

SUBTYPES OF DEVELOPMENTAL DYSLEXIA

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ABSTRACT

In light of teaching students with dyslexia and other learning difficulties (LD), neuroscientists claim that such deficiencies happen due to a neural base, depending on biological and environmental factors, and experience developing properties and improving reading skills. The research claims two types of dyslexia: developmental (or innate) and deep (or acquired due to brain traumas or diseases). This article researches developmental dyslexia (DD), which may be primary and secondary. DD is divided into two main subtypes: surface and phonological. While reading; our brains must "rewire" neural circuits initially used for other tasks, such as visual and speech processing and attention and cognition. Psycholinguistics investigates the cognitive process of perception, production, and general use of language. This article revises teaching English in light of neuroscience, psycholinguistics, and appropriate methods to train working memory and other ways to overcome DD and its subtypes.

KEYWORDS

developmental dyslexia, neurodiversity, special education, working memory, neuroscience.

1. INTRODUCTION

Educators have always tried to discover why some students do well while others struggle with reading, writing, and decoding; even multiple training only sometimes works [26]. "Do resilient dyslexics have distinct brain structures that allow for better resiliency or is their success in reading a result of compensation strategies that altered the density of neurons in a specific region of the brain?" asks Dr. Patael from Tel Aviv University [30]. Scientists scanned young children's brains for MRI to find the answer to this question and tested their reading ability three years later. They found that a higher density of neurons in three-year-old kids indicated their potential abilities to read at an older age.

"Psycholinguistics deals with how language is learned. It is a subdivision of the fields of psychology and linguistics." [2]. The research claims that psycholinguistics today is one of the first scientific areas to talk about the close relationship between language, speech, thinking, and human consciousness. This discipline researches the psychological functions involved in the use of languages, such as language acquisition, general language comprehension, and language production. Therefore, it will help to discover DD and potential learning difficulties (LD). A new scientific approach can help educators to teach students with resilient dyslexia appropriately with the help of neurobiological and psycholinguistic support [19].

This article consists of three chapters. The first one demonstrates the hypotheses of DD and the research done on young children that enables scientists to find out this disorder in very young kids. It explains DD considering neuroscience and psycholinguistics. Neuroscience is a new discipline, and it helps scholars, psychologists, therapists, and remedial teachers understand the sources of DD and other sorts of neurodiversity and find appropriate ways to prevent LD or

overcome them successfully. The second part deals with two main subtypes of DD: phonological and surface, which might be accompanied by dysgraphia, ADHD, and other neurodiversity. The final part is about a methodology that may help educators make students with DD interested in classroom activities and motivated to progress.

2. DEVELOPMENTAL DYSLEXIA IN LIGHT OF NEUROSCIENCE

2.1. Types and Subtypes of Developmental Dyslexia

The term DD was mentioned by W. Pringle Morgan (1896) when he researched a teenager as "word-blind" due to his poor visual memory. Another term, "congenital word blindness," was used until the 1960s, when dyslexia was introduced to encompass developmental reading difficulties [17]. Scientists claimed that reading difficulties were not caused by low intelligence. They found that dyslexia was characterized by unexpected reading difficulty in the face of an average level of IQ and adequate opportunity to learn to read. This 'intelligence discrepancy' definition was stated by the World Federation of Neurology in 1968 [6].

Educators have always tried to discover why some students do well while others struggle with reading, writing, and decoding; even multiple training only sometimes works. "Do resilient dyslexics have distinct brain structures that allow for better resiliency or is their success in reading a result of compensation strategies that altered the density of neurons in a specific region of the brain?" asks Dr. Patael from Tel Aviv University [30]. Scientists scanned young children's brains for MRI to find the answer to this question and tested their reading ability three years later. They found that a higher density of neurons in three-year-old kids indicated their potential abilities to read at an older age.

Dr. Laurie H.C. Philipps & Associates claim that two types of DD, primary and secondary, have different sources. Primary dyslexia is a genetically inherited disorder, meaning one or both parents struggle with reading and learning. Secondary dyslexia comes from problems with brain development during pregnancy. Since primary or secondary dyslexia is present at birth, they are both types of DD [8]. Understanding the causes of dyslexia leads to the "identification of people who have behavioral or emotional or emotional problems at school because they have specific reading and spelling problems." [9].

2.2. Psycholinguistic Approach to Developmental Dyslexia

The research claims that psycholinguistics today is one of the first scientific areas to talk about the close relationship between language, speech, thinking, and human consciousness [14]. This discipline researches the psychological processes involved in language acquisition, comprehension, and production [2]. Therefore, it will help find out potential problems with dyslexia and teach students with resilient dyslexia appropriately with the help of neurobiological and psycholinguistic support. Dyslexia is a reading disorder characterized by difficulty in "decoding" the information received and navigating between the visual form and the sounds of written language. However, some people diagnosed with resilient dyslexia demonstrate high reading comprehension [12].

