

# Dyslexia, Relevant Learning Disabilities and Biological Parameters – An Approach across Languages with Different Orthographies

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**Abstract.** In this paper, there will be an initial attempt to briefly introduce and define dyslexia. Subsequently, learning disabilities accompanying dyslexia will be presented, followed by an analysis of dyslexia on the basis of biological factors such as age and gender. In continuation, dyslexia is examined across languages with different orthographies.

**Keywords:** dyslexia, disorder, learning difficulty, learning disabilities, dysgraphia, dyspraxia, developmental coordination disorder, attention – deficit / hyperactivity disorder, auditory processing disorder, age, gender, alphabetic orthographies, logographic orthographies, transparent writing system, arbitrary writing system.

## DEFINITIONS

Dyslexia is a neurodevelopmental disorder with a probable genetic basis. The core feature of dyslexia is a problem with word decoding, which in turn impacts spelling performance and the development of reading fluency. Thus, dyslexia is considered to be both a spelling and a reading disorder. For many years, dyslexia was conceptualized as a specific reading difficulty affecting children for whom reading achievement was below than expected on the basis of their age and attributed in many cases to a below-than-average intelligence quotient (IQ). However, it is now recognized that dyslexia occurs across the IQ spectrum [1].

The term “dyslexia” is Greek and means “difficulty with reading words.” There are various definitions of dyslexia, ranging from “difficulty with spelling, phonological processing or rapid visual-verbal responding” [2] to “a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling” [3]. It is characterized by “difficulties in phonological awareness, verbal memory and verbal processing speed” [4]. Developmental dyslexia (DD) is defined as a specific deficit in reading acquisition that cannot be accounted for by low IQ, poor educational opportunities or an obvious sensory or neurological damage [5].

## LEARNING DISABILITIES ACCOMPANYING DYSLEXIA

Learning disabilities which accompany the reading disorder of dyslexia are attention – deficit / hyperactivity disorder, dysgraphia, developmental coordination disorder and auditory processing disorder.

Attention-deficit/hyperactivity disorder (ADHD) is a brain disorder marked by an ongoing pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development [6]. About 15% of people with dyslexia also have ADHD and 35% of those with ADHD have dyslexia [7]. Another source suggests that ADHD occurs in 12–24% of all individuals

with dyslexia [8]. Children with ADHD often move more quickly than other children into a state of high agitation or excitement, talk incessantly and loudly, frequently switch from one activity to another without pause, cannot filter out unimportant stimuli, have low self-esteem and often dislike themselves, are often remorseful after behaving 'badly'[9]. This generalized "lack of focus" is found in cases of dyslexia as well. Both individuals diagnosed with dyslexia and individuals diagnosed with ADHD may resort to disruptive behavior to avoid scheduled schoolwork or may have low self-esteem. However, a dyslexic is unlikely to show the symptoms of hyperactivity and impulsiveness that are common in ADHD.

Dysgraphia is a disorder characterized by writing difficulties. More specifically, it is defined as a difficulty in automatically remembering and mastering the sequence of muscle motor movements for writing letters or numbers [10]. Since **handwriting skills require memory** for the movement path for each letter as well as for how letters connect, children with memory and/or attention deficits can have difficulty mastering handwriting skills. Dyslexic children, whose difficulties begin with *speech sound awareness*, typically have difficulty with the fluent and unconscious association of *phonemes* (speech sounds) to *graphemes* (letter symbols). Dyslexic dysgraphia is due to various factors such as difficulty retrieving the visual picture of words required for spelling. In dyslexic dysgraphia, spontaneously written text is illegible when complex. Oral spelling is poor, but drawing and copying of written text are relatively normal.

