

Cognitive and Behavioral Profile in Dyslexia: Challenges in Interdisciplinary Assessment

Thalita Francielli Lopes Ferreira*, Janaína Aparecida de Oliveira Augusto, Patrícia Regina Flaviano Stella, Rita de Cássia Coutinho Vieira Fornasari, Rodrigo Genaro Arduin, Sylvia Maria Ciasca

Laboratório de Pesquisa em Distúrbios, Dificuldades de Aprendizagem e Transtornos de Atenção (DISAPRE), Hospital das Clínicas from Campinas' State University-HC/UNICAMP, Campinas, São Paulo, Brazil
Email: *thalitafrancielli@gmail.com

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Abstract

The diagnostic assessment in Dyslexia must be carried out in an interdisciplinary way, prioritizing cognitive, phonological, psychopedagogical and biological aspects. In this sense, the aim of the study was to compare the cognitive and behavioral profile of two individuals with Developmental Dyslexia (DD), discuss the importance of interdisciplinary assessment and also describe the main behavioral and academic impacts. These two patients were treated at a neuropediatrics outpatient clinic of the public health network in Brazil. The criteria for selecting participants were patients with the diagnosis of Developmental Dyslexia given by the outpatient clinic, patients with comorbidities with Attention Deficit/Hyperactivity Disorder were excluded from the study. The participants were evaluated by the areas of neuropsychology, speech therapy, psychopedagogy and medicine, in order to obtain the global profile of the patients' functioning. The results indicated the presence of multivariate profiles and reinforced the importance of an interdisciplinary view for the diagnosis and subsequent planning of interventions.

Keywords

Dyslexia, Child, Case Reports, Reading, Cognitive Profile, Behavioral Profile

1. Introduction

Developmental Dyslexia (DD) is characterized as a specific learning disorder, in which reading and writing performance are below expectations regarding the individual's age, education and level of intelligence (APA, 2023).

Regarding the etiological factors, DD is a neurobiological disorder that occurs

due to dysfunction in the central nervous system (CNS), involving deficits in the acquisition and development of academic skills, which the main difficulty is accuracy and fluency in reading, as well as impairments in the comprehension and expression of writing (APA, 2023).

From a neuropsychological point of view, DD is accompanied by changes in several cognitive functions. Although language and phonological processing have received greater attention due to their relationship with reading and writing (Hulme & Snowling, 2016), other cognitive skills have also been emphasized, such as attention and executive functions (EF) (Taran et al., 2022; Smith-Spark & Gordon, 2022; Ferreira, Ciasca, & Lima, 2019; Soriano-Ferrer, Piedra-Martínez, & Arteaga, 2018).

Attention is defined as a cognitive process that allows the individual to respond to relevant stimuli (Carreiro et al, 2015). EF, on the other hand, refers to a set of cognitive skills that help the individual to engage autonomously in goal-directed activities (Diamond, 2013). Reading and writing skills are directly related to both attention and EF, as both act in all stages of information processing, from receiving stimuli to processing, planning and organizing responses (Smith-Spark & Gordon, 2022).

Barbosa et al. (2019) compared a sample of 47 children (ages between 8 and 13 years), 24 of whom were dyslexic and 23 with typical development. The results showed difficulties in EF in individuals with DD when compared with controls, mainly in selective attention and in EF components (cognitive flexibility and inhibitory control). For the authors, these difficulties seem to be affected by deficits in phonological working memory, typically associated with dyslexia.

The study by Soriano-Ferrer, Piedra-Martínez & Magali Arteaga (2018) compared the performance of 19 individuals with DD and 20 controls, with a mean age of 16 years, in ecological EF tasks, using the BRIEF-A Behavior Rating scale Inventory of Executive Function (BRIEF-A). This scale aims to assess ecological executive functioning, that is, behavioral assessment of EF in daily life. The results indicated that the first group had more EF problems in daily life, mainly in initiation, working memory, planning, task supervision and planning. The authors also suggest that the results coincide with the EF deficits found in neuropsychological tests.