For the last few years, scientists have tried to find the exact ways to overcome the decoding disorder and extract meaning from texts. Neurologists, psychologists, and teachers in special schools understood this too, and in the 1970s, suggested that dyslexia had a neurological basis. Dyslexia has become a term for a lesser degree of neurological impairment in reading ability in

children. However, the presence of neurological causes in dyslexia has only recently been definitively determined [1].

2.3. Identifying Developmental Dyslexia in Very Young Kids

According to the researchers from Tel Aviv University, the work helped understand the cognitive mechanisms dyslexic children use to cope with texts despite their relative weakness in decoding. The new data could also help invent new strategies for teaching reading. "The poor readers in the study remembered far fewer letters than the age-matched controls, suggesting that they have difficulty temporarily storing verbal information. The people with dyslexia showed less of a phonological confusability effect." [21]. The research suggests new approaches that develop cognitive function and working memory. If a child enters first grade, more than the practice of simply learning the alphabet may be required for him. Games and activities that stimulate working memory can help here. Over time, this will contribute to a better understanding of the text.

The researchers from the University of California examined 55 English-speaking children aged 10-16 with good reading skills. Nearly half of the study participants had dyslexia. The researchers created a simple formula to calculate the difference between participants' reading ability and decoding skills. Next, the scientists scanned the children's brains in MRI and compared the images with the results of the calculations. As a result, it turned out that the area of the brain responsible for executive functions and working memory, the DLPFC of the left hemisphere in "resistant dyslexics," has a large amount of grey matter. [30].

One of the most significant findings in reading learning in recent years is that most interventions to detect and treat dyslexia in schools have come too late. Over the past decade, long-term studies of young children were done in Nadine Gaab's laboratory at Harvard Medical School. Research has shown that the brains of children who subsequently develop dyslexia are already atypical even before when they go to kindergarten. "The functional brain differences exhibited by the children with developmental dyslexia are noteworthy in that the scanner task did not involve reading or the phonological processing of auditory language." [11]. Gaab claims that at three months, children already have the basic infrastructure, thanks to which it is possible to predict their future success in reading. The laboratory team scanned the brains of 140 infants at genetic risk for dyslexia and followed them over time to study changes in their brain structure and function. According to the latest data, 45 of the children tested were already 5 or 6 years old, which allowed the researchers to match their brain scans from infancy to the age they were taught to read [18]. Therefore, while in most cases, dyslexia is evident in kindergarten kids, the differences in brain development may be present even prenatally.

Thus, DD may be diagnosed in babies. It is caused by genetic factors, otherwise due to problems with pregnancy or birth injury [20]. "The main finding from recent studies suggests that reading difficulties (inferior phonological skills) interact with other cognitive skills and environmental factors to produce a continuously increasing risk of dyslexia." [28]. Moreover, "abnormalities in cerebral structure and functioning" also causes other developmental delays [28]. Babies with DD start sitting and walking later, or toddlers do not talk until they are two or older. Usually, they catch up with their peers until they have more severe disorders, such as ADHD, ASD, or mental retardation [7]. With the help of the correct diagnosis, medical treatment, and individual treatment, such as speech therapy, it is possible to help them, and by the age of six, they can start school. Nevertheless, most of them need special education classes.

3. DEVELOPMENTAL AND ITS HETEROGENEITY

3.1. Primary and Secondary Dyslexia and Other Learning Difficulties

People with primary and secondary dyslexia experience various difficulties in any work with printed or written text. Most of them need help recognizing individual symbols and signs (letters or numbers), because of which the meaning of both individual words and entire sentences is distorted or not captured at all. However, in the presence of similar symptoms, dyslexia affects each person differently. Some students experience difficulties in phonological awareness, and some in orthography, which identifies such subtypes of DD as phonological and surface, respectively. The prognosis of success depends not only on teaching and therapy methods but also on the deepness of dyslexia, especially if it is accompanied by other LD, for instance, ADHD, dyscalculia, or dysgraphia [7].

Most often, dyslexia is detected at the age of six or seven, that is, in childhood, when the child has time to go to school and learn to write, read, and count. However, even at an early preschool age, the first signs of dyslexia can be noticed. Thus, in the case of primary dyslexia in the family's history, toddlers may have difficulty learning nursery rhymes and start talking later. Moreover, they mispronounce words and need help with active speaking: their sentences sometimes are long and non-informative [24]. The same signs might identify secondary dyslexia. Kindergarten teachers can notice possible dyslexia when kids have problems with motor skills [20]. "Left-handedness, difficulties with spatial (including right-left) orientation, trouble tying shoelaces, and clumsiness are also associated with dyslexia." [25]

3.2. Surface and Phonological Dyslexia

When preschool children learn to read, they do so through visual or phonological ways. It is time when they know letter names, and "a type of early primitive reading becomes evident" [25]. Therefore, kindergarten teachers can notice kids' strengths and weaknesses. Thus, some may be talented or even gifted in music, art, or math. At the same time, they might have surface or phonological dyslexia or double-deficit dyslexia because giftedness is also neurodiversity [15]. Moreover, sometimes DD combines both subtypes simultaneously [31].

