Understanding Dyslexia: Why Early Prevention and Intervention are Crucial

By Dr. Dale Webster

We are all born with dyslexia. The difference among us is that some are easy to cure and others are not.
(Liberman, 1996).

This quote, by one of the scientists who uncovered the role that phonemic awareness plays in learning to read, makes the point that unlike learning to speak, reading is not a natural process. Reading has to be taught. For many, learning to read is one of the most difficult cognitive tasks they will ever encounter. In his quote, Liberman is referencing this group of people for whom learning to read is very difficult — the ones who are not "easy to cure." The human brain is not inherently wired for reading like it is for speaking. Instead, learning to read and the act of skilled reading itself require multiple language components built on the human speech system: phonology, orthography, morphology, syntax, semantics, pragmatics. Due to the complexity of skilled reading, researchers created a simplified framework to help understand it. This framework, known as the "Simple View of Reading" (Gough & Tunmer, 1986) describes reading as consisting of two main components — language comprehension and word recognition. Using this "simple view" framework has guided researchers for over 30 years to understanding the complexities of reading. Scarborough (2000) furthered this framework by describing the subcomponents of language comprehension and word recognition to create the Rope Model of Reading Development which can be viewed here. In light of these components of skilled reading, it is no wonder Liberman argued that we as human beings may begin our early years as "dyslexic" until we are taught to read, and for some learning to read is relatively easy and for others it is very challenging.

Phonology: The study of sounds and sound patterns within a language.

Orthography: A writing system for representing language

Morphology: The study of how words are put together and structured.

Syntax: The sequence in which words are put together to form sentences.

Semantics: The study of word and phrase meanings and relationships.

Pragmatics: The study of how words are used in a social context.

The following is the current definition of dyslexia used by researchers and is the official definition for the International Dyslexia Association (IDA):

> 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. (Lyon, Shaywitz & Shaywitz, 2003)
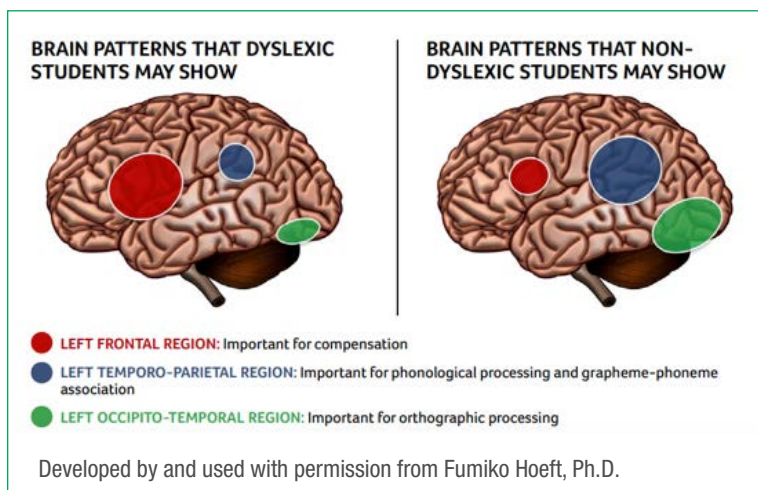
The term *unexpected* in the definition refers to students who are underachieving but not due to sensory or physical conditions, mental retardation, emotional disturbance, or environmental, cultural or economic disadvantage.

What We Know About Dyslexia

Due to a great deal of research over more than 30 years we know a lot about dyslexia, enough to successfully identify and treat those who are diagnosed. We also know that there are other subtypes of reading disability other than dyslexia — one subtype relates to fluency where students can accurately decode and do not seem to have a phonological impairment and another subtype where students have accurate and fluent decoding, but they still have difficulty comprehending (Fletcher et al., 2007). We know that more severe forms of dyslexia often involve deficits in oral language and rapid naming of letters and digits which require more intensive intervention (Catts et al., 2017). We know that students with dyslexia can often have other difficulties not related to reading. One common difficulty that children with dyslexia often have is ADHD/ADD. About 12-24% of students classified as dyslexic also have ADHD/ADD. Interestingly, about 25-35% of students characterized with ADHD/ADD also have dyslexia (Fletcher, 2017). Other comorbidities such as math difficulties or difficulties with written expression can occur.

