Chapter # 7

COMPARISON OF VISUAL AND PHONOLOGICAL SKILLS IN DYSLEXIA SUBTYPES: CLINICAL AND EDUCATIONAL IMPACTS

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ABSTRACT
The objectives of this study were to characterize and compare the visual, phonological and mixed subtypes of schoolchildren with an interdisciplinary diagnosis of developmental dyslexia. A total of 122 schoolchildren, aged between 8 years and 11 years and 11 months, from the 3rd to 5th year of Elementary School I in the public network, divided into groups, being GI (61 schoolchildren with an interdisciplinary diagnosis of dyslexia); and GII (61 schoolchildren with good academic performance), paired with GI in relation to the school year. All were submitted to Phonological Skills and Visual Perception Assessments. Factors were created for profile classification for GI, with dyslexics separated into phonological, visual and mixed profiles. The results indicated that there was significance for all comparisons between GI and GII. There was a significant difference between the GV and GPH groups; GPH and GM groups and Between GV and GM. The findings of this study allow us to conclude that schoolchildren with dyslexia can present visual defects regardless of the phonological one. These findings have clinical and educational implications.

Keywords: phonological awareness, visual perception, learning, education, educational measurement.

1. INTRODUCTION

Reading places great emphasis on visual skills and can therefore, improving them, as acquisition of literacy transforms the human brain (Dehaene, Cohen, Morais, & Kolinsky, 2015). Learning to read must be seen as multifaceted, in which visual and phonological skills are united (Woodrome & Johnson, 2009). Reading requires visual perception and discrimination, memory and retrieval of visual sequential aspects and directional orientation (Dehaene et al., 2015; Woodrome & Johnson, 2009). Considering the fundamental role of reading, learning it is necessary as soon as you enter school, in elementary school. To learn to read in an alphabetic writing system, as Brazilian Portuguese language, the child must develop the perception that speech can be represented by graphic symbols, and that graphic symbols represent the sounds of the language (Dehaene et al., 2015; Scliar-Cabral, 2003). This perception develops through constant exposure to the writing system and the efficient teaching of alphabetic principles (Germano & Capellini, 2016; Scliar-Cabral, 2003).

Furthermore, it is necessary that the different brain regions, responsible for processing the skills involved in the acquisition and development of reading, are functioning properly and integrated. (Dehaene et al., 2015; Germano & Capellini, 2016). It also requires intermodal integration, that is, the translation of visual symbols into meaningful auditory equivalents (Birch & Belmont, 1964). In this way, typical readers use visual skills to read familiar words that constitute their visual vocabulary, without having to discriminate

individual letters or component syllables (Myklebust, 1965). In contrast, when there are unknown words, the reader needs to use the auditory pathways, through a process of phonetic and syllabic analysis and synthesis (Chiarenza, Di Pietro, & Casarotto, 2014). Difficulties in any of these aspects of the process of learning to read will lead to the development of poor reading skills and potentially to a reading disorder, such as dyslexia.

Based on these assumptions, Boder (1973) postulated the existence of three subtypes of dyslexia: dysphonetic, dyseidetic and mixed. Readers with dysphonetic or phonological dyslexia have good visual skills and an inability to analyze phonological aspects, as evidenced by the difficulty in associating phoneme-grapheme and consequently fail in phonetic decoding. Readers with dyseidetic or visual dyslexia present good phonological analytical-synthetic skills and difficulties in visual function, referred to as a deficit in visual memory, and in the perception of letters or whole words, with important negative consequences in the development of an adequate internal vocabulary. Readers with mixed dyslexia present a global deficit, including difficulties in organizing visual and auditory perception, resulting in difficulties in the formation of an internal vocabulary and the acquisition of phonetic skills (Boder, 1973; Chiarenza et al., 2014).

Developmental dyslexia is a neuro-cognitive disorder described as a difficulty in acquiring reading skills, despite adequate intelligence and sufficient reading opportunities (Shaywitz, 1996). Reading requires the coordination and integration of visual and verbal information. In particular, children's awareness of the relationship between sounds and letters, or letter-sound correspondence, has been emphasized. Phonological awareness was suggested to underlie grapheme–phoneme conversion (Share, 1995). In contrast, visual perceptual skills, which appear to be essential to letter learning, have been much less thoroughly investigated (Woodrome & Johnson, 2009) especially regarding dyslexia.

Therefore, this study was based on the hypothesis that schoolchildren with dyslexia subtypes would have difficulties with visual and phonological skills.

