Revista Iberoamericana de Neuropsicología, Vol. 8, No. 1: 24-38, enero-junio, 2025.

The Neuropsychology of Reading Disorders: A Global Perspective on Literacy

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INTRODUCTION

Imagine being a professional educator some 200 years ago, when the literacy rate across the globe was a mere 12% and compulsory education had not yet come to fruition. Needless to say, business was not exactly robust in our nations' public-school systems. Furthermore, the thought of diagnosing a student with a reading disability and recommending special education services in a non-literate world simply defied all aspects of logic. The fundamental tenets of compulsory education did not formally begin in the United States until 1837 when a lawyer by trade, Horace Mann, overhauled the public education system in Massachusetts, and established a series of schools to train teachers. There were six overarching principles that Mann proposed for public education that continue to serve as its core foundational principles[1]:

1) citizens cannot maintain both ignorance and freedom,
2) education should be paid for, controlled and maintained by the public,
3) education should embrace children from varying backgrounds,
4) education must be nonsectarian,
5) education should be taught using tenets of a free society,
6) education should be provided by well-trained, professional teachers.

These educational tenets provided the foundational infrastructure for the eventual creation of the National Educational Association some 100 years ago. The National Education Association was established using federal funds to finance public schools, and mandated formal educational training for all children. At that time, the world's literacy rate had risen to just a shade over 30 percent, with some parts of the United States boasting a 70 percent literacy rate (See Figure 1). A tangible question soon emerged: What exactly is literacy?

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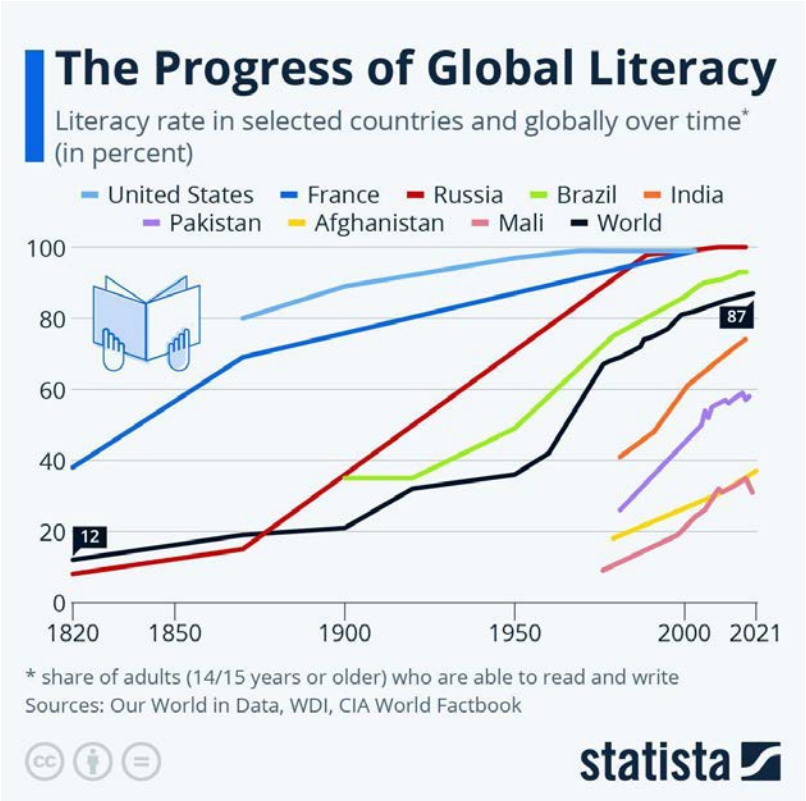

Figure 1. The Progress of Global Literacy

Literacy is a slippery concept, and not as straightforward to quantify when examining reading proficiency across cultures. According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO)[2], literacy can be defined as:

"*Literacy is a continuum of learning and proficiency in reading, writing and using numbers throughout life and is part of a larger set of skills, which include digital skills, media literacy, education for sustainable development and global citizenship as well as job-specific skills.*"

From the aforementioned definition, it is readily apparent that the term "literacy" is both expansive, in that it refers to all learned skills and not just reading, and relative, in that it is predicated on having the pre-requisite knowledge to independently navigate the ever-changing attributes of a given society. The United States currently boasts a 79 percent literacy rate, which is below the global literacy rate of 86 percent[3]. While this may seem rather disconcerting, the fact remains many countries do not report their literacy every year, and many countries have mismatched definitions as to what qualifies as literacy. Furthermore, the United States is a highly technical and sophisticated society thereby having a much higher bar or threshold as to what constitutes literacy to meet the burgeoning demands of the culture. Perhaps a more meaningful statistic to quantify literacy acquisition is to focus solely on a particular academic skill; reading, and the quantitative measurement of that skill according to a predetermined set of curriculum standards. When redefining this argument by utilizing grade-level standards as the metric of choice for evaluating literacy, reading proficiency remains rather disconcerting since 54 percent of U.S. adults are reading below a 6th grade level standard[4], or what is also considered a Level 1 literacy level.