We also know that there is a unique "neural signature" for people who have reading difficulties compared to those who do not. In normally developing readers three areas in the left hemisphere of the brain are linked together for reading words. Figure 1 below, from functional Magnetic Resonance Imaging (fMRI), shows a clear distinction between the brain activation patterns in dyslexic readers and non-dyslexic readers. The dyslexic brain image on the left shows under-activation in the posterior portions of the brain as compared to the non-dyslexic brain on the right. The areas in blue and green in the figure are automatic and unconscious processes related to hearing sounds and visually identifying spelling patterns while the area in the frontal region is responsible for more strategic and conscious thinking related to reading. The dyslexic brain relies more on these strategic and conscious processes rather than on the automatic processes in the back of the brain, causing reading to be laborious and slow. In addition, in the dyslexic brain, there is more activation in the pre-frontal right hemisphere of the brain (which is part of the brain's memory network) that is linked to the green area in the left hemisphere — the Left Occipito-Temporal region (Shaywitz, 2006). In the non-dyslexic brain there is much less connection between this automatic area in the left rear of the brain and the memory network.

Figure 1. Differences in Brain Activation Patterns

BRAIN PATTERNS THAT DYSLEXIC STUDENTS MAY SHOW

BRAIN PATTERNS THAT NON-DYSLEXIC STUDENTS MAY SHOW

● **LEFT FRONTAL REGION:** Important for compensation

● **LEFT TEMPORO-PARIETAL REGION:** Important for phonological processing and grapheme-phoneme association

● **LEFT OCCIPITO-TEMPORAL REGION:** Important for orthographic processing

Developed by and used with permission from Fumiko Hoeft, Ph.D.

What is exciting is that these dyslexic neural patterns usually will change after intervention is provided and look similar to students who do not have dyslexia (Barquero, Davis, & Cutting, 2014). In other words, effective teachers can actually alter a child's brain patterns with appropriate instruction.

We know that reading disabilities such as dyslexia can be hereditary. As defined above, dyslexia is regarded as a neurobiological condition that is genetic in origin. This means that individuals can inherit this condition from a parent. In fact, it can occur in "up to 50% of individuals who have a first degree relative with dyslexia" (Gaab, 2017). It is common for a dyslexic child to have an immediate family member who has had reading difficulties and in some cases two or more children in a family can have dyslexia. Also while we don't know precisely how many people have dyslexia, estimates range between 5-15% depending on the study. Generally, about 13-14% of the student population qualifies for special education and of this group about 85% have a primary learning disability in reading and language processing (IDA, 2012).

What We Know About Learning to Read, Prevention and Intervention
Automaticity and Orthographic Mapping

In order to read fluently readers need to be automatic at recalling the words on the page. Words read automatically are considered part of a reader's sight vocabulary. This sight vocabulary is effortless and considered "pre-cognitive," meaning that one is invariably forced to read a "sight" word if it is presented visually. This pre-cognitive phenomenon is exemplified by the "Stroop Effect" where a color word, e.g., "purple" is visually presented but is written in a non-purple color. The idea is to name the color of the text, not the word, but because the word "purple" is read automatically, it interferes with the ability to name the correct color of the text. For example, try to quickly name the following text colors, not the words: **Brown Black Blue Green**.

Notice that naming the color of the text is somewhat difficult since the color words are automatically read and slows down your ability to name the color. You are forced to read a word that is automatic, or that is in your sight vocabulary. This automatic recognition of the word dominates everything else — this is what is meant by "pre-cognitive." This pre-cognitive phenomenon demonstrates that, although our brains are not biologically wired to read, we can learn to read and our brains adapt to doing so. But for some this adaptation of the brain to become automatic does not occur easily.

