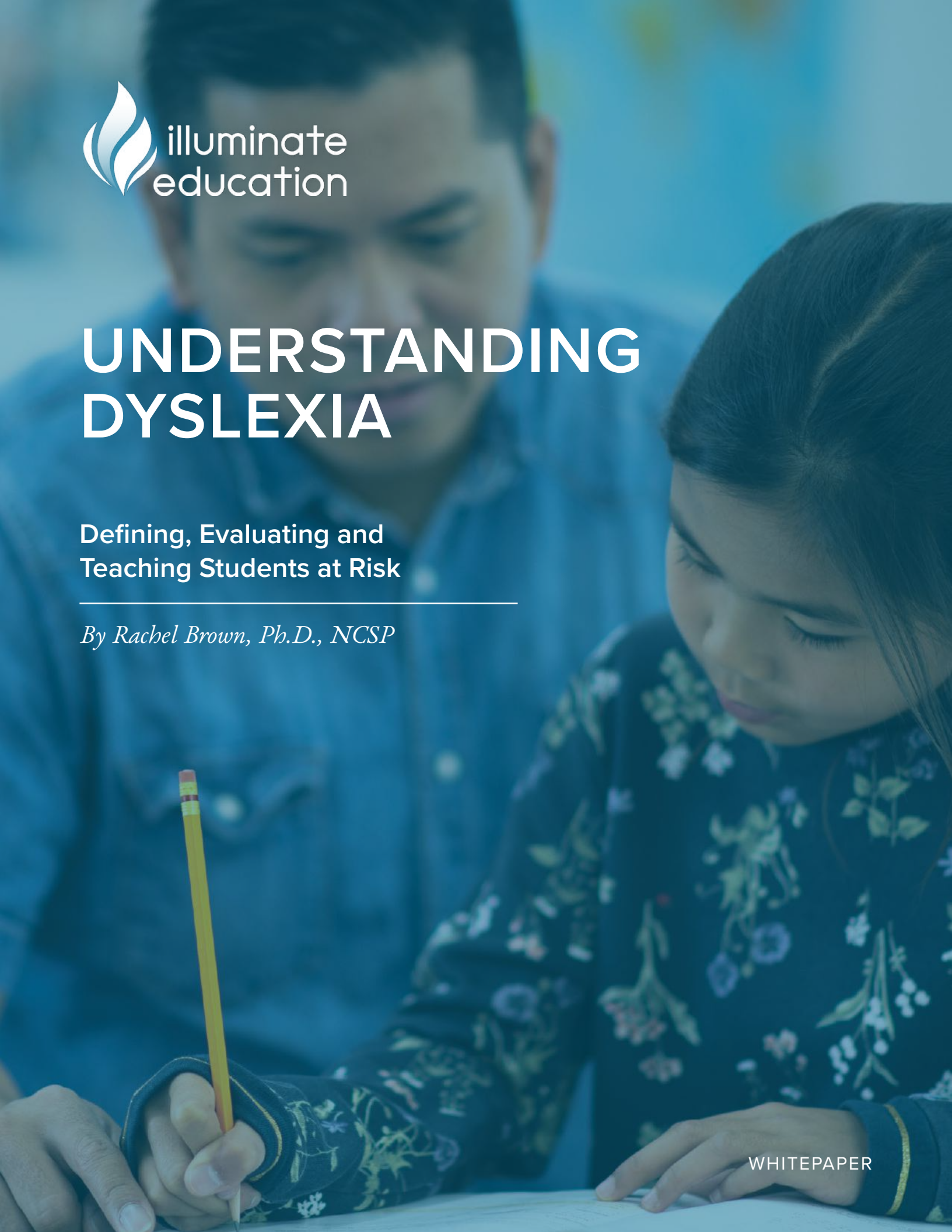

illuminate education

UNDERSTANDING DYSLEXIA

Defining, Evaluating and Teaching Students at Risk

By Rachel Brown, Ph.D., NCSP

WHITEPAPER

CONTENTS

EXECUTIVE SUMMARY

- Dyslexia is a neurological disorder that interferes with learning to read and applying reading skills across the lifespan.
- Recent research using fMRI indicates that readers with and without dyslexia exhibit activation of different brain regions during reading, with the regions used by those with dyslexia requiring greater time and effort.
- It is possible to screen for dyslexia using brief assessments in the primary grades and screening results can be used to plan intervention or recommend follow-up diagnostic evaluation.
- Universal dyslexia screening will also identify other students with reading difficulties who do not have dyslexia but will benefit from the same structured reading instruction as students with dyslexia.
- There are effective treatments for dyslexia and these include direct and systematic reading instruction that incorporates phonemic awareness, phonics, fluency, vocabulary, and comprehension.
- With effective treatment, individuals with dyslexia can learn to read, participate in all school activities, complete high school and attend post-secondary programs.
- Some students with dyslexia will require more intensive instruction and these students might be eligible for special education services.

WHAT IS DYSLEXIA?

Dyslexia is one type of learning disability that affects a student's ability to learn how to read. The following is the definition adopted by the International Dyslexia Association (IDA; 2019):

> *Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.*

Although the term dyslexia has been used for many years, it is not the only reason that a student might struggle when learning to read. Indeed, research documents that most reading difficulties are due to poor instruction (National Research Council, 1998). Early research about dyslexia and its causes suggested that it was due to poor visual processing (Anderson & Meier-Hedde, 2001; Handler & Fierson, 2011; Kirby, 2018). Later research has confirmed that dyslexia involves difficulty reading due to poor phonological processing (Benton, 2002; Tunmer & Greaney, 2010; Shaywitz & Shaywitz, 2005).

KEY FEATURES OF DYSLEXIA