According to the National Center for Educational Statistics (2022)[5] reading rates have remained relatively stagnant over the past 25 years in U.S. schools and recently has shown a substantial regression due in part to the pandemic. In the Spring of 2020, all public schools in the United States closed as a result of the COVID pandemic, along with schools from 169 other countries affecting the educational development of nearly 1.5 billion students globally[6]. In fact, many schools operated in virtual or hybrid models across much of the following school year as well. With respect to reading and literacy, virtual learning was not a terribly effective alternative as general reading scores in most school districts plummeted. Specifically, there were considerable declines in test scores in larger school districts relying upon virtual learning, with inequity in outcomes as Black and Hispanic students were disproportionately impacted[7]. In summary, nearly 50 million U.S. public school students had their education and continuity of learning disrupted as educational institutions scrambled to deploy an alternative model of instruction that was both safe and effective.

The National Assessment of Educational Progress (NAEP) is commissioned by the National Center of Educational Statistics (NCES) to assess academic literacy every two years on reading achievement. The NAEP uses a carefully designed sampling procedure that best represents the geographical, racial, ethnic, and socioeconomic diversity of the schools in the United States. The results from the 2022 post-pandemic reading assessments[5] were based on a massive sample of 108,200 fourth graders from 5,780 schools and 111,300 eighth graders from 5,190 schools. The reading assessment itself measured reading comprehension skills using both literary and informational texts. The test results revealed the largest drop in reading scores seen in decades as determined by the declining number of students considered to be *proficient* readers in Grades 4 and 8 (see Figure 2). In fact, reading score deficits were noted in 43 states when compared to pre-pandemic reading levels from 2019. This finding was fairly consistent with learning loss estimates across the globe of approximately 33 percent of a standard deviation, equivalent to more than a year of schooling[8].

In perhaps the largest study conducted to date examining the impact of the pandemic on student achievement, Kuhfeld and colleagues[9] assessed reading test scores from nearly 5 million students in grades 3-8, and noted that students of color attending high-poverty elementary schools saw the largest test declines in reading. Furthermore, within high-poverty schools, elementary grade students showed larger achievement declines than secondary students, but in relatively low-poverty schools achievement declines were similar across all grades. In summary, the decline in reading test scores in high-poverty elementary schools was approximately 2.5 times larger than in low-poverty elementary schools.

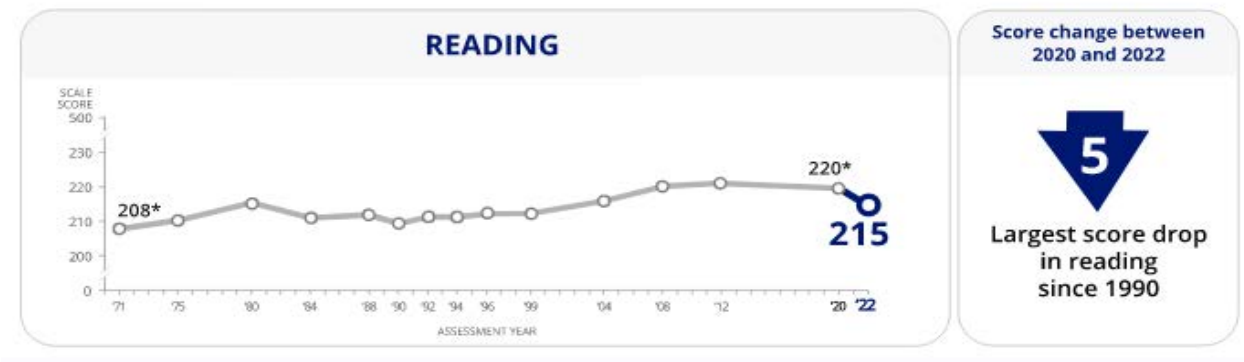

Figure 2. U.S. Literacy Rates Among Fourth-Grade Students
Note. Approximately 35% of fourth-grade students demonstrated reading proficiency across challenging subject matter. From the National Assessment of Educational Progress, by the U.S. Department of Education, the Institute of Education Sciences, & the National Center for Education Statistics, 2022. Reprinted with permission.

Taken together, these results suggest that younger students in poverty were most impacted by disruptions in their reading achievement due to the pandemic. This may have been due to a multitude of factors including of lack of internet access for consistent virtual learning, fewer books in the home environment, or an inability to afford tutors or educational surrogates. However, the seeds of reading and literacy acquisition are planted well before 3rd grade, as the developmental journey to acquire reading readiness skills begins by stimulating brain circuits sensitive to language development beginning in infancy. No matter the language, there is a universal reading brain with targeted pathways dedicated to convert graphemes to phonemes in an automatic fashion to facilitate the literacy process for all children[10].