Students need to have a large storage of words that are part of their sight vocabulary to be automatic and fluent readers. For students with reading difficulties, this automaticity with words is compromised so they are less able to develop a large bank of sight words. Typically developing readers from second grade on require one to four exposures to a word to become automatic (Kilpatrick, 2015), but readers who are struggling may require up to 20 or even more exposures to a word before it becomes automatic. Therefore, it is easy to understand how struggling readers can take longer to develop a large sight word vocabulary which then impedes their word reading development.

Based on an extensive research review in his book, *Essentials of Assessing, Preventing and Overcoming Reading Difficulties,* Kilpatrick (2015) posits that this sight word learning or orthographic mapping is the "holy grail" of reading education and is at the core of reading difficulties. Linnea Ehri and

others have been researching orthographic mapping for several decades. Ehri states, "Orthographic mapping involves the formation of letter-sound connections to bond the spellings, pronunciations, and meanings of specific words in memory. It explains how children learn to read words by sight, to spell words from memory, and to acquire vocabulary words from print" (Ehri, 2014). Kilpatrick describes further orthographic mapping:

> …the mental process readers use to store written words for later, instant retrieval. Orthographic mapping explains how students turn unfamiliar words into instantly accessible sight words, with no sounding out or guessing. This is something that weak readers do very poorly, and as a result, they have limited sight vocabularies and limited reading fluency. Orthographic mapping represents a very important part of reading acquisition and should guide curricular decisions, evaluation practices, and intervention approaches (p. 18).

In other words, orthographic mapping is successful when a word has been decoded enough times that it becomes a word recognized by sight. Dr. Kilpatrick refers to these as "sight words."

For additional information regarding Linnea Ehri's research and her phases of word recognition development, refer to CORE's *Teaching Reading Sourcebook* pp. 163-167 (Honig, Diamond, & Gutlohn, 2003). Orthographic mapping is occurring as students enter into Ehri's consolidated phase.

Kilpatrick contends that supporting students' full orthographic mapping is the key to proficient reading. In typically developing readers who have a solid phonological awareness base that continues to naturally develop as they become more proficient readers, orthographic mapping seems to occur relatively easily and naturally with reading practice. However, weak readers who do not have a solid phonological awareness base do not develop more advanced phonological skill even if they have been remediated in Kindergarten or first grade to achieve improved decoding skills. Thus, orthographic mapping is challenging for them.

How is orthographic mapping developed in weak readers? Advanced phonological awareness that involves the ability to manipulate phonemes (phoneme substitution, phoneme deletion, and reversing phonemes) seems to be an important underpinning for successful orthographic mapping. Page 119 of CORE's *Teaching Reading Sourcebook* provides an overview of phonological skills by level with examples. An example of phoneme deletion is: what is spark without the /s/ (park). An example of phoneme substitution is: replace the last sound, /g/, in rug with /n/ (run).

The intervention research indicates that weak readers need direct training in these advanced phonological manipulation skills to improve orthographic mapping. Phonological oral blending and segmenting training is not enough for weak readers, especially those in second grade and beyond.

Word Reading Development
In his book, Kilpatrick lays out a correspondence table between Phonological Skill Development and Word Reading Development. This correspondence helps educators to think about various levels of phonological awareness and how they correlate to levels of word reading development —learning letters and sounds, learning how to decode using phonics, and becoming automatic with words, what

Kilpatrick and others refer to as orthographic mapping. This paper replicates Kilpatrick's table (Figure 1), but takes this table a step further by correlating these two categories to Ehri's Phases of Word Reading Development referenced above. Each of Ehri's Phases are briefly described in parentheses in the corresponding column.

Figure 2: Word Reading Development

Phonological Skill Development	Word Reading Development	Ehri's Phases of Word Reading Development
Early Phonological Awareness • *Rhyming, alliteration, first sounds*	Letters and Sounds • *Requires simple phonology to learn sounds*	• Partial Alphabetic *(knows some letters and sounds)*
Basic Phonemic Awareness • *Blending and segmentation*	Phonic Decoding • *Requires letter sounds and blending*	• Partial Alphabetic • Full Alphabetic *(extensive knowledge of letters and sounds)* • Consolidated Alphabetic *(reads larger chunks in words)*
Advanced Phonemic Awareness • *Deletion, addition, substitution*	Orthographic Mapping • *Requires letter sound skills and advanced phoneme awareness*	• Consolidated Alphabetic • Automatic *(building an extensive sight word vocabulary)*