The above IDA definition identifies key features which are indicators of dyslexia. Difficulty with word reading, decoding, and encoding are common indicators of possible dyslexia, however, there are other reasons why a student could experience reading problems. The definition specifically mentions that effective classroom reading instruction must have been provided to determine if dyslexia is present. In addition, the definition points to primary and secondary dyslexia features. The following reading skills can be affected by dyslexia.

SKILL	DEFINITION	DYSLEXIA SYMPTOMS
Phonological Awareness	Understanding that words are made up of individual sounds that map to letters	Errors when saying the sounds in words
Rapid Automatized Naming (RAN)	Automatic recognition of letters, letter-sounds, colors, and objects	Slow and incomplete word reading
Decoding	Recognizing and reading the individual sounds in letters and words	Errors when matching sounds to letters and words when reading
Encoding	Writing the letters that match specific sounds; also known as spelling.	Spelling errors
Vocabulary	Knowledge of word meanings	Limited knowledge of grade-level word meanings
Comprehension	Understanding the meaning of words and sentences	Inaccurate and/or incomplete understanding of texts

The above features are important because it is the chronic absence of one or more of these skills that indicates possible dyslexia. When a student does not reach grade-level reading goals, teachers need to consider the specific details of that student's reading performance to determine if there is a risk for dyslexia or another reading problem.

DYSLEXIA AND OTHER READING PROBLEMS

Although dyslexia has most likely been present since the origin of written words (van Gijn, 2015), it did not become an identified condition until the nineteenth century when the ability to read became more important (Pickle, 1998). In the U.S., most states introduced compulsory school attendance laws in the late nineteenth and early twentieth centuries. When school attendance became mandatory, those students who might have stayed at home due to difficulty learning to read were now required to attend school (Chirkina & Grigorenko, (2014). Although dyslexia is most often identified once a student begins school and is expected to learn how to read, evidence indicates that it is a life-long condition, with some symptoms present in the preschool years (Raschle et al., 2011) and ongoing effects into adulthood (Poncelet et al., 2003).