Dyspraxia, a form of developmental coordination disorder (DCD), is a disorder affecting fine and/or gross motor coordination in children and adults and, possibly, speech. DCD is a lifelong condition and, like dyslexia, might affect participation and functioning of everyday life skills in education, work and employment [11]. Dyspraxia manifests itself in problems in adequately registering, interpreting, organizing and integrating sensory information to produce an efficient response. Children with dyspraxia tend to bump into things and to have trouble with sports. Dyslexic and dyspraxic individuals share common features such as the marked discrepancy between intelligence and academic achievement, the fact that both dyslexia and dyspraxia are probably hereditary, the difference in cognitive style affecting learning, organization and memory, frequent histories of frustration and failure especially at school.

Auditory processing disorder (APD) is a neurological defect that affects how the brain processes spoken language. This makes it difficult for the child to process verbal instructions or even filter background noise in the classroom [12]. It affects almost 5% of school-age children. Children with APD are often distracted by background noise, or may not hear clearly when background noise is present; they may find it difficult to follow spoken instructions and often misinterpret what is said; they have mishearing problems, problems following directions, remembering what they hear, attending to oral messages[12]. Some research indicates that auditory processing skills could be the primary shortfall in dyslexia [13]. It has been suggested that auditory processing deficits adversely affect one's ability to detect and process speech patterns. This results in impaired phonological representations, specifically required for speech perception, which are likely to lead to impaired phonological awareness which in turn may result in the development of reading disorders. To be a successful reader one must have adequate knowledge of, and fast access to the speech sounds (phonemes) corresponding with the letter combinations (graphemes) being read.

## DYSLEXIA ON THE BASIS OF AGE AND GENDER

The existence of dyslexia manifests itself in different ways on the basis of age with regard to language, reading, speaking, writing, social-emotional and other skills. For each of the aforementioned parameters there are common manifestations regardless of age [14], mentioned below. The four age groups described are pre-kindergarten to 2<sup>nd</sup> grade children, 3<sup>rd</sup> grade to 8<sup>th</sup>

grade children, teens, and adults. In the group of adults college students are included. Language, reading and writing signs of dyslexia concern mainly dyslexics' phonological processing, that is, the ability to initially recognize the letters that make up a word, then use them to identify the phonemes, and put them together to make sense of the word. Social-emotional signs of dyslexia concern dyslexics' poor learning performance, boredom and discouragement.

The first two age groups (pre-kindergarten to 2<sup>nd</sup> grade, 3<sup>rd</sup> grade to 8<sup>th</sup> grade) share common language difficulties concerning naming people and objects, pronouncing words correctly and rhyming words [15]. Also, in these first two categories and in teens dyslexia is manifested by difficulties in deviating from the topic of conversation. Dyslexics from 3<sup>rd</sup> grade to 8<sup>th</sup> grade and teens show difficulties speaking smoothly, fluently, accurately, not haltingly and without many filler words [14]. Dyslexics from 3<sup>rd</sup> grade to 8<sup>th</sup> grade, teens and adults have difficulties learning a foreign language [14],[16], distinguishing between words that look or sound alike, understanding humor commonly expressed by non-literal language. Finally, all age groups have problems in understanding verbal instructions or directions [14].

There are also common reading difficulties among dyslexic age groups. Dyslexics of all age groups do not like reading books and may lose their place when reading, often skipping words [17], a fact which might impair comprehension. There is a deficit manifested mainly during the two first age groups, which concerns remembering new vocabulary and printed words [14]. Also, there may be problems in almost all age groups connected with word analysis to figure out unfamiliar words. Also, mostly dyslexics from 3<sup>rd</sup> grade to 8<sup>th</sup> grade and teens seem to take a lot of time to complete reading assignments and spend a lot of time re-reading passages[18].

Moreover, speaking difficulties among dyslexic age groups exist. Dyslexics of all ages speak hesitantly, with pauses [16]. Also, they search for a specific word and end up using vague language, that is, words such as "thing" [16], without naming the object. Also, they confuse words that sound alike and mispronounce long, unfamiliar or complicated words[16].