When considering how Ehri's Phases connect to Kilpatrick's three categories of word reading development and the phonological awareness levels, it is important to note that there is not a one-to-one mapping to those phases as they overlap, in particular, with phonic decoding. In addition, as students are recognizing larger chunks in words, they have entered the consolidation phase which is leading to full orthographic mapping. Students experiencing reading difficulty often get stuck in the phonic decoding level (partial or full alphabetic phases) and don't move easily into the orthographic level (automatic phase).

What Needs to Happen

Even though we have known about the causes and the treatment for those with reading difficulties and dyslexia for over 20 years, we don't seem to agree on a common set of practices for addressing reading instruction, prevention, and reading intervention in our nation's schools. Policies and programs from state to state are inconsistent which contribute to this problem.

Early Screening is critical.
Since dyslexia is a neurobiological disorder and brain plasticity decreases through childhood, it takes four times as long to intervene in fourth grade as it does in late kindergarten (Lyon & Fletcher, 2001). In addition, because of the increase in content for students to learn as they grow older, it makes it very challenging for children to catch up. Thus, universal screening is critical during the K-2 grade span to identify those who need early intervention to "catch them before they fall" (Torgesen, 1998).

A recent publication on universal screening by the International Dyslexia Association (2017) suggests the following about screening measures in Kindergarten and grade one. Kindergarten screening measures should include phonological awareness including phoneme segmentation, blending, onset and rime; rapid automized naming, including letter naming fluency; letter sound association; and phonological memory, including non-word repetition (Catts, et al. 2015; Jenkins & Johnson, 2008). First-grade screening measures should include phoneme awareness, specifically phoneme segmentation, blending, and manipulation tasks; letter naming fluency; letter sound association; phonological memory, including nonword repetition; oral vocabulary; and word recognition fluency (i.e., accuracy and rate) (Compton, et al., 2010; Jenkins & Johnson, 2008). The IDA also suggested that starting in mid-first grade, oral passage reading can also be included to begin checking for fluency. It is important to reiterate the above, that starting in first grade, phoneme manipulation tasks such as deletion and substitution are important to include in assessment. (See previous example). Kilpatrick reinforces this research by suggesting that phonological and phonemic awareness measures must include deletion and substitution tasks (phoneme manipulation) to measure advanced level phonological/phoneme awareness. He argues that our current practice of assessing only the basic levels of phonemic awareness of blending and segmenting is insufficient for identifying many of the students with weaker phonological awareness. Numerous research reports include data to show that from first grade onward, manipulation tasks display higher correlations with reading measures than segmentation tasks. Segmentation tasks correlate with reading at .29-.50, whereas deletion tasks correlate at .50-.70. Thus, Kilpatrick argues that, "Phonological manipulation tasks are more sensitive to reading development than other phonological awareness tasks. This is likely because one must be able to use the skills tapped by those other tasks (i.e., segmentation, isolation, and blending) to respond correctly to phonological manipulation tasks" (p. 179). With this knowledge of assessing advanced levels of phoneme awareness, i.e., phoneme manipulation tasks of deletion and substitution, and using diagnostic assessments such as the CORE Phonics Survey found in *Assessing Reading: Multiple Measures,* targeted and early intervention is the next step to helping students.

Effective Tier 1 Instruction and Early Intervention is key.
Effective Tier 1 reading/language arts instruction should be comprehensive in nature and address all five components of reading (phonological awareness, phonics, fluency, vocabulary, and comprehension) as well as spelling, handwriting, grammar, and writing to address comprehensive reading/ language arts instruction. It is critical for all students in all grades, but especially in K-2 to have a devoted time to specific word instruction to further their vocabulary development. During the early grades of Kindergarten and first grade when children's listening vocabulary is much higher than their reading vocabulary (the words they can read independently), vocabulary development and listening comprehension instruction can be incorporated into read-alouds using high quality literature and non-fiction text. This parallel vocabulary/comprehension strand uses text that is one to two grade levels above the students' grade level. Having this parallel strand is critical to further children's language skills while they are learning the foundational skills of decoding where children are reading simple but progressively more advanced decodable text. As children become independent readers in the latter part of grade 1 and beyond, they should have opportunities to read widely in and out of school to build vocabulary as well as build fluency. However, students should still continue to receive specific word instruction and be taught word learning strategies that develop the more complex morphological