Causes

Thanks to modern technologies such as functional magnetic resonance imaging (fMRI), much more is known about the specific causes of dyslexia. By recording brain activations of typical and dyslexic readers while they read, researchers have learned that those with dyslexia have far fewer activations in the temporal and occipital brain regions, and many more in the frontal region. The greater number of frontal lobe activations mean that the reader is struggling to recognize and understand the letters and sounds in words. By contrast, typically developing readers use connections in the temporal and occipital lobes to recognize words automatically, leaving the majority of reading effort for comprehension (Chyl et al., 2018; Norton et al., 2014- 2015). As a result of less automatic letter and sound recognition, readers with dyslexia often spend much longer decoding words, identifying their meanings, and understanding connected text.

One of the symptoms most often observed in students with dyslexia is slow decoding. To investigate the underlying reasons for slow decoding among students with dyslexia, Denckla and Rudel (1976) initiated a series of studies that examined how quickly students named a variety of stimuli, including letters, numbers, colors, and objects. Denckla and Rudel (1976) found that students with dyslexia demonstrated deficits in rapid and automatic naming across all the stimuli used and they developed the term Rapid Automatized Naming (RAN). This finding was instrumental in later research efforts to identify predictors of reading difficulties, including dyslexia, for the purpose of providing early intervention. Among subsequent research findings, Wolf and Bowers (1999) hypothesized that dyslexia is caused by two specific deficits: (a) phonological deficits, and (b) naming speed deficits (i.e., RAN). This double deficit hypothesis has contributed to recent research related to dyslexia's symptoms and predictors.

In recent years, research has confirmed that RAN is one of several key predictors of later reading skills. Schatschneider et al. (2004) summarized over 60 years of research about early reading (e.g., kindergarten) assessments to identify which ones best predict later reading success. Findings indicated that the best predictors were measures of letter names, letter sounds, naming speed (e.g., RAN), and phonological awareness (Schatschneider et al., 2014). These results confirmed Denckla and Rudel's early findings that RAN is a significant predictor of reading, however, did not determine which types of visual stimuli best measure RAN skills. Araujo et al. (2014) conducted a meta-analysis of studies that used RAN as part of reading assessment to determine whether certain visual stimuli used in RAN measures are better predictors of later reading than others. Specifically, Araujo et al. (2014) considered the moderating effects of RAN stimulus type on word and text reading by comparing alphanumeric (e.g., letters, numbers) and non-alphanumeric (e.g., colors, objects) RAN stimuli. The findings showed that stimulus type was a statistically significant moderator of reading

performance ($p < .001$) and that letter naming scores contributed the most variance to reading skills (Araujo et al., 2014). This result suggests that a timed measure of letter names is the best correlate of reading skills.

Additional research has documented that there appears to be a familial pattern in dyslexia (Carroll et al., 2014; Giménez et al., 2017). Some of the research concerning familial patterns has focused on identifying children who could have a higher risk for dyslexia and then providing them with specialized instruction in order to lower or eliminate the risk of reading problems (Snowling et al., 2007). The good news is that young children at risk for dyslexia who participate in highly structured direct reading instruction can learn to read well (Hulme et al., 2015). The research documenting the benefits of early reading intervention for children at-risk for dyslexia contributed to the passage of laws requiring dyslexia screening in all elementary schools. As of June 2021, 48 U.S. states have some type of dyslexia statute and 37 require dyslexia screening (National Center on Improving Literacy, n.d.).