A Universal Reading Brain

Literacy acquisition in children is a byproduct of how speech sounds in a specific language (i.e., phonemes) are represented or mapped out orthographically to a writing system. This is not a simple task, as there are a multitude of moving parts to the process. First, the number of different phonemes differ greatly among languages (see Table 1). For instance, English has some 44 distinct phonemes, Italian has 30 distinct phonemes, and Japanese has a mere 22 phonemes comprising the language. Second, not only do phonemes differ among languages, but also orthographic writing systems representing these phonemes vary widely as well. For instance, the English language has 26 letters that can be combined using nearly 1,100 different grapheme representations[11], whereas Mandarin Chinese has nearly 7,000 characters or logograms used to represent syllables, not individual sounds, in the language. Lastly, some languages such as Arabic and Hebrew are both written and read in a right-to-left fashion, while other languages are more traditional in their left-to-right presentation. Nevertheless, the brain has developed a common network of neural structures in order to guide reading acquisition in children of any language. According to Rueckl and colleagues[12] no matter the sound or syllable structure of the language, and no matter the type of symbol system used, phonological and orthographical processing systems ultimately converge toward a common network of neural structures that support the acquisition of literacy skills (see Figure 3).

Using Neuropsychology to Identify Reading Disorders

The National Association of School Psychologists' (NASP) most recent position paper on what constitutes a specific learning disability[13] has been supported by both the National Joint Committee on Learning Disabilities as well as the International Academy for Research in Learning Disabilities. Included are a number of statements issued regarding how specific learning disabilities should be conceptualized by school psychologists, as well as their fundamental nature. First and foremost, specific learning disabilities are a manifestation of cognitive processing deficits interfering with the acquisition of one or more academic skills. A brief synopsis of some key points of the NASP position paper highlights the importance of neuropsychology in the identification of a specific learning disability:

NASP Position Statement on Specific Learning Disabilities

- SLDs are endogenous in nature and are characterized by **neurologically** based deficits in cognitive processes, particularly in reading.
- These **cognitive processing deficits** are specific and interfere with the acquisition of one or more academic skills.
- SLDs are **heterogeneous**—there are various **types** of learning disabilities, and there is no single defining academic or cognitive deficit or characteristic common to all subtypes of SLDs.
- SLDs occur in **all** cultures and nations in the world.
- SLDs may **coexist** with other disabling conditions *(e.g., speech or language impairment, attention deficit hyperactivity disorder, and other behavior problems*), but they are not primarily caused by these conditions.
- SLD remains the largest category of educational disability, with the majority (**80%**) have a disability in reading.

Table 1. Number of Phonemes Per Language (10)

Language	Consonants	Vowels	Total Phonemes
1. Lithuanian	47	12	59
2. Danish	20	32	52
3. Hindustani	37	11	48
4. Welsh	31	14	45
5. German	25	20	45
6. Belarusian	39	6	45
7. Norwegian	25	19	44
8. Irish Gaelic	33	11	44
9. Bulgarian	36	8	44
10. Hungarian	27	14	41
11. Ukranian	34	6	40
12. Russian	34	6	40
13. Slovak	29	10	39
14. Latvian	27	12	39
15. French	22	17	39
16. Estonian	30	9	39
17. Dutch	23	16	39
18. Icelandic	22	16	38
19. Portuguese	23	14	37
20. Polish	31	6	37
21. Czech	27	10	37
22. Albanian	30	7	37
23. English*	24	12	36
24. Catalan	28	8	36
25. Swedish	18	17	35
26. Mandarin	26	9	35
27. Finnish	18	16	34
28. Arabic	28	6	34
29. Hausa	24	10	34
30. Esperanto	27	5	32
31. Persian	26	6	32
32. Turkish	23	8	31
33. Serbo-Croatian	25	5	30
34. Italian	23	7	30
35. Basque	24	6	30
36. Romanian	22	7	29
37. Galician	19	7	26
38. Spanish	20	5	25
39. Greek	18	5	23
40. Japanese	17	5	22

Note. *English has 44 phonemes including 19 vowel sounds when including r-controlled vowels and diphthongs.