Additionally, common writing difficulties are manifested among dyslexics. The first two age groups have difficulty writing letters, numbers, and symbols in the correct order. Dyslexics of all ages have difficulties spelling words correctly and consistently, proofreading and correcting work [14], as well as messy handwriting [16],[19]. Dyslexics ranging from school age to adults may find it difficult to express ideas in writing in a logical and organized way [20].

Concerning the social and emotional problems accompanying dyslexia, the majority of dyslexic preschoolers are happy and well adjusted. Their emotional problems begin to develop when early reading instruction does not match their learning style [21]. Dyslexics of the first two age groups may have problems in interpreting non-verbal communication such as body language and tone of voice [14]. Teen and adult dyslexics may have problems with understanding other people's moods and feelings, understanding and responding appropriately to teasing, or with having a realistic knowledge of their social strengths and weaknesses [14]. Dyslexics of 3<sup>rd</sup> grade to 8<sup>th</sup> grade, teens and adults share feelings of anxiety, frustration or withdrawal [19],[22],[23]. Also, dyslexics of all ages have low self-esteem, which may not be immediately visible [16], [19]. Finally, dyslexics ranging from 3<sup>rd</sup> grade to adults have difficulty dealing with peer pressure and embarrassment [14], [20].

Other difficulties among dyslexics of all ages concern mainly the sense of direction and spatial concepts [14]. Also, their performance varies from day to day [19]. Dyslexics ranging from the 3<sup>rd</sup> grade to adults may also find it difficult to apply skills learned in one situation to another situation [14]. Dyslexics varying from the 3<sup>rd</sup> grade to teens may encounter difficulties learning new games and mastering puzzles [14]. Dyslexics ranging from pre-kindergarten to teens have trouble finishing tests on time [16]. Similarly, adult dyslexics may lose track of time or find it difficult to estimate how long a task will take to complete [19].

Dyslexia is at least twice as common among males as it is among females, thus previous neuroanatomy studies have focused heavily on dyslexic males [24]. It is generally agreed that more boys than girls are affected by dyslexia [1]. Sex differences are apparent in that males are

disproportionately represented in reading-disabled populations [10]. However, existing male-based brain models of dyslexia may not apply to dyslexic females. Among males, the results were consistent with previous studies: dyslexics had less gray matter volume in brain areas like the left temporal gyrus, which is involved in language, than their non-dyslexic counterparts [24]. Among females, dyslexics had less gray matter volume in areas like the right parietal lobe, which is involved in sensory and motor processing than their non-dyslexic counterparts. The researchers were surprised to find that, unlike males, there were no differences in the temporal lobe of dyslexic females [24].

## **DYSLEXIA ACROSS LANGUAGES WITH DIFFERENT ORTHOGRAPHIES**

Given that research about dyslexia concerns primarily the English language, it is of great importance to know whether dyslexia is the same across different languages [25]. Neuroimaging studies suggest a universal neurocognitive basis for dyslexia and that differences in reading performance among dyslexics of different countries are due to different orthographies [26], claiming that phonological deficits are very similar for dyslexics in different languages. Contrastively, behavioral studies suggest that the nature and prevalence of dyslexia may differ between the written form of different languages but that there are differences in the severity of written language impairments, due to differences in orthographic consistency [27]. While the initial signs of dyslexia may present differently in different orthographies, the underlying neurological underpinnings are the same, regardless of language.