2. OBJECTIVES

The objective was to characterize and compare visual, phonological and mixed profiles in schoolchildren with an interdisciplinary diagnosis of developmental dyslexia and with good academic performance.

3. METHODS

This study was approved by the Research Ethics Committee of the Faculty of Philosophy and Sciences – CEP/FFC/UNESP, under numbers 3.202.014 and 4.862.668. A total of 122 schoolchildren, aged from 8 years to 11 years and 11 months old (35 women, 43 men, mean age = 25.25, SD = 2.248), from the 3rd to the 5th year of Public Elementary School I, were divided into GI groups composed of 61 schoolchildren with the interdisciplinary diagnosis of dyslexia; and GII composed of 61 schoolchildren with good academic performance, matched with GI in relation to the school year. GI was composed of schoolchildren with the interdisciplinary diagnosis, carried out by the Learning Deviations Laboratory (LIDA/ UNESP – FFC/ Marília – SP), composed of speech therapists, neuropsychologist and occupational therapist, based on the criteria described in the Statistical Manual for Mental Disorders and of Behavior – DSM-V (APA, 2014; Germano, Reilhac, Capellini, & Valdois, 2014). Schoolchildren from GII were indicated by their teachers with good academic performance, with good academic performance being those

who presented satisfactory performance in two consecutive two-month periods in the Portuguese Language and Mathematics assessment, with a grade greater than or equal to the average (5.0). Schoolchildren from GII were paired with GI and their profiles, according to chronological age and school year. As exclusion criteria, schoolchildren who did not present the Free and Informed Consent Term signature, with the presence of sensory (hearing and/or visual impairment) and cognitive deficits described in school records and/or in neuropsychological assessment findings and who participated in speech therapy and pedagogical remediation.

As procedures, the schoolchildren were submitted to the following assessments, individually, lasting up to 4 sessions, with approximately 30 minutes, as follows: 3.1 Phonological skills assessment protocol (PROHFON- Germano & Capellini, 2016): composed of 12 tests that assess the student's performance in phonological awareness, allowing classification by test and school year. 3.2 Visual Perception Development Test III - DTVP III (Hammill, Pearson, & Voress, 2014). This protocol consists of a battery of five subtests that measure different visual-motor and visual-perceptual skills

After applying the assessments, the GI schoolchildren were separated according to the profiles of the dyslexia subtypes. For the separation in the diagnostic profiles, the following criteria were considered:

- Phonological Profile. To compose the phonological subtype, we considered the classification “under attention” in more than 50% of the phonological skills subtests (PROHFON – Germano & Capellini, 2016) and performed within and/or above average for the visual subtests (Figure – Background; Visual Closing; and Constancy of shape) and for the composite score of reduced motor perception of the visual perception test (DTVP-III; Hammill et al., 2014). A total of 22 schoolchildren met this criterion.

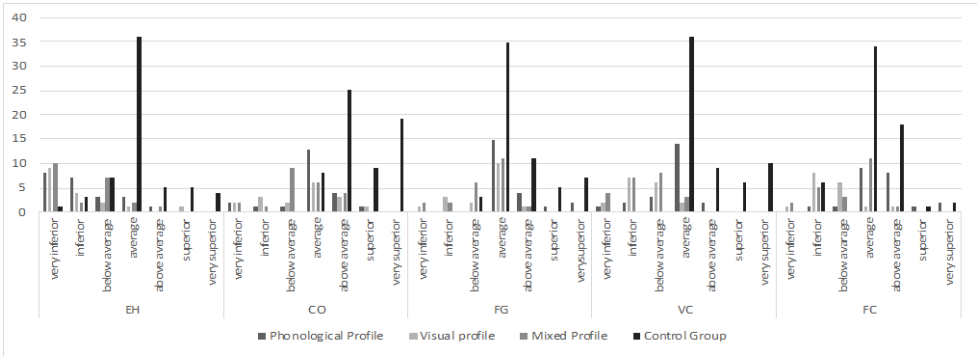
- Visual profile. To compose the visual subtype, we considered schoolchildren who performed “expected” in more than 50% of the metaphonological skills subtests (PROHFON, Germano & Capellini, 2016) and presented below average performance for the visual subtests (Figure – Background; Visual closure; and Shape constancy) and for the composite score of reduced motor perception of the visual perception test (DTVP-III; Hammill et al., 2014). A total of 17 schoolchildren met this criterion.