- Surface dyslexia is characterized by orthographic coding skills [22]. The difficulties of assimilation of letters often cause it due to the fuzziness of their perception and the instability of ideas about the visual images of letters. As a result, students need help with whole-word recognition and spelling. They can pronounce words quite well but find it difficult to read words spelled differently. For instance, they make mistakes while reading sight words and irregular verbs. Moreover, they read slowly or avoid reading activities [16].

This reading challenge is caused by optical visual problems or cognitive or neurological disorders [32]. The research claims that students with this subtype of DD struggle with inadequate information processing in the visual, lexical, or direct neural pathways. So, kids with this subtype of DD often practice mirror reading [27]. For instance, they confuse similar letters (b - d, p - q). "Jumping" over lines of printed text is also one of the most common symptoms of perceptual-visual dyslexia.

- Phonological dyslexia is a challenge in matching letters to sounds. That is because the function of the phonemic system is underdeveloped. Children with phonological dyslexia struggle with decoding and have difficulties with phonological awareness. They

understand some words exactly and some approximately – so they often read by guesswork. In this case, kids confuse similar-sounding words, rearrange syllables, and skip letters when reading or saying words that do not exist [28].

Ceron et al. [5] claim that one of the reasons for phonological dyslexia is phonemic hearing disorder. Phonemic hearing is the ability to listen to the sounds that make up speech and distinguish one speech sound from another. Insufficient formation of auditory perception and phonemic hearing can cause incorrect pronunciation of sounds, words, and phrases. Correction of sound shortcomings - pronunciation in children begins with setting an accurate, finely differentiated pronunciation of sound combinations [5]. At the same time, they develop phoneme perception, which "refers to a set of perceptual, acoustic, and linguistic processes to detect, discriminate, categorize, and identify phonemes. Since the analysis of phonemes is one of the first processing steps in language comprehension, deficits may lead to difficulties in the consecutive language processes" [1]. Their correct pronunciation is only possible with a whole perception of phonemes and a clear distinction between them.

3.3. Bilingualism and Phonological Awareness

In conditions of bilingualism (for instance, Hebrew-English), dyslexia is influenced by psychological difficulties, difficulties forming speech, and learning difficulties. English has a non-phonemic spelling system and is entirely different from Hebrew. "The relationship between letters and sounds is not straightforward, i.e., there is no one-to-one correspondence between letters and phonemes." [28]. In bilingualism, it is not a psychological conflict or affective disorder that leads to dyslexia, but rather the features of expressive speech that develop a bilingual environment and are characterized by various disorders: pronunciation disorders, different vocabulary, and grammar, and understanding of speech. Although most Israeli bilingual students speak English well, they still need help with spelling and writing.

As a remedial teacher, I have noticed that students with surface dyslexia try to match sounds to letters and pronounce the word "tennis" as [tinnais], the word "school" as [skhul] or [skhoul]. Most became rather good readers later than those with phonological or double-deficit dyslexia. Hebrew speakers often need help understanding the relation of letters to sounds in English and often need clarification. For instance, if they keep reading [nomki] instead of "monkey" or [mokputer] instead of "computer." They tend to read more and more, but they still need to gain phonological awareness, especially when learning letter combinations and diphthongs. Thus, reading is much more than associating letters with sounds. Mainly it means knowing vocabulary and using it for reading unfamiliar texts by the usual reading rules. "A skilled reader has a huge internal dictionary of stored words. The aspiring reader must use the phonetic code to create his storehouse of words and continue to rely on the phonetic code." [25].

Students often have such accompanying LD as dysgraphia, dyspraxia, dyscalculia, ADHD, and many more. Therefore, remedial teachers cooperate with clinical psychologists and specialists to help such children, especially bilinguals, who have the interference of two languages. For instance, they can confuse Hebrew and English letters while writing or even write in English from right to left, like in Hebrew.

For the last few years, clinical linguistics has practiced a complex neurolinguistic and neuropsychological approach to overcoming dyslexia. In both cases, specialists in this field use such a standard classification of difficulties as one or both subtypes of DD and other LD. Since LD students need special education, they are offered speech-language therapy, nonverbal therapy, and transcranial magnetic stimulation (TMS) to overcome such difficulties [23].

