compositional fluency and quality (Berninger, 2004; Berninger & May, 2011).

Most recently, fMRI studies have been demonstrated to be a valuable method to diagnose learning disabilities, including dyslexia and dysgraphia, via a computer-interfaced drawing pad (Reitz et al., 2013). Precise pen location and handwriting strokes can be determined via a color map system. This allows spelling and legibility of the writing to be assessed. Preliminary results show that participants with dysgraphia showed fewer connections in Broca’s area than participants with dyslexia, but more research is warranted to support these findings. No further information regarding biological or neurological diagnostic mea-

sures was found using “dysgraphia” along with such keywords as “diagnosis,” “testing,” “neurological,” and “biological” in the following databases: PsycINFO, JSTOR, and Academic Search Complete. However, the neurological bases of learning disabilities such as dysgraphia are being studied and this may one day lead to greater advancement in neuropsychological testing for these disorders (e.g., see Berninger & Richards, 2010).

Dysgraphia Treatments

Treatment for dysgraphia varies and may include treatment for motor disorders to help control writing movements (Synapse, 2008). Similarly, the use of educational therapy can be effective in the classroom as long as teachers are well informed about dysgraphia (Berninger & Wolf, 2009). The needs of children with dysgraphia should be addressed on a case-by-case manner with an Individualized Education Program and individual accommodations to provide alternatives regarding submitting work and modifying tasks to avoid the area of weakness (National Center for Learning Disabilities, 2010). Treatment of dysgraphia may include an analysis of a student’s ability to cognitive process information, including hearing, vision, general comprehension, and haptic writing skills (Brunsdon, Coltheart, & Nickels, 2005).

Prevention, remediation and accommodation are concurrently important elements in the treatment of dysgraphia. Muscle training, including occupational therapy, and over-learning good techniques are both critical for the remediation of dysgraphia (National Institute of Neurological Disorders and Stroke, n.d.). Other treatments may address impaired memory or other neurological problems (The Learning Disabilities Association of Ontario, n.d.). Individuals can benefit from a variety of modifications and accommodations. Alternative recommendations suggests that individuals with dysgraphia modestly use computers to avoid the problems of handwriting (National Institute of Neurological Disorders and Stroke, n.d.).

Educational Interventions for Dysgraphia

Educational interventions are available to support students with dysgraphia function in the classroom.

Table 1
Classifications of Dysgraphia

ICD-9-CM	ICD-10-CM	MeSH	DSM-IV-TR
F81.1	315.20	D000381	315.2
R48.8	784.61		
R27.8	784.69		

The most commonly used educational intervention is writing instruction, which involves direct consultation with the student to correct handwriting technique, pencil grip, and paper position. Students are also given clear examples of accurate handwriting to emulate and take part in drills to build fine motor muscle control (Crouch & Jakubecy, 2007). Additional research has shown that calming music may stimulate cursive and printing skills (Wagmeister & Shifrin, 2000). Teachers are advised to create a calm comfortable environment in which the student can learn. While educational interventions are designed to boost writing ability, a number of technological adaptations have been developed so that students with dysgraphia do not fall behind in school. The use of technology, when adapted to special education needs, has been found to promote academic success (Jimenez et al., 2003), and can help meet the needs of students in large classrooms (Polat, Adiguzel, & Akgun, 2012).

Laptop computers, and the use of word processing and adaptive word processors, are commonly used as a supplemental, temporary solution to aid students with dysgraphia while their writing skills are being improved with direct educational intervention (Mortley, Enderby, & Petheram, 2001). Laptops have been found to motivate children with dysgraphia (Lie, O'Hare, & Denwood, 2000) and, in some cases, improve their self-esteem. Students report feeling "high-tech" (Mortley, Enderby, & Petheram, 2001), and the visual elements of using a computer can help children to focus better. Also, since computers are "not judgmental towards children" (p. 3253) they can be used in special education to help students learn without pressure (Polat, Adiguzel, & Akgun, 2012).