Screening

Dyslexia screening is important because the earlier that any type of reading difficulty is identified, the easier and more effective it is to provide intervention. For students with dyslexia, early intervention with a specific type of instruction is the single best way to help them become readers. Dyslexia screening is typically very brief (e.g., 4-5 minutes per student) and can be done as part of other screening procedures. Classroom teachers can conduct screenings, or they can be done by literacy specialists, special educators, school psychologists or others with the correct training. Schatschneider et al. (2004) reviewed research about the best early predictors of later reading skills. Based on over 60 years of available research, Schatschneider et al. found that assessments of letter names, letter sounds, rapid naming, and phonological awareness used for screening in kindergarten are the best predictors of reading skills in later grades. By screening students in kindergarten and grade 1, teachers can identify priority learning needs for groups and individual students. Common screening tasks include blending and segmenting oral words to measure phonemic awareness, naming letters to measure rapid automatized naming (RAN; Araujo et al., 2014), reading pseudowords to measure phonics skills, and sometimes reading sentences or short stories. Starting in first grade, screeners often involve the student reading three short stories for 1 minute each while the teacher records any errors that the student makes.

It is the types of errors that the student makes that can be indicators of dyslexia. If older students cannot read well enough to complete the oral reading stories, additional screening of more basic skills such as word segmenting and letters sounds can identify the source of the reading difficulty. If the screening score and error pattern indicate that the student might have reading problems, including dyslexia, then a comprehensive evaluation might be recommended, or the school might conduct additional screenings to confirm the initial scores. In addition, the school could provide reading intervention right away since all students with reading difficulties are likely to benefit from the type of reading instruction that works best for students with dyslexia (Gersten et al., 2008). If the accumulated results consistently show that a student has persistent reading problems, the student can be referred for a comprehensive evaluation for special education services. The main difference between dyslexia screening and the kind of evaluation required for special education services is that eligibility for special education requires a comprehensive evaluation by a multidisciplinary team that is far more in-depth than screening. For students whose screening data suggests reading problems, additional diagnostic evaluation can provide important information.

Diagnostic Evaluation

For students whose screening and intervention data indicate a profile consistent with dyslexia, a diagnostic evaluation can be helpful to confirm the data, rule out other possible reasons for reading problems, and recommend additional instructional strategies. The personnel with the training to conduct a diagnostic reading evaluation are psychologists. Such evaluations are available through psychologists in private practice, however, the cost for a private evaluation must be paid by the family. School-age children with persistent reading problems are typically evaluated by a school-based team that considers whether the student is eligible for special education. Students with dyslexia are not automatically eligible for special education. Instead, the team needs to consider how the symptoms affect school performance and whether specialized instruction is needed. Dyslexia is not a specific category of special education service; instead, dyslexia is recognized as a type of specific learning disability and that is the category for special education service. For more information about the procedures for evaluation and eligibility in your child's school, contact the district's special education director.

Treatments

As noted, the earlier that dyslexia symptoms are identified, effective treatment can be provided. The good news is that there is a strong body of evidence for the most effective reading instruction practices for children with dyslexia. Importantly, many of these practices benefit children with dyslexia, children with other reading difficulties, and children with typical reading development (Foorman & Torgeson, 2001; Gersten et al. 2008). Research examining effective treatments for dyslexia goes back over 100 years (Rooney, 1995). One of the pioneers of such research was Dr. Samuel T. Orton, a U.S. physician. He began by conducting research to understand why some children had difficulty learning to read. Although some of the hypotheses Dr. Orton developed were not confirmed by later research, his work was instrumental in creating an awareness of reading disabilities and eventually led to the founding of the Samuel T. Orton Society, later renamed the International Dyslexia Association. One of the lasting effects from Dr. Orton's work was the development of assessment and instruction methods for identifying and treating dyslexia. Later researchers confirmed the basic features and indicators of dyslexia as well as how best to identify and treat it (Shaywitz, 2005).

The defining features of effective dyslexia treatment are that it includes direct and systematic instruction in all core areas of reading, including (a) phonemic awareness, (b) phonics (c) fluency, (d) vocabulary, and (e) comprehension (National Reading Panel, 2000; Stockard et al., 2018) as well as spelling. A specific type of instruction often associated with dyslexia is called the Orton-Gillingham method. This method was developed by Dr. Samuel Orton and his associate Anna Gillingham in the 1950s when much less was known about the causes and treatments for dyslexia. The Orton-Gillingham method involves individualized instruction to learn the sounds (phonemes) for all letters, strategies for reading words that are phonetically irregular, and many, many repetitions to master these skills. There are a number of modern adaptations of the Orton-Gillingham method (e.g., Wilson Reading). In addition, there are other methods that focus exclusively on single component skills such as phonics or fluency; however, these do not appear to work as well as comprehensive instruction (Alexander & Slinger-Constant, 2004; Brunsdon et al., 2002).