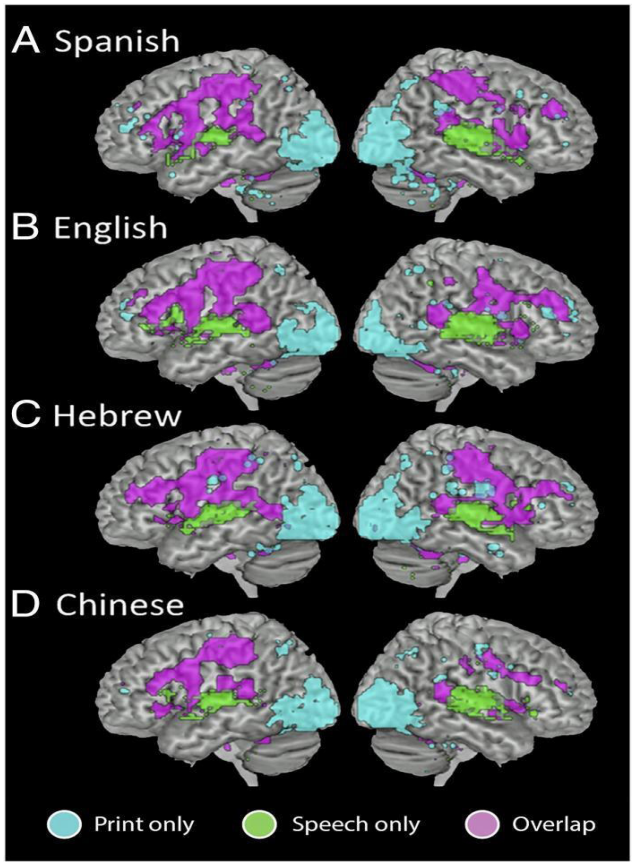

Figure 3. A Universal Reading Brain

Note. There is a common brain signature of reading proficiency and speech to print convergence across a wide spectrum of selected languages, whether the writing system is alphabetic (English) or logographic (Mandarin Chinese), whether it is opaque (English) or transparent (Spanish), and regardless of the phonological and morphological structure it represents. From "Universal Brain Signature of Proficient Reading: Evidence from Four Contrasting Languages," by J. G. Rueckl, P. M. Paz-Alonso, P. M., P. J. Molfese, W. Kuo, A. Bick, S. J. Frost, R. Hancock, D. H. Wu, W. E. Mencl, J. A. Dunabeitia, J. Lee, M. Oliver, J. D. Zevin, F. Hoeft, M. Carreiras, O. J. L. Tzend, K. R. Pugh, & R. Frost, R., 2015, Proceedings of the National Academic of Sciences, 112(50), p. 1-6. Reprinted with permission.

The literature is strife with classification schemes regarding the nature of learning disabilities in children, but with respect to reading disorders and developmental dyslexia, there is emerging consensus that dyslexia emanates from processing deficits in the brain. In a systematic literature review of more than 6000 articles, Yang and colleagues[14] utilized a set of stringent standards to whittle down their meta-analysis to 56 research studies to establish a worldwide prevalence of developmental dyslexia. Their results indicated the prevalence of developmental dyslexia was approximately 7.1% with two noteworthy findings. First, the results of their study noted developmental dyslexia was much more prevalent in boys than girls, which is typically why most special education classes have approximately a 4:1 ratio of males to females. Second, their systematic review of the literature found no significant differences in the prevalence rate of developmental dyslexia between logographic and alphabetic writing systems, or between alphabetic scripts with different orthographic depths[14]. These findings suggest that developmental dyslexia presents as a neurological disorder manifested from the brain's inability to pair graphemes with phonemes, and most likely has a genetic base housed in the Y chromosome given the prevalence rate of the disorder among males across all cultures. Therefore,

Table 2. Cognitive Processes Involved With Reading[10]

Process	Reading Function
Phonemic Awareness	*Identifying, recognizing, categorizing, and manipulating the 44 sounds of the English language.
Phonological Processing	*Connecting the alphabetic code or letter symbol system with its corresponding phonemic code.
Decoding	*The application of phonological processing to accurately sound out the printed word form.
Orthographic Perception	*The ability to accurately detect and recognize the alphabetic code.
Orthographic Processing	* The ability to recognize the printed word form as visual gestalt, or unique whole in order to develop more fluent text recognition skills.
Morphological Processing	* The ability to recognize the printed word form using morphological or semantic cues to facility word recognition.
Fluency	* The rapid and automatic recognition of the printed word form in isolation or in context.
Prosody	* The emotional tone or tenor the author intended for a passage to be read.
Retrieval Fluency	* The speed in which a letter or sound cue can trigger a lexical representation.
Vocabulary of	* The child's semantic knowledge or general fund language development skills.
Working Memory	*The ability to temporarily suspend previously read information with newly acquired information in conscious awareness.
Executive Functioning	* The ability to self-organize and retrieve archived verbal information to facilitate text comprehension.

the role of School Neuropsychology assessment remains essential in differentiating between students with an underlying cognitive processing problem consistent with dyslexia versus those students who are underachieving in reading, but whose cognitive functions remain intact. The key neuropsychological processes underscoring reading are depicted in Table 2[10].

Cognitive neuroscience has greatly facilitated our understanding of the neural underpinnings of literacy, and how to best intervene for children with language-based learning disabilities. Nevertheless, the ability to accurately identify learning disorders in children and provide appropriate intervention strategies remains a challenge given the shortages of professional educators and diagnosticians who provide these invaluable services. According to the National Center for Educational Statistics[15], the number of students receiving special education services in our nation's public schools has increased from 6.4 million to 7.5 million over the past decade, which constitutes approximately 15 percent of total public-school enrollment. Among the 13 federally funded disability categories, approximately 32 percent of all students who receive special education services are found eligible due to a specific learning disability; with 80% having a reading disorder.