Children with dysgraphia have been shown to respond positively to word processing on laptops and tend to enjoy writing more with a word processor than by hand. Lie, O'Hare, and Denwood (2000, p. 93) emphasized the need of word processing assistance to children with dysgraphia stating "as an artificial limb restores function to a person who has lost a limb, a typewriter or word processor can provide a means of written communication for the child with dysgraphia."

In addition to regular word processors, adaptive word processors can be used to increase the speed of the writing process. In adaptive word processing, as letters are typed a list of possible words appears which the user can then select in place of typing out the whole word. Though some adaptation to this technology is required, adaptive word processors can increase typing speed, and, by providing an automatic dictionary, help with the spelling of longer words, a common problem in those with dysgraphia (Mortley, Enderby, & Petheram, 2001).

Laptops and word processing programs, however, do present a few difficulties. Teachers have reported un-

certainty about who should teach keyboard skills (Lie, O'Hare, & Denwood, 2000) and, furthermore, laptops represent a high cost for parents and schools (Polat, Adiguzel, & Akgun, 2012). Also, select children do not adapt well to laptop computers, commonly mentioning that slow typing represents a major obstacle (Lie, O'Hare, & Denwood, 2000). In addition to word processing programs, there are a few web-assisted learning systems that have been designed for students with extra educational needs. Web-assisted learning systems can be designed to fit the needs of a child with instruction and support tools. Also, web-assisted learning systems can allow assignments to be viewed by remote access, allowing parents to take a more active role in their child's education (Polat, Adiguzel, & Akgun, 2012).

Workplace Accommodations Related to Americans with Disabilities Act

The Americans with Disabilities Act of 1990 prohibits discrimination on the basis of *disability*, a "physical or mental impairment that substantially limits one or more of the major life activities of such individual" [(Americans with Disabilities Act of 1990, Pub. L. No. 101-336, 104 Stat. 328 (1990))]. Major life activities, as defined by the Americans with Disabilities Act of 1990, include learning and working. As such, accommodations must be made for individuals with disabilities as long as there is no significant difficulty or expense on the part of the employer and/or learning institution. Federal funds are available to assist in providing accommodations for individuals with disabilities [(Americans with Disabilities Act of 1990, Pub. L. No. 101-336, 104 Stat. 328 (1990))]. Concerning dysgraphia, worksite and classroom accommodations may include the use of technology including laptop computers, audio-recording devices, and adaptive word processors (Mortley, Enderby, & Petheram, 2001). Classroom adapted equipment is specifically mentioned in the Americans with Disabilities of 1990 (ADA) as an auxiliary aid that must be provided by private entities offering courses to persons with disabilities. Also specific to the classroom, the ADA may require modifications such as "changes in the length of time permitted for the completion of the course, substitution of specific requirements, or adaptation of the manner in which the course is conducted or course materials are distributed" with regards to dysgraphia as a disability (Americans with Disabilities Act of 1990, Pub. L. No. 101-336, 104 Stat. 328 (1990)). Other examples of adapted course measures include: course waivers, spelling errors ignored for grading purposes, and alternative testing forms (Wilhelm, 2003). According to the Americans with Disabilities Act of 1990, accommodations must also be made for persons with disabilities regarding all forms of testing, including psychological testing. "Required modifi-

cations to an examination may include changes in the length of time permitted for completion of the examination and adaptation of the manner in which the examination is given" [(Americans with Disabilities Act of 1990, Pub. L. No. 101-336, 104 Stat. 328 (1990)]. Private entities offering examination are required to provide auxiliary aids to persons with disabilities, as long as the use of the aid will not "alter the measurement of the skills or knowledge the examination is intended to test" [(Americans with Disabilities Act of 1990, Pub. L. No. 101-336, 104 Stat. 328 (1990)].