One of the lingering challenges in dyslexia treatment is that the amount of specialized instruction that each student needs tends to vary. For example, one student with dyslexia might need 100 hours of specialized instruction and another will need 1000. It is clear that earlier treatment is best and that programming for older students tends to require more time and resources (O'Brien et al., 2011). These findings support the use of school-based dyslexia screening and treatment as a means to improve student outcomes. Earlier intervention also can reduce financial costs for schools and communities (Hakkaart-van Roijen et al. 2011).

MYTHS ABOUT DYSLEXIA

Myth: *Dyslexia doesn't affect children until elementary school when we're teaching them to read.*

Fact: Dyslexia is a language-based disability. As such, signs of dyslexia are often seen much earlier than Kindergarten (Raschle et al., 2011; Shaywitz, 2005). Studies have shown that learners with reading difficulties in elementary school had delayed speech and language skills as toddlers, and were slower to learn pre-literacy skills, such as rhyming, as younger children (Lyytinen et al., 2005). Early intervention can be extremely successful for learners who are developmentally delayed in early childhood, and we recommend providing it to all struggling learners. Early intervention is more effective than waiting until much larger learning gaps have formed. In schools, specific learning disabilities, including dyslexia, aren't diagnosed until elementary school but early intervention can be provided with or without a dyslexia diagnosis.

Myth: *Most students with dyslexia can't learn to read.*

Fact: Students with dyslexia can learn to read with structured literacy instruction. This includes daily intensive instruction in the big ideas of reading, as well as language and spelling, provided in an explicit and systematic format (Kilpatrick, 2015).

Myth: *Dyslexia can be remediated through visual training methods.*

Fact: Learners with dyslexia always need intensive, systematic and explicit literacy instruction. There is a belief that visual training can be used to treat dyslexia. However, there is no evidence that dyslexia is a vision disorder and visual training has not been found to be an evidence-based intervention for reading difficulties. Additionally, the American Academy of Pediatrics does not support the use of visual training to treat dyslexia (Handler & Fierson, 2011).

Myth: *Dyslexia is caused by not reading enough to a child at home.*

Fact: Dyslexia is a neurobiological condition. Many learners with dyslexia have families that have surrounded them with literacy and language experiences from birth. The neurological nature of dyslexia is persistent, regardless of the home environment provided to young children. As noted, there is a familial pattern to dyslexia that can affect multiple generations (Carroll et al, 2014). Some states' dyslexia screening requirements include a parent survey to learn about family history. These students will need more structured, intensive instruction to learn to read, regardless of their early home experiences.

Myth: *Most students with dyslexia cannot attend college.*

Fact: Students with dyslexia can attend college and be very successful. There are many well-known individuals with dyslexia who have careers in all professions. That said, it appears that dyslexia is a persistent condition and is likely to affect all learning experiences that involve reading (Poncelet et al., 2003). For this reason, many colleges now offer supports for students with dyslexia and there are specialized colleges with preparation programs for students with severe dyslexia (e.g., Landmark College).

SUMMARY

Although dyslexia is a well-known reading disorder with life-long effects, there are ways to identify children at risk for dyslexia and provide early intervention. Universal dyslexia screening of all students in the primary grades allows educators to identify and support those who demonstrate early symptoms. With the correct treatment, most of these students will be able to participate with their peers in general education settings as well as graduate from high school and attend college. The causes of dyslexia are now better known; however, research continues to uncover more details about the specific mechanisms that contribute to symptoms as well as the most effective treatments. It is clear that early screening and intervention are two of the most effective steps to support children at risk for dyslexia.