4. EFFECTIVE WAYS OF OVERCOMING DYSLEXIA.

4.1. Methods of Enhancing Receiving Information

The pedagogical impact on children and the correction of impaired functions is carried out in a complex. One of the priority tasks of remedial teachers is the adaptation of students with DD and the construction of education in such a way as to activate the strengths of the child, i.e., help him use everything available ways of receiving information. Working memory techniques are practiced in Israeli schools for special education. Speech therapy, and much more training depending on each student's needs, are also done to help them to achieve the goals set [4].

Information is of great importance peace of mind of the child's family members and his teachers' manifestations and mechanisms of dyslexia, providing measures of psychological support and training power for children with dyslexia (additional time to complete tasks, especially control ones, work with computers, learning through listening - copying texts recorded on audio media) [20]. Therapeutic activities should start immediately after the confirmation of the diagnosis, but the computer lexical character is not limited to purposeful - partly exclusively for overcoming violations of written language. Computerized lessons with self-checking tasks do well because they contribute to "phonological awareness and improvement of reading and spelling minimizing teacher interference." [13].

While teaching students with phonological dyslexia, work on the development of phonemic perception is crucial [16]. Thus, the teacher introduces flashcards with letters and identifies them with sounds. Kids are supposed to remember and say them when the teacher demonstrates the cards again. Later they are supposed to distinguish sounds associated with specific images, then recognize them in words. So, filling in the blanks with missing letters and saying their sounds can help kids with phonological dyslexia. In Israeli schools for special education, teachers practice Hickey methods. They ask students to compare the letters in English and Hebrew and then notice the difference between sounds present in English and do not exist in Hebrew, and vice versa. The next stage is the combination of letters with other letters to form words [29].

4.2. Training Working Memory

Training working memory is crucial while teaching dyslexic students. Working memory is a type of short-term memory. It is a set of processes that allow us to store and temporarily use the information to perform complex cognitive tasks such as understanding speech, reading, applying mathematical abilities, learning, or reasoning [30]. "Interactive multimedia applications increase, motivate and encourage the active role of children by using multi-sensory channels. Multimedia applications allow and reinforce the bimodal presentation of information via visual and auditory channels." [13]. Thus, the forenamed Hickey method deals with the multi-sensory approach. It engages all the senses: hearing, sight, and touch, to reinforce the working memory through all the possible brain channels [29]. In my opinion, it also helps kids with surface dyslexia because it develops decoding skills.

Thanks to working memory, we can correlate new knowledge with previously acquired ones, which enables us to learn and keep information in mind [3]. Working memory is essential for decision-making and the correct functioning of executive functions. Therefore, its impairment is associated with the deregulatory syndrome and various learning disorders such as ADHD and dyslexia or dyscalculia. Many specialists in psychological and pedagogical diagnostics need neuropsychological testing tools that can be used to measure executive functions accurately [7].

5. CONCLUSION

DD is neurodiversity and one of the most common LDs. If a parent has dyslexia, a child has a 50% possibility of inheriting it [10]. Most researchers consider dyslexia as a neuro-phonological deficit [28]. It is generally characterized by a lack of phonological awareness, slow reading, and making errors, such as skipping and confusing sounds and syllables or missing words. Sometimes mirror reading occurs more than typical for Hebrew and Arab speakers due to reading and writing in those languages from right to left. Dyslexia can also manifest in permutations of sounds, jumping from one line to another, and inability to synthesize sound when reading words. So, kids might have phonological or surface dyslexia or even both [31].

Although, dyslexia is detected at the school stage, affecting the reading processes, which ultimately has consequences and interferes with the writing processes. At the same time, the most modern methods enable medical practitioners to discover signs of DD in preschool kids and even babies [21]. As for the types of dyslexia, we can classify them according to their origin or according to the pathways that affect learning time. A child with dyslexia has difficulty synthesizing words [11]. In severe cases, dyslexia is characterized by the inability to read groups of two or three letters, and children read by guessing.

The human brain has executive functions responsible for cognitive processes that help humans read, understand, and learn. Gaab and other scientists at Harvard Medical School claim that the structural framework of the brain is formed before birth and during infancy [11]. Therefore, future reading may be processing that refines the brain framework. Children with dyslexia find it difficult and need neurobiological and psycholinguistic support [6]. Thus, training working memory in very young kids will help them in the future, especially if DD was detected in their infancy period [19].

Kenninson et al. claim that psycholinguistics studies language in the mind because it focuses on the process of language and its relationship with thinking, while neurolinguistics studies language in the brain or the neural function of the language [14]. Using theoretical and neurolinguistic knowledge, remedial educators can help their students to improve their brain functions, which will help them to enhance language acquisition [23]. Being a remedial teacher, I am convinced that the sooner work is started on the prevention of phonemic dyslexia in preschool children, the more meaningful the results will be, and the children will more successfully master the skills of writing while studying at school.

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