- Mixed. To compose the mixed subtype, we considered schoolchildren who performed “under attention” in more than 50% of the metaphonological skills subtests (PROHFON, Germano & Capellini, 2016) and presented below average performance for the visual subtests (Figure – Background; Visual closure; and Shape constancy) and for the composite score of reduced motor perception of the visual perception test (DTVP-III; Hammill et al., 2014). A total of 22 schoolchildren met this criterion.

4. RESULTS

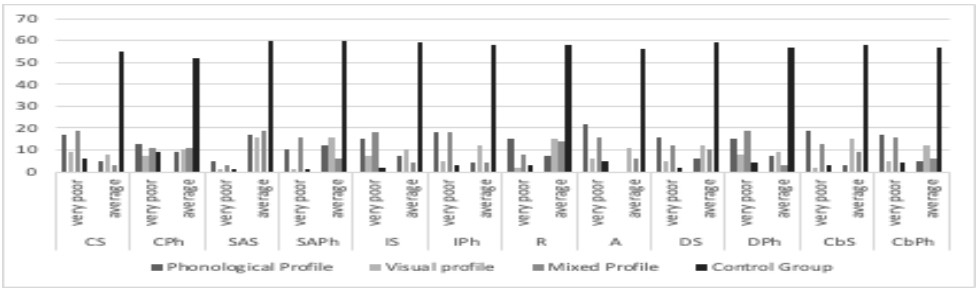
Figure 1 and 2 show the performance classification for the visual and phonological variables, respectively. The Likelihood Ratio Test was applied for comparison between categorical variables, that is, according to the classification of procedures. All variables showed significant differences.

Figure 1.
Distribution of performance classification of visual variables.



Caption: EH: hand-eye coordination; CO: Copy; FG: Figure –ground; VC: Visual closure; CF Shape Constancy

Figure 2.
Distribution of performance classification of phonological variables.



Caption: S: syllable; Ph; C: Count; SA: Synthesis and Analysis; I: Identification; A: Rhyme; A: Alliteration; D: Deletion: Cb: Combination

5. DISCUSSION

The findings of this study allowed us to observe that Brazilian schoolchildren with dyslexia showed differences in performance regarding phonological aspects and visual perception, indicating the heterogeneity of dyslexic manifestations.

Specifically, it was possible to observe that the phonological subtype was characterized by deficits in the phonological skills of syllable and phoneme synthesis and analysis, alliteration, and syllable combination. Phonological deficits primarily affect pseudoword reading, although they also prevent the normal acquisition of lexical orthographic knowledge (Share, 1995, 1999).

The issue of phonological deficit has been discussed for at least 30 years (Wagner & Torgesen, 1987), highlighting that schoolchildren with dyslexia fail in three dimensions, namely phonological awareness, short-term verbal memory and lexical recovery. Thus, understanding that the three dimensions are affected together as they imply phonological representations, each in its own way. In this study we observed failures in the first

dimension, phonological awareness. Ramus and Szenkovits (2008) proposed that the phonological difficulties of dyslexics were related to phonological access. For the authors, phonological awareness tasks require the subject to maintain segmented phonological units in short-term memory, as well as requiring conscious access to these representations, and such tasks overload short-term memory. Verbal short-term memory requires access to phonological representations in order to copy them into buffers, then access to phonological buffers for retrieval, as well as access to input representations in order to copy them into output representations, and access to output representations to recycle them into input representations, that is, the phonological loop, as described by Baddeley (1984). Phonological awareness tasks additionally involve a special type of access, conscious access to phonological representations, which may place special demands on access mechanisms. Therefore, it seems to us that people with dyslexia tend to fail in particularly demanding tasks in terms of phonological access.

As for the visual subtype, its characteristics were deficits in visual motor skills, visual figure-ground and constancy of form. Visual figure-ground is a high-level discrimination skill, the student must recognize relevant lines and curves and, simultaneously, disregard unimportant ones. The teaching of visual figure-ground activity can help the student to give adequate and concentrated attention to relevant stimuli, ignoring irrelevant ones (Fusco, Germano, & Capellini, 2015; Frostig, Horne, Miller, & Lorenzo, 1984). Regarding constancy of form, it enables student to develop the ability to generalize in relation to the visual stimulus, as well as the identification of geometric shapes and learned words, regardless of their size, color, shading or positioning (Frostig et al., 1984).