ADDITIONAL RESOURCES

The following websites provide additional information about the causes and treatments for dyslexia.

- International Dyslexia Association: https://dyslexiaida.org/
- IRIS Center: https://iris.peabody.vanderbilt.edu/
- Meadows Center: https://www.meadowscenter.org/
- National Center for Improving Literacy: https://improvingliteracy.org/
- Reading Rockets: http://www.readingrockets.org/

REFERENCES

Alexander, A. W., & Slinger-Constant, A. (2004). Current status of treatments for dyslexia: Critical review. *Journal of Child Neurology*, *19*(10), 744-758.

Anderson, P. L., & Meier-Hedde, R. (2001). Early case reports of dyslexia inthe United States and Europe. *Journal of Learning Disabilities, 34*(1), 9-21.

Araújo, S., Reis, A., Petersson, K. M., & Faísca, L. (2015). Rapid automatized naming and reading performance: A meta-analysis. *Journal of Educational Psychology, 107*(3), 868-883.

Brunsdon, R. K., Hannan, T. J., Coltheart, M., & Nickels, L. (2002). Treatment of lexical processing in mixed dyslexia: A case study. *Neuropsychological Rehabilitation*, *12*(5), 385-418.

Benton, A. (2002). Otto Wernicke on developmental dyslexia. Journal of the *History of the Neurosciences*, *11*(3), 278-281. Link

Carroll, J. M., Mundy, I. R., & Cunningham, A. J. (2014). The roles of family history of dyslexia, language, speech production and phonological processing in predicting literacy progress. *Developmental Science*, *17*(5), 727-742.

Chirkina, G. V., & Grigorenko, E. L. (2014). Tracking citations: A science detective story. *Journal of Learning Disabilities*, *47*(4), 366-373.

Chyl, K., Dębska, A., Łuniewska, M., Marchewka, A., Kossowski, B., Pugh, K.R., & Jednoróg, K. (2018). Reading acquisition in children: Developmental processes and dyslexia specific effects. *Journal of the American Academy of Child and Adolescent Psychiatry.*

Denckla, M.B., & Rudel, R.G. (1976). Rapid 'automatized' naming (R.A.N.): Dyslexia differentiated from other learning disabilities. *Neuropsychologia, 14*(4), 471-479.

Foorman, B. R., & Torgesen, J. (2001). Critical elements of classroom and smallgroup instruction promote reading success in all children. *Learning Disabilities Research & Practice, 16*(4), 203-212.

Gersten, R., Compton, D., Connor, C.M., Dimino, J., Santoro, L., Linan-Thompson, S., and Tilly, W.D. (2008). Assisting students struggling with reading: Response to Intervention and multi-tier intervention for reading in the primary grades. A practice guide. (NCEE 2009-4045). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from https://ies.ed.gov/ncee/wwc/practiceguides

Giménez, A., Ortiz, A., López-Zamora, M., Sánchez, A., & Luque, J. L. (2017). Parents' reading history as an indicator of risk for reading difficulties. *Annals of Dyslexia*, 67(3), 259-280.

Hakkaart-van Roijen, L., Goettsch, W. G., Ekkebus, M., Gerretsen, P., & Stolk, E. A. (2011). The cost-effectiveness of an intensive treatment protocol for severe dyslexia in children: CEA of treatment for severe dyslexia. *Dyslexia*, 17(3), 256-267.

Handler, S. M., Fierson, W.M., the Section on Ophthalmology and Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists (March 01, 2011). Learning disabilities, dyslexia, and vision. *Pediatrics, 127*(3).

Hulme, C., Nash, H. M., Gooch, D., Lervåg, A., & Snowling, M. J. (2015). The foundations of literacy development in children at familial risk of dyslexia. *Psychological Science*, *26*(12), 1877-1886.