Unfortunately, over the past decade the number of special education teachers has decreased by approximately 17 percent, thus impacting the all-important student-teacher ratio in these classrooms. Furthermore, attrition rates among general education teachers in the U.S. have been approximately 8% over the past decade, with teacher shortages being as much as 112,000 per year in 2018 and similar levels thereafter[16]. With more students now eligible for special education services yet fewer qualified instructors to provide those services being available, it is vital school psychologists tailor their assessments toward identifying the cognitive strengths and needs of each student in order to maximize the effectiveness of interventions. In other words, the purpose of a psychological evaluation should not necessarily focus on arbitrary qualification parameters that seemingly change from school district to school district, but rather to determine WHY a student struggles by singling out specific neurocognitive strengths and weaknesses in order to best inform intervention decision making. An understanding of why the student struggles allows educators to better determine WHAT to do about the problem within a specific academic context. Simply put, specificity of assessment leads to specificity of intervention, and specificity begins with appropriate training in School Neuropsychology in order to identify

specific subtypes of dyslexia based upon neuropsychological parameters.

Subtypes of Dyslexia

Developmental dyslexia has an estimated prevalence rate ranging anywhere from 5% to 17% of school aged children[17] depending upon the definition used. Herein lies the problem. What exactly is the definition of developmental dyslexia, and how does this definition differ from a traditional learning disability? Dyslexia has traditionally been defined by the World Health Organization as a neurodevelopmental disorder hindering the acquisition of reading abilities that cannot otherwise be explained by deficits in general intelligence, academic learning opportunities, general motivation, or specific sensory acuity. While concise and well stated, this definition merely entails what dyslexia is not, rather than what it is. Instead, the International Dyslexia Association (IDA)[18] offers a more accurate and comprehensive definition of dyslexia:

"*Dyslexia 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.*"

This definition implies that dyslexia can impact either phonological accuracy, and/or fluent word recognition skills. In other words, some children with dyslexia struggle to consistently identify words accurately and often *"guess"* or substitute a word that may look similar when reading in various contexts. Conversely, other children may perform quite well accurately sounding out each letter or syllable within the printed word form, but do so slowly, dysfluently, and with little emotive tone or prosody. These children lack reading speed and automaticity, and especially struggle reading phonologically irregular words where letter sounds cannot be readily combined *(i.e. "onion", "debt", etc..)*. Therefore, by definition, there are different kinds of dyslexia that hinders either reading speed, reading accuracy, or a combination of both with respect to word identification skills.

Conversely, dyslexia *does not* directly entail reading comprehension deficits per se, though if a student struggles with word identification skills, then quite naturally there will be a downstream impact on reading comprehension. Suffice to say, students can have a reading disability, though may not necessarily be dyslexic, if they can mechanically read the actual words in a passage but still struggle with text comprehension. In summary, dyslexia is a neurodevelopmental disorder that directly disrupts word identification and fluency skills and should be conceptualized as a subset of a specific reading disability.

From a neuropsychological standpoint, the primary distinction between subtypes of reading disorders and dyslexia is *phonological dyslexia* vs *surface dyslexia*. Phonological dyslexia is associated with a selective deficit in reading accuracy due to poor decoding skills. Surface dyslexia is associated with poor reading speed and difficulty reading irregularly spelled words due to poor orthographic skills. This classification scheme is based upon two separate, though overlapping, routes for reading in the brain: a quicker lexical route highly dependent upon orthographic processing to automatically recognize the printed word, and a slower non-lexical route highly dependent upon phonological cues to stitch together segments of individual words to trigger whole word recognition[19]. It is important to note the phonological route requires the explicit learning of specific letter-sound correspondences according to a prescribed set of rules. This lends itself more to a structured and systematic teaching of phonological processing starting very early in the reading process. Conversely, the lexical route for reading uses orthographic mapping, and tends to be more *implicitly* learned based on word familiarity and individual differences in preferred letter groupings[10]. For instance, the word *"psychology"* cannot be accurately decoded by combining individual letter sounds. In order to recognize the word, the

student would have previously encountered the word in context, and learned to associate unique letter groupings *(i.e. "psych"* or *"psy")* with the actual word. Therefore, *phonemic proficiency* is very important in developing orthographic skills to recognize certain sounds, even if these sounds do not follow traditional letter-sound patterns[20]. Based upon this delineation, the following reading disorders' subtypes are offered:

Dysphonetic Dyslexia

The first reading disorders' subtype is termed *dysphonetic dyslexia* and is characterized by a student's inability to utilize a phonological route to successfully bridge letters with sounds. Instead, these readers tend to over rely on visual and orthographic cues to identify words in print. In other words, they guess. Since these readers rarely rely on letter-to-sound conversions, there is a tendency to frequently *guess* on words based upon the initial letter cue. For instance, the word *cat* may be read as "*couch*" or "*corn*" or any other *"c"* word stored in the lexicon. Often times, these students struggle with reading accuracy, as they feebly approach reading by memorizing visual shapes and words, often void of sound-based or phonological cues. In addition, children with poor phonemic awareness do not necessarily perceive sounds as being discrete entities, and have difficulty segmenting and blending bursts of sounds when reading and spelling[21]. In summary, children with poor phonemic awareness and phonological processing skills in the early years have reading difficulties in later years due to inefficient neural mappings between letters and sounds[22].