The results of this study corroborate Feagans and Merriwether (1990), who observed a positive correlation between visual discrimination skills and reading performance, and children with stronger visual discrimination skills tended to perform better on the lowercase letter identification task (Woodrome & Johnson, 2009). Before learning to identify letters, schoolchildren must learn to discriminate between similar two-dimensional figures, in order to later make phonemic access. The findings of this study suggest that difficulties in the skills of shape, figure and background constancy and visual closure can contribute to the failure of this recognition, causing an impact on reading. As indicated by Woodrome and Johnson (2009), if a children cannot differentiate the letters, it will be difficult to learn the names of the letters, resulting in poor reading performance. Additionally, studies indicated that visual skills are an important predictor of future reading performance, and this relationship may change with development (Kavale, 1982; Kavale & Forness, 2000).

The difficulty in acquiring these skills contributes to the promotion of the visual subtype. Studies indicate that directional visual perception is necessary for children at the beginning of the process of learning to read, as it precedes access to semantic and syntactic information (Bakker, 1992; Satz & Sparrow, 1970; Woodrome & Johnson, 2009). Thus, children must learn to differentiate between symbols (e.g., ‘‘p’’, ‘‘b’’ and ‘‘d’’) before they can relate sounds to letters and read words. Visual discrimination skills contribute to learning to read, facilitating the acquisition of letter knowledge, which is one of the strongest predictors of future reading ability (Badian, 1994; Catts, Fey, Zhang, & Tomblin 2001; Sawyer, 1992; Woodrome & Johnson, 2009). Thus, for the visual subtype of this study, we can infer that the representations of letters may not have occurred satisfactorily, causing difficulty in establishing the grapheme-phoneme conversion at the time of reading, due to poor visual perception rather than phonological awareness.

Therefore, these schoolchildren with difficulties in visual perception and the absence of phonological deficits alert us to the need to investigate these profiles in the population, in addition to the fact that the findings corroborate literature that indicates that dyslexic

readers may have other problems that do not only involve phonological deficits (Castles & Coltheart, 1993).

The findings of this study indicate that it was possible to identify subgroups of dyslexic children in terms of visual and phonological abilities, and these discoveries clearly document the existence of individual differences in the dyslexic population. Thus, cases of developmental dyslexia with normal phonological processing have been documented (Valdois, Bosse, & Tainturier, 2004), despite the use of sufficiently sensitive phonological measures. Another important aspect observed is in relation to phonological skills. When observing the distribution of schoolchildren regarding performance classification, it is noted that all subtypes had some phonological impairment. That is, we can infer that dyslexic had failures in accessing the phoneme, in some way. This aspect can be related to the current literacy methodology in Brazil, which does not prioritize the systematic and reflective teaching of grapheme-phoneme conversion.

In the study by Germano et al. (2014) it was also possible to verify schoolchildren with the absence of visual and phonological deficits, based on other classification criteria, which were called the "no disorder" group. Authors had suggested that visual processing and phonological processing may independently contribute to reading ability. Such findings indicate that the heterogeneous profile of dyslexia goes beyond visual and phonological deficits. The literature has addressed the existence of schoolchildren who are less likely to demonstrate decoding difficulties, but who have specific difficulties in reading comprehension.

The children in the "no disorder" group showed impairments in reading, but not justified by deficits in phonological and visual skills. In this study, the "no disorder" group was identified as being composed of students diagnosed with dyslexia, but who did not have significant deficits in visual-attentional or phonological skills. This finding has a very important implication for clinical diagnostic investigation, as conventional assessment batteries would not be sufficient to identify these profiles, requiring the application of refined criteria such as accuracy and reading speed, as provided for in DSM-V (APA, 2014). In addition, it's possible that they might had suffered a limited experience with the language used in written texts (Graves et al., 2014).

In a recent meta-analysis study (Georgiou et al., 2022), suggested that reading comprehension deficits in individuals with dyslexia are likely the product of deficits in both decoding and oral language skills. Authors highlight that individuals with dyslexia experience great difficulties in reading comprehension and this reinforces the notion of considering reading comprehension a secondary symptom of dyslexia. This study corroborates our findings, which reiterate that the reading difficulties experienced by dyslexic's have several levels, ranging from the underlying reading skills (i.e., visual and phonological processing) to reading comprehension.

These studies, together with ours presented here, move towards the understanding that dyslexia need to be seen as a heterogeneous impairment, and that the clinical evaluation process should include different protocols, to better characterize each individual profile.