Evidence-Based Diagnosis and Treatment for Specific Learning Disorders

Because there has been so little research on developmental dysgraphia, Berninger and May (2011) offer an example of a case study which provides information about the diagnosis and treatment of this learning disability. The boy presented in the case study, A.B., scored in the 99th percentile on a cognitive assessment, but had been failing classes because his handwriting is so poor and he could not keep up with written assignments. An occupational therapist originally evaluated A.B. when he was seven years old, however he did not get an official diagnosis of dysgraphia until the summer before he entered the eighth grade. Diagnostic assessment included the WISC-IV, the WIAT-II Spelling and Written Expression, and the PAL Finger Succession, among others. A.B.'s assessment coincided with what Berninger and May (2011) term the "hallmark phenotypes" for dysgraphia: automatic legible letter writing, orthographic coding, and finger succession. These hallmark phenotypes are thought to contribute to the proper functioning of the orthographic loop, which in turn, contributes to the working memory. In other words, individuals with dysgraphia have impairments in their orthographic loops and orthographic word form coding.

Roles of Professionals and Resources for Dysgraphia

Several different types of professionals can assist in the diagnoses of dysgraphia. Other professionals, while they may not be able to diagnose dysgraphia, can still play a vital role in working with people who live with this learning disability. Generally, someone with a background in clinical, educational, or school psychology may assist in the diagnosis of dysgraphia because they are trained in the proper assessment and treatment of disabilities. However, other professionals, such as psychometrists and neurologists, may also be qualified to make the diagnosis if they have obtained the appropriate license or certification to do so. Physicians, such as pediatricians and psychiatrists, may suspect dysgraphia in a patient, but usually do

not have the special skills needed for assessment in order to make an official diagnosis. Instead, these physicians will refer the patient to a psychologist or other professional who is trained to perform the appropriate testing. Other professionals are not directly involved in the diagnosis, but may contribute in different ways. For instance, nutritionists may be helpful in the prevention of dysgraphia because poor prenatal nutrition has been linked to the later development of learning disabilities. Additionally, behavior analysts may be able to assist with the treatment of people with dysgraphia by using a "skill-oriented approach" that focuses on modifying behaviors to lead to more successful writing composition and fluency (Bredberg & Siegel, 2001).

Dysgraphia Compared to Other Learning Disorders

The historical definition of a learning disability has been accepted as a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in imperfect ability to listen, think, speak, read, write, spell or perform mathematics. There are numerous types of learning disabilities, however, and the definitions and characteristics of each is what distinguish one from the other. For instance, dysgraphia is categorized as a learning disability that affects handwriting, specifically the development of written language and the ability to use those skills to formulate written language (Berninger, 2008; National Center for Learning Disabilities, 2010). On the other hand, agraphia is characterized by abnormal mental processing that result in difficulty in reading and spelling nonwords relative to real words (Beeson, Rising, Kim, & Rapcsak, 2010). With dyscravica there is a substitution of the target letter with a letter that differs only with respect to the voicing feature. It occurs with words that have similar sounds, but are not properly pronounced (i.e., "coat" for "goat" or "vagd" for "fact") (Gvion & Friedmann, 2010). Conversely, character amnesia is a different phenomenon altogether. It is a lapse in memory when it comes to utilizing Chinese symbols with written communication. Character amnesia seems to occur when Chinese-speaking people who know the Chinese alphabet fluently can no longer communicate efficiently in this way. This is believed to be largely in part because of the pinyin system, which is a computer input device used to ephonetically translate Chinese words and symbols into Latin-based publications internationally. The characters generated from this program are simplified and lose their historical and cultural significance; therefore, many Chinese-speaking people completely lose the memory of the original character (Lu, 2013).

Dysgraphia and Working Memory

Working memory may be defined as the active part of the memory system, which is used to retrieve data as one goes from task to task. Working memory is used to reclaim and access information whereby the brain may process things in an orderly fashion and ultimately store it in the long-term memory department (Unsworth, Brewer, & Spillers, 2013). In other words, there is an active buffering of information that is being actively manipulated as it relates to working memory (Buchwald & Rapp, 2009). Association and recollection of retrieval of data is a key component that is often associated with working memory (Olson, Romani, & Caramazza, 2010). In individuals with dysgraphia, there was spelling errors associated with the mishandling of information as processed by the working memory. These errors result in issues such as letter transposition, substitution, deletions, and additions (Buchwald & Rapp, 2009). Verbal working memory is another component of working memory that may be affected by learning disorders such as dysgraphia. This is due in part to the disruption of the shielding of the network associated with the verbal working memory (O'Dowd & De Zubizaray, 2003).