From a neuropsychological standpoint, the development of phonics can be viewed within a *hierarchical* framework. For instance, Heschl's gyrus, which lies on the superior (top) portion of the temporal lobe and adjacent to Wernicke's area (see Figure 4) makes up the primary auditory cortex in the brain[23]. This region paves the way for phonemic awareness, or the ability to recognize and distinguish among the 44 phonemes comprised in the English language. The primary auditory cortex inclusive of Heschl's Gyrus becomes activated when making core sound distinctions[24].

The next step in the phonological hierarchy involves making the all important letter (grapheme) to sound connection, which lies at the heart of phonological development. This process is usually dependent upon exposure to the books and printed material, along with some form of direct instruction to learn the specific rules that underscore the foundational components of literacy. A key brain region responsible for the integration of speech and print processing is the left superior temporal gyrus[25,26]. In fact, a crucial function of the left superior temporal gyrus is *phoneme synthesis*, which involves the blending of individual sounds together to cue word recognition. According to Randazzo and colleagues[25], *phonemic synthesis* is more of a *"part to whole"* psychological construct and tends to develop before *phonemic analysis*, which involves the segmenting or breaking apart of the visual word form.

Lastly, the ability to disassemble words in a "whole to part" format represents the highest tier or tertiary processing area in the brain as multiple sensory modalities are involved in the spatial manipulation of sounds within the printed word form. The supramarginal gyrus, which lies at the intersection of the temporal (sounds) and parietal (spatial) lobes plays a critical role in determining the spatial positioning of sounds as well as the phonological assembly of words for both reading and spelling skills[27,28,29]. The phonological hierarchy in the brain, from phonemic awareness, to phonemic synthesis, to phonemic analysis is represented in Figure 4.

Surface Dyslexia

The second reading disorders' subtype is termed *surface dyslexia*, and in many respects, is an extension of the dysphonetic dyslexia subtype. Students with surface dyslexia are readily able to sound out individual letter clusters, but lack the ability to automatically and effortlessly recognize words in print. Consequently, they tend to be letter-by-letter and sound-by-sound readers, and often sacrifice speed for accuracy. In fact, these students rely too heavily on the phonological properties of the word and under-appreciate the orthographical or spatial properties of the printed word form.

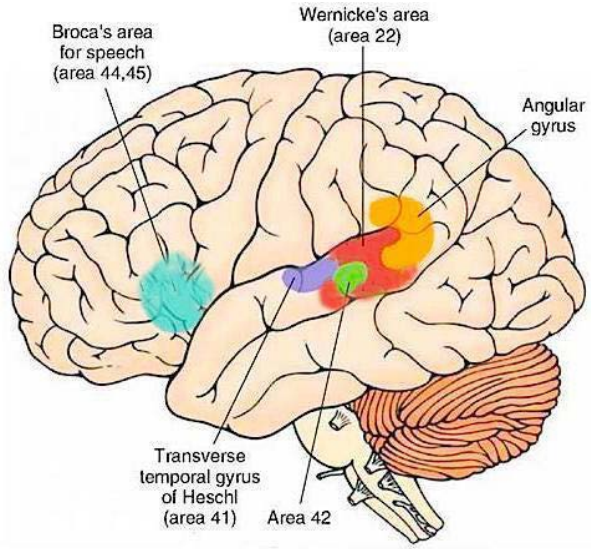

Figure 4. The Phonological Hierarchy

Note. The primary auditory cortex is Heschl's gyrus and functions to decipher the 44 phonemes of the English language. The superior temporal gyrus is a secondary association area that integrates graphemes and phonemes to make the all important sound-symbol connection. The tertiary region of the phonics hierarchy is the supramarginal gyrus which is a heteromodal area that facilitates decoding skills and the spatial arrangement of sounds in words. Deficits in these pathways may lead to Dysphonetic Dyslexia.

Therefore, most words are painstakingly broken down to individual phonemes and read slowly and laboriously. Fluency tends to suffer the most, though phonological processing skills remain relatively intact.

Students with surface dyslexia can readily sound out a word that follows a predictable phonological pattern, such as a consonant-vowel-consonant (CVC) word, if given enough time. Conversely, these students tend to make frequent errors on phonologically irregular words that do not follow a prescribed set of sound-based rules *(i.e., "could", "comb", "surely", etc.)*. Therefore, the primary processing deficit with surface dyslexia is orthographic processing, resulting in difficulty automatically recognizing the printed word form as a holistic entity[30,31].