Alphabetic orthographies use letters and letter clusters to represent phonemes, whereas logographic ones use characters to represent monosyllabic morphemes of the spoken language [28]. In alphabetic orthographies the orthographic depth of a language indicates the degree to which a written language deviates from simple one-to-one grapheme-phoneme correspondence. Dyslexics find languages with transparent phoneme-grapheme correspondence easier than languages with arbitrary phonemic orthography. A language whose writing system has graphemes mapping almost one-to-one onto phonemes is called a transparent writing system (e.g. Spanish, Italian), while a writing system where graphemes have many phonetic interpretations or phonemes have many graphemic interpretations is called an arbitrary (opaque) writing system (e.g. French, English). Dyslexia is an issue of phonemic awareness and converting graphemes to phonemes, so languages with transparent writing systems are the ones whose speakers have relatively low rates of dyslexia because it is easier to convert graphemes to phonemes when there is an almost one-to-one correspondence [29]. An accumulating number of studies suggest that learning to read English is harder than learning to read other European orthographies such as Italian, Spanish, German or Greek [25] because English has a more inconsistent mapping between grapheme and phoneme and consequently a more arbitrary phonemic orthography concerning spelling patterns on syllables, morphemes and letter-sound correspondence. In relevant studies, Italian, English, and French dyslexics performed equally poorly in phonological tasks, but the Italian dyslexics performed better in reading comprehension tasks than did the speakers of languages with opaque (arbitrary) writing systems, showing that while the condition of dyslexia is the same in these three languages, it is more clearly manifested in languages with opaque orthographies [30].

Most of this discussion of dyslexia so far has been focused on languages with alphabetic writing systems, but there are many languages in the world with logographic writing systems, such as Chinese. There is not enough research to give a conclusive answer as to whether dyslexia is a different condition between languages with alphabetic orthographies and languages with logographic orthographies. Since readers of Chinese do not perform a lot of conversion from

graphemes to phonemes because their writing system is non-alphabetic, dyslexia in Chinese is somewhat related to phonological problems, but is more an issue of low levels of activation in the left middle frontal gyrus, where visuospatial and verbal working memory is coordinated [31]. Chinese readers have issues processing the characters before even dealing with phonological processing. Dyslexia in Chinese may also be related to handwriting skills because to learn and memorize characters, Chinese children copy the characters out many times over in school [31].

## CONCLUSIONS

Dyslexia is a learning disability with that has been proven to occur across the IQ spectrum and is characterized by poor word decoding, which in turn influences performance in spelling and the development of reading fluency.

There are conclusions to be drawn as to other learning disabilities accompanying dyslexia. Both individuals diagnosed with dyslexia and individuals diagnosed with ADHD present the symptom of “lack of focus” and similar psychological and study consequences (such as disruptive behavior to avoid scheduled schoolwork) due to these disabilities. Dyslexia is connected with dysgraphia due to the non-fluent and unconscious association of phonemes to graphemes. Dysgraphic individuals find it difficult to retrieve the visual image of words required for spelling, thus dysgraphia is connected with the lack of visual and verbal memory of dyslexics. Dyslexic dysgraphia is a disability combining features of dyslexia and dysgraphia. Moreover, dyslexia and dyspraxia are connected with a difficulty in processing sensory information. Dyspraxic and dyslexic individuals are both characterized by common features such as the discrepancy between one’s intelligence level and academic achievement. Both dyslexia and dyspraxia are probably attributed to heredity, are connected with stories of frustration and low academic performance and with differences in cognitive style influencing memorizing, language, organisation. Finally, auditory processing disorder could be the primary shortfall in dyslexia, because it leads to impaired phonological representations.

Regarding dyslexia and age, dyslexics of all ages share difficulties which have been classified as language, reading, writing, social – emotional and other types of difficulties. For each and every of the aforementioned categories, some difficulties accompanying dyslexia are common among all age groups, others are common among some age groups.

Concerning dyslexia and gender, various research findings indicate that generally males show a higher incidence of dyslexia than females. Brain analysis differences between dyslexic and non-dyslexic males are not similar to brain analysis differences between dyslexic and non-dyslexic females. In addition, it appears likely that there are many females whose dyslexia has not still been adequately recognised because male dyslexic students are more extroverted in expressing their frustration with dyslexia [32] than their female counterparts.

There are some differences in the way dyslexia manifests itself across different languages. With regard to languages with alphabetic orthographies, dyslexics find languages with transparent phoneme-grapheme correspondence easier than those with arbitrary phonemic orthography. The issue arising from the comparison of dyslexia between languages with alphabetic orthographies and languages with logographic orthographies is if dyslexia is a different condition in each case. Not enough research has been done yet to give a confident answer to this interesting issue.

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