Based on this understanding, and following global research trends, educational and interventional implications should also be considered. In Brazil, in addition to the reading programs used in clinics by speech-language pathologists, programs based on the educational model of response to intervention (RTI) began to be implemented in the educational environment, focusing on phonological and visual aspects. Such programs enabled the early identification and referral of children with dyslexia, favoring access to treatments and the discussion of curricular adaptations (Cerqueira César, Germano,

& Capellini, 2018; Fletcher, & Vaughn, 2009; Fusco et al., 2015; Germano, César, & Capellini, 2017; Vaughn, Miciak, Clemens, & Fletcher, 2024).

Daniel, Clucas and Wang (2024) also discuss the misconceptions held by professionals who treat dyslexics. The authors emphasize that dyslexia need to be understood in its entirety, and that misconceptions prevent a more accurate diagnosis and, subsequently, the targeting of appropriate interventions, whether in the clinical or educational context.

In any ways, Zoccolotti (2020) draws our attention to the analysis of reading behavior, that is, the assessments emphasize the quantitative analysis and functional significance of the reading deficit (as well as exclusion criteria, such as sufficient educational opportunities and lack of general sensory or intellectual problems), severity and relevance of reading difficulties. From this perspective, in agreement with the findings of this study, especially with “no disorder” group, the author defines dyslexia as a complex behavioral disorder, characterized by low performance on standardized reading tests and significant impairment in daily life (mainly in school activities). In this way, dyslexia can be better understood when seen in a multilevel analysis approach, a perspective originally claimed by Frith (1999), who already highlighted that behavioral aspects of dyslexia would extend far beyond problems with written language.

In addition, Pennington (2006) proposed the multiple deficit model of neurodevelopmental disorders in an attempt to explain multiple deficits related to dyslexia, rather than the traditional single deficit model. An interesting point of multiple deficits is the interindividual variability in the profiles, proposing that each risk factor is probabilistically (and not deterministically) related to neurodevelopmental disorders, as pointed out by McGrath, Peterson, and Pennington (2020). This aspect entails not only theoretical implications, but also in terms of clinical and educational practice, as it denotes the need for interventions with phonological remediation programs, even in the case of a visual subtype.

Finally, the findings of this study also agree with Wolf et al. (2024), who discuss the need for a new definition of dyslexia, since traditional definitions do not encompass the different models and studies carried out in recent decades. The authors advocate a definition that the still evolving history of attempts to explain dyslexia, including in varied writing systems, and the study of the reading brain circuit, its development, and its genetic and environmental influences. Thus, the study described in this chapter, with the Brazilian reality, corroborates international studies, highlighting the view of dyslexia as a specific reading disorder, but with heterogeneous manifestations.

6. FUTURE RESEARCH DIRECTIONS

Research on dyslexia subtypes in Brazil has shown that there are heterogeneous profiles, which have an impact on identification and intervention. The continuity of these investigations is important to better characterize this population.

Therefore, this chapter brings as future directions the need to review clinical and educational practices, in terms of carrying out assessments with different procedures, which range from the underlying processes of decoding (phonological and visual processing) to the processes of reading comprehension. With this, the way of intervening in individuals with dyslexia will also undergo changes, since the delineation of the student's profile will favor a better direction for clinical and educational intervention.

7. CONCLUSION

The findings of this study allowed us to observe that Brazilian schoolchildren with dyslexia showed differences in performance regarding phonological aspects and visual perception, indicating the heterogeneity of dyslexic manifestations. These findings contribute to the discussion about the diagnostic criteria used by professionals, in addition to increasing the need to implement intervention programs with visual and phonological approaches. The findings of this study are in line with international studies, which have indicated that dyslexia should be seen as multimodal, with varied impairments that go beyond traditional conceptions.

Clinical and educational professionals must be prepared to make curricular adaptations aimed at a more individualized profile, allowing access to intervention programs based on phonology and/or visual language, which will impact decoding skills and consequently reading comprehension. What emerges from this study is a dynamic conceptualization of dyslexia that corroborates other research on the heterogeneity of dyslexia, which highlights the interdependent contributions of multiple biological and sociocultural risk and prevention factors. Critical to the social understanding of dyslexia is that, although typically described as a specific learning disability, dyslexia is a learning difference that becomes a disability when environments are disabling. Furthermore, individuals with dyslexia may be impacted not only academically, but also socially, emotionally, and occupationally.

Finally, these findings alert us to the need to better understand the student's profile to improve curricular adaptation policies.

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