From a neuropsychological standpoint, surface dyslexia can also be viewed within a *hierarchical* framework based upon specific deficits with text orthography. For instance, some students have difficulty with *orthographical input* impacting their overall letter recognition skills[32]. Deficits with orthographical input is a primary processing deficit, and involves visual perceptual difficulties with letters and words leading to inconsistencies with fluent reading. Once a symbol is recognized as carrying some linguistic value, the information then travels to the visual word form association region of the brain, or fusiform gyrus[33] for *orthographic processing* and rapid recognition of the printed word form.

Mixed Dyslexia

The third reading disorders' subtype is termed *mixed dyslexia,* and constitutes the most severe type of reading disability for students. Generally, these readers have difficulty across the language spectrum and are characterized by a combination of poor phonological processing and poor orthographic processing skills[34]; inconsistent language comprehension skills[35]; slower processing speed and short-term memory deficits[36]; and bizarre error patterns in their reading. Often times, the term *"double-deficit"* hypothesis applies here. Simply put, most students with *mixed dyslexia* have no usable key to successfully unlock the reading code.

Suffice to say, mixed dyslexia is associated with numerous cognitive deficits that can disrupt the natural flow of automatically recognizing words in print. Consequently, most of these students are multiple grade -levels below their peers in reading, and somewhat resistant to conventional types of reading interventions. Furthermore, students with mixed dyslexia often require an Individualized Education Plan (IEP) and specialized instruction that drastically customizes reading programs to help mitigate specific weaknesses. Unfortunately, reading progress with mixed dyslexia tends to be rather slow, with the goal being to develop functional reading skills as opposed to "closing the gap" between these students and their peers. Hence, most interventions should focus on a multifaceted approach to literacy featuring strategies targeting multiple aspects of the reading process. For instance, using multisensory instructional techniques of the Orton Gillingham or Wilson Reading Programs to explicitly teach sounds, coupled with some of the repeated reading techniques of Read Naturally can help to develop both reading accuracy and reading fluency.

Reading Comprehension Deficits

The final reading disorders' subtype is not a dyslexia per se, because it assumes adequate word identification skills, but instead involves deficits with reading comprehension skills. In essence, these readers struggle to derive meaning from print despite adequate reading mechanics. Therefore, reading a social studies chapter about the industrial revolution is not much of a problem, but answering the ten questions in the back of the book becomes a daunting challenge. To help determine the underlying causes for reading comprehension deficits, a thorough assessment of reading should focus on the following cognitive processes. First, there should be an emphasis on examining executive functioning skills, which refers to the strategies students use to self-organize verbal information in order to facilitate retrieval[37]. According to Cutting and colleagues[38], executive functioning includes the capacity to plan, organize, and self-monitor incoming information to better enable text comprehension. The second reason for poor reading comprehension involves deficits with working memory. The longer the information is available in working memory, the greater the mental flexibility to manipulate, store, and slot this information in a manner that facilitates retrieval[6]. Lastly, the final piece of the comprehension puzzle involves language foundation skills, which refers to the breadth and depth of vocabulary words with which a student is familiar, coupled with the ability to understand the syntactical arrangement of words[37].

Assessment

School psychologists should focus their assessments on identifying the strengths and weaknesses of the student in order to develop effective interventions while also understanding the biological, cultural, and social impact on academic skills. By examining specific underlying cognitive processes inherent in literacy and reading, the emergence of **diagnostic achievement tests** prove extremely beneficial. There is much greater ecological validity using diagnostic achievement tests because these measures incorporate specific elements of cognitive processing built directly into the academic skill in question. In other words, clinicians do not necessarily have to administer a stand-alone test of working memory, or stand-alone test of executive functioning, or stand-alone test of phonology, morphology, or orthography skills when all of these constructs can be measured within the framework of reading. This tends to be a more efficient, economical, and practical approach toward assessment. Therefore, by having an assessment measure that is based upon a neurocognitive model of reading, flexible enough to serve as a screening instrument or progress monitoring tool, and serves as a comprehensive diagnostic measure, evaluators can incorporate the most important tenets of a processing strengths and weaknesses (PSW) model with one unitary instrument. With respect to reading, the Feifer Assessment of Reading (FAR) is offered.

Feifer Assessment of Reading (FAR)

The Feifer Assessment of Reading (FAR)[39] is a diagnostic reading test designed to examine the underlying cognitive and linguistic processes that support proficient reading skills. The FAR is unique in that it

helps determine not only the presence of a reading disorder but also the specific dyslexia subtype as well. The FAR is based on a neuropsychological approach to reading, which suggests that multiple neural pathways underscore various aspects of the reading process; therefore, multiple reading pitfalls can emerge. The measure is comprised of 15 individual subtests designed to represent four broad reading disorder subtypes; namely, dysphonetic dyslexia, surface dyslexia, mixed dyslexia, and comprehension deficits. Table 3 provides an overview and description of each FAR subtest along with the approximate administration time.