Aoife Lonergan et al. (2019) conducted a meta-analysis of 26 studies examining performance on inhibition, alternating attention, and auditory working memory in children with DD alone and in children with DD and attention deficit hyperactivity disorder (ADHD). The results revealed that children with DD had difficulty with inhibition, alternating attention and auditory working memory. Children with DD comorbid with ADHD exhibited relatively the same degree of inhibition, switching attention, and working memory impairment compared to children with DD alone. The results reinforce the presence of EF deficits in individuals with DD. Furthermore, the authors suggest that impairments in executive functioning may be shared deficits in different neurodevelopmental dis-

orders.

Thus, in order to provide an accurate diagnosis, an interdisciplinary evaluation process must be carried out to examine the different cognitive abilities, phonological processing, written language and emotional aspects, since it is characterized both by alterations that compromise learning and emotional problems, which can result in comorbidities with psychiatric disorders (Aro, Eklund, Elooranta, Ahonen, & Rescorla, 2022; Lima, Salgado-Azoni, Dell'Agli, Baptista, & Ciasca, 2020). Therefore, for the diagnosis, in addition to investigating the cognitive profile, it is necessary to take into account the behavioral profile to understand the impact of DD on other domains of development.

The diagnostic process of DD is complex and, consequently, it should occur in an interdisciplinary way involving areas such as: psychology, speech therapy, psychopedagogy and media (Back et. al, 2020). The objective of the medical evaluation is to investigate possible neurological alterations that justify the learning difficulties, the psychopedagogue is responsible for investigating academic performance, the role of the speech therapist is to evaluate written and oral language, in addition to the phonological process, and the role of the psychologist is to investigate cognitive functioning (intelligence, memory, attention and executive functions), in addition to behavioral and emotional aspects (Rotta, Ohlweiler, & Riesgo, 2016).

Therefore, the aim of this article is to compare the cognitive and behavioral profile of two individuals with DD, discuss the importance of interdisciplinary assessment and describe the main behavioral and academic impacts.

2. Methods

2.1. Participants, Location and Ethical Aspects

This article is based on information obtained from the analysis of clinical records of two patients, who were treated at the Laboratory for Research in Difficulty, Learning Disturbances and Attention Disorder (Disapre/State University of Campinas) in 2020, in the city of Campinas, Brazil. The aforementioned outpatient clinic serves children and adolescents (6 to 14 years old) with complaints of learning difficulties, inattention, behavioral problems and neurodevelopmental delays. The diagnosis of Dyslexia is carried out through an interdisciplinary assessment that includes the following areas: psychology, psychopedagogy, speech therapy and pediatrics.

The assessments performed at the outpatient clinic were synthesized and transcribed for this case report, highlighting the information considered most relevant for defining the condition. The criteria for selection of participants were they had the diagnosis of Developmental Dyslexia given by the outpatient clinic, and patients with comorbidities with Attention Deficit/Hyperactivity Disorder (ADHD) were excluded from the study.

Thus, the signature of the informed consent term was requested from the patients' legal guardian, as well as the signature of the free and informed consent

term from the adolescents themselves in order to authorize the use and disclosure of their clinical data, without the possibility of their individualization or identification. This study was approved by The Research Ethics Committee (CEP) of the institution hosting the study 63960720.0.0000.5404.

2.2. Case Description

2.2.1. Case 1

The first case is about an 11-year-old female teenager enrolled in the 5th year of elementary school at a private school in a city in the state of São Paulo. She was referred by the school for the aforementioned assessment.

The main complaints reported by the family during the anamnesis interview were: learning difficulties, reading changes and omission of syllables, with mirrored writing (numbers and letters), difficulty understanding and solving math problems. There were no family case reports with learning disabilities or neurodevelopmental delays. On the other hand, there were no reports of neurodevelopmental delays, complaints of inattention or behavior problems. Based on the diagnostic hypothesis of DD, she was referred for an interdisciplinary assessment.