layer of the English language, e.g., prefixes, suffixes, and Greek and Latin roots. Effective vocabulary instruction and language development practices are summarized in CORE's *Teaching Reading Sourcebook* and other publications such as Beck, Kucan, and McKeown's *Bringing Words to Life* (2013) and Biemiller's *Words Worth Teaching* (2010).

Effective foundational skills instruction includes systematic and explicit phonics instruction that uses a six-step process which is thoroughly described on p. 175 of CORE's *Teaching Reading Sourcebook:* 1) Develop phonemic awareness; 2) Introduce sound-spelling; 3) Blend words; 4) Build automatic word recognition; 5) Apply to decodable text; 6) Word work for decoding and encoding. Using high quality instructional materials aligned to the research base that has a planned scope and sequence is key for effective delivery of these foundational skills.

For students who are still experiencing difficulty at the word reading level as measured by screening and diagnostic assessments, targeted intervention will be necessary. For Kindergarten it will be important for students who are experiencing difficulty with learning letter names and/or phonological awareness to start receiving targeted intervention that addresses these areas for about 15 minutes per day, four to five times per week no later than mid-year. From first grade through middle school, using an evidence-based intervention program that develops phonemic awareness to the advanced level (deletion/substitution), reviews and practices sound-spellings taught in Tier 1, provides additional opportunities to practice blending words with those sound-spellings, and provides more opportunities to do "massive amounts" of reading in connected text will be critical for students to develop the needed orthographic mapping skills. An important caveat is that as students who are experiencing difficulties progress into third grade and up the vocabulary and reading comprehension gap they are experiencing will continue to widen. Therefore, it is important for elementary and secondary students receiving intervention to also receive targeted instruction in vocabulary and language to accelerate their comprehension abilities.

Conclusion

Unless our system of education commits to using research-based approaches for early assessment, and research-based instruction for prevention and intervention for reading difficulties and is able to scale up these approaches in every school district throughout the country, we will continue to have too many students in the upper elementary and secondary schools who fall behind and have difficulty catching up. For those children who are not reading independently by the end of first grade, they will suffer a huge experiential gap over time compared to children who have learned to read by the end of first grade. The evidence is clear, we can help kids in all grades improve their word reading accuracy, but it is much harder to improve their fluency once this experiential gap starts to intensify beyond grade 1. This gap has been coined the Matthew Effect, where those who learn to read early and well continue to get better at reading because they are reading. For those who do not learn to read early and well, they do not like reading thus they do not read. We have not a moment to waste.

The Approach of the Consortium on Reaching Excellence in Education

For over 20 years, CORE has provided technical assistance and professional development to the most vulnerable schools in America. CORE's model rests on the research on effective professional learning that fosters durable implementation. CORE's approach builds knowledge and skills through well-structured courses and site-based coaching, modeling, and mentoring. CORE's Reading Academies (Elementary and Adolescent) and other ELA trainings blend theoretical and practical knowledge with hands on practice, video models, collaborative discussions, reflection, readings, simulations, modeling and feedback from an expert — the hallmarks of quality professional learning. CORE's typical implementation model emphasizes ongoing job-embedded coaching to implement evidence-based instructional techniques in the classroom. Coaching teachers on implementing effective reading instruction and intervention practices in the classroom through collaboration, observation and reflection, and model lessons are part of the extensive professional learning services provided by CORE.

ABOUT THE AUTHOR

Dr. Dale Webster is CORE's Chief Academic Officer. Dale has served on the California Curriculum Commission, an advisory body to the California State Board of Education on curriculum frameworks and textbook adoptions, as well as numerous other state and local educational panels. He is a board member of the San Diego branch of the International Dyslexia Association.

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