Lastly, the most important application of the FAR is that it enables clinicians to directly inform intervention decision making. In fact, users of the instrument can directly plug their raw scores into the PAR-IConnect scoring platform and take advantage of the automatic scoring system and integrative report writer feature. A litany of reading recommendations are offered including general reading considerations, lists of targeted reading programs, general reading strategies, and a table of references. Furthermore, the FAR Spanish is currently in development as well to address the early reading needs of second language learners.

Table 3. FAR Index and Subtest Structure[38]

FAR Subtest Description: **Phonological Index**	**Index**	**Grade Range**	**Admin Time**
***PHONEMIC AWARENESS:** A series of four subtests arranged in a hierarchy of increasingly more sophisticated phonemic awareness and processing skills. **a) Rhyming** is a phonemic awareness task requiring the student to determine whether word pairs sound the same or different. **b) Blending** is a phonemic assembly task requiring the student to say the correct word after hearing the word's individual syllables, presented at a rate of 1 syllable per second. **c) Segmenting** is a phonemic analysis task requiring the student to repeat words while simultaneously tapping out each syllable. **d) Manipulation** is a phonemic modification task requiring the student to repeat a spoken word while adding, deleting, or substituting a specified sound within it.	Phonological Index	PK to College	5- 10 minutes
NONSENSE WORD DECODING: Requires the student to decode a series of individual nonsense words arranged by increasing difficulty.	Phonological Index	PK to College	2 minutes
ISOLATED WORD READING FLUENCY: Requires the student to read a list of words, arranged by increasing difficulty according to grade level, in 60 seconds.	Phonological Index	Kindergarten to College	1 minute
ORAL READING FLUENCY: Requires the student to read a passage composed of the words from ISO in 60 seconds. Reading rate and accuracy for target and nontarget words are recorded.	Phonological Index	Kindergarten to College	2-3 minutes
POSITIONING SOUNDS: A phonemic localization task requiring the student to determine the missing sound(s) in an incomplete word printed under a picture.	Phonological Index	PK to College	3-4 minutes
FAR Subtest Description: Fluency Index	**Index**	**Grade Range**	**Admin Time**
***RAPID AUTOMATIC NAMING:** A series of timed tasks requiring the student to name as many different objects or individual letters as possible in 30 seconds. **a) Object naming** requires the student to name familiar objects presented in an array. **b) Letter naming** requires the student to name individual letters presented in an array. **c) Stencil naming** requires the student to name letters from an array of stenciled (partially shaped) letters.	Fluency Index	PK to College	2 minutes

Table 3. FAR Index and Subtest Structure[38]
(continuation)

FAR Subtest Description: Fluency Index	Index	Grade Range	Admin Time
VERBAL FLUENCY: The first trial requires the student to rapidly name items from a particular category in 60 seconds. The second trail requires the student to name items that start with a particular letter in 60 seconds. Scoring is done in 15-second intervals.	Fluency Index	PK to College	2 minutes
VISUAL PERCEPTION: Requires the student to identify the backward letters embedded within an array of letters or from an array of words in 30 seconds.	Fluency Index	PK to College	1 minute
ORTHOGRAPHIC PROCESSING: Requires the student to recall a letter, or group of letters from a previously seen targeted word presented for just 1 second.	Fluency Index	Kindergarten to College	8 minutes
IRREGULAR WORD READING FLUENCY: Requires the student to read a list of phonologically irregular words arranged by increasing difficulty in 60 seconds.	Fluency Index	Grade 2 to College	1 minute
FAR Subtest Description: Comprehension Index	**Index**	**Grade Range**	**Admin Time**
***SEMANTIC CONCEPTS:** A multiple-choice test requiring the student to select the word that is either similar in meaning (synonym) or opposite in meaning (antonym) to a target word.	Comprehension Index	PK to College	5-8 minutes
WORD RECALL: Requires the student to repeat a list of words that are presented at a rate of one word per second. A second trial requires the student to recall only selected words from on the list that fit a particular category.	Comprehension Index	PK to College	4 minutes
PRINT KNOWLEDGE: Requires the student to answer a series of preliteracy questions about a storybook.	Comprehension Index	PK to Grade 1	4 minutes
MORPHOLOGICAL PROCESSING: A multiple-choice test requiring the student to choose the morpheme that best completes an incomplete target word.	Comprehension Index	Grade 2 to College	7 minutes
SILENT READING FLUENCY: Requires the student to silently read a passage and answer a series of literal and inferential questions about the story. Reading rate is also recorded. The student is not allowed to reread the passage when asked the questions.	Comprehension Index	Grade 2 to College	8 minutes

*Denotes a subtest that represents the FAR Screener Form

In summary, given the challenges of meeting the diverse educational needs of all children following a global pandemic, with reading scores down and fewer diagnosticians and educators to provide services, it is imperative that School Neuropsychological principles be the guiding light to more precisely identify and remediate literacy challenges for future generations of learners. Lastly, it is also imperative to have monographs to disseminate contemporary research papers related to School Neuropsychology, in order to better train clinicians in the application of School Neuropsychology to further meet the complex learning challenges of our students.

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