Screening for Dysgraphia in São José do Rio Preto

A study was conducted in the city of São José do Rio Preto in the state of São Paulo, Brazil to screen for warning signs of dysgraphia in public schools in order to allow for early intervention. The researchers randomly selected thirteen schools from various neighborhoods, and a total of 630 students attending the sixth grade were evaluated. The students were evaluated using the adapted Analytical Dysgraphia Inventory, which is designed to highlight difficulties in writing through the tracing of graphics and identify warning signs of dysgraphia such as illegible letters, letter confusion, touched-up letters, abnormal patterns in letters, or uneven lines of text. An Analysis of variance was conducted to analyze the results, and this study found that 22% of the sample presented with symptoms of dysgraphia. It was also found that dyslexia was found to be the most significant indicator of dysgraphia. The researchers suggest, given the large number of warning signs for dysgraphia found in this sample, that screening for symptoms of dysgraphia be implemented in order to allow for early interventions (Martins et al., 2013).

Classification of Dysgraphia

Dysgraphia has been classified along various dimensions, including the ICD-CM, MeSh, and the DSM-IV-TR (displayed in Table A). The ICD, or International Classification of Diseases, Clinical Modification, has many revisions, and dysgraphia has been

classified in the Ninth and Tenth Revision. In the ICD-9-CM, dysgraphia is classified in Chapter 5 Mental Disorders and Chapter 16 Symptoms, Signs, and Ill-defined Conditions. In Chapter 5 dysgraphia is classified under 315.2, or Other Specific Learning Difficulties, with subcategory of Disorder of Written Expression. In Chapter 16, dysgraphia is classified under 784.61 Alexia and Dyslexia and 784.69 Other symbolic dysfunction (Centers for Disease Control and Prevention, 2010). In the ICD-10-CM, dysgraphia is classified in Chapter 5 Mental, Behavioral, and Neurodevelopmental Disorders and Chapter 18 Symptoms, Signs, and Abnormal Clinical and Laboratory Findings Not Elsewhere Classified. In Chapter 5, it is classified under F81.1 Specific spelling disorder. In Chapter 18, it is classified under R48.8 Other and unspecific symbolic dysfunctions and R27.8 Other and unspecific lack of coordination (World Health Organization, 2011). In MeSH, or Medical Subject Headings, dysgraphia is classified under Agraphia under the ID D000381. According to MeSh, agraphia and dysgraphia are defined as the "loss or impairment of the ability to write (letters, syllables, words, or phrases) due to an injury to a specific cerebral area or occasionally due to emotional factors" (National Library of Medicine, 2013). In the DSM-IV-TR dysgraphia is classified as a type of learning disorder, specifically 315.2 Disorder of Written Expression (American Psychiatric Association, 2000). The diagnostic criteria for a Disorder of Written Expression are:

- A. Writing skills, as measured by individually administered standardized tests (or functional assessments of writing skills), is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education.
- B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require the composition of written texts (e.g., writing grammatically correct sentences and organized paragraphs).
- C. If a sensory deficit is present, the difficulties in writing skills are in excess of those usually associated with it.

Conclusion

Dysgraphia is represented as a learning disability that is principally defined and characterized as a handwriting impairment which is symptomatic of the individuals' inability to write and formulate letters. However, making the diagnosis for this disorder is very difficult. Dysgraphia mimics and has many overlapping qualities of other learning disorders such as agraphia, dyscravia and character amnesia. The common thread among these disabilities is that these dis-

orders represent an inability to correctly formulate words or characters. In the same consideration, the treatment for dysgraphia is varied. Treatment may include educational therapy, muscle training, occupational therapy, or a combination of treatments. In some cases, there is also an analysis of the individuals hearing and writing in regard to the written output in a school or work setting. In addition to or in lieu of treatment, accommodations may be made to assist those with dysgraphia. Things such as laptop computers, audio-recording devices, and adaptive word processors may be utilized in a work and classroom setting to accommodate individuals who are working and learning with dysgraphia. The vocational counselor must consider the diversity of this disorder, including identification, treatment, and accommodations when adopting either educational or vocational settings.

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