International Dyslexia Association. (2019). Definition of dyslexia. Retrieved from: https://dyslexiaida.org/definition-of-dyslexia/

Kilpatrick, D. (2015). Essentials of assessing, preventing, and overcoming reading difficulties. Hoboken, NJ: Wiley.

Kirby, P. (2018). What's in a name? The history of dyslexia. *History Today*, *68*(2), 48-57.

Lyytinen, P., Eklund, K., & Lyytinen, H. (2005). Language development and literacy skills in late talking toddlers with and without familial risk for dyslexia. *Annals of Dyslexia*, *55,* 166–192.

National Center on Improving Literacy. (2019). State of dyslexia. Retrieved from: https://improvingliteracy.org/state-of-dyslexia

National Reading Panel (U.S.), & National Institute of Child Health and Human Development (U.S.). (2000). *Report of the National Reading Panel: Teaching children to read. An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups.* Washington, D.C.: National Institute of Child Health and Human Development, National Institutes of Health.

National Research Council. (1998). Preventing reading difficulties in young children. Washington, DC: The National Academies Press.

Norton, E. S., Beach, S. D., & Gabrieli, J. D. (2014;2015;). Neurobiology of dyslexia. *Current Opinion in Neurobiology*, *30,* 73-78.

O'Brien, B. A., Wolf, M., Miller, L. T., Lovett, M. W., & Morris, R. (2011). Orthographic processing efficiency in developmental dyslexia: An investigation of age and treatment factors at the sublexical level. *Annals of Dyslexia*, *61*(1), 111-135.

Pickle, J. M. (1998). Historical trends in biological and medical investigations of reading disabilities: 1850–1915. *Journal of Learning Disabilities*, *31*(6), 625-635.

Poncelet, M., Schyns, T., & Majerus, S. (2003). Further evidence for persisting difficulties in orthographic learning in highly educated adults with a history of developmental dyslexia. *Brain and Language*, *87*(1), 145-146.

Raschle, N. M., Chang, M., & Gaab, N. (2011). Structural brain alterations associated with dyslexia predate reading onset. *Neuroimage, 57(*3), 742-749.

Rooney, K. J. (1995). Dyslexia revisited: History, educational philosophy, and clinical assessment applications. *Intervention in School and Clinic, 31*(1), 6-15.

Schatschneider, C., Fletcher, J. M., Francis, D. J., Carlson, C. D., & Foorman, B. R. (2004). Kindergarten prediction of reading skills: A longitudinal comparative analysis. *Journal of Educational Psychology, 96(*2), 265-282.

Shaywitz, S. E. (2005). *Overcoming dyslexia: A new and complete science-based program for reading problems at any level.* New York: Vintage Books.

Shaywitz, S. E., & Shaywitz, B. A. (2005). Dyslexia (specific reading disability). *Biological Psychiatry, 57*(11), 1301-1309.

Snowling, M. J., Muter, V., & Carroll, J. (2007). Children at family risk of dyslexia: A follow-up in early adolescence. *Journal of Child Psychology and Psychiatry, 48*(6), 609-618.

Stockard, J., Wood, T. W., Coughlin, C., & Khoury, C. R. (2018). The effectiveness of direct instruction curricula: A meta-analysis of a half century of research. *Review of Educational Research*, *88,* 479–507.

Tunmer, W., & Greaney, K. (2010). Defining dyslexia. *Journal of Learning Disabilities, 43*(3), 229-243.

van Gijn, J. (2015). A patient with word blindness in the seventeenth century. *Journal of the History of the Neurosciences*, 24(4), 352-360.

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91*(3), 415-438.

Illuminate Education partners with K-12 educators to equip them with data to serve the whole child and reach new levels of student performance. Our solution brings together holistic data and collaborative tools and puts them in the hands of educators. Moment-by-moment, our users can visualize each student's progress, determine the right instructional or intervention strategy, and take the next best action. Headquartered in Irvine, CA., Illuminate supports over 17 million students and 5200 districts and schools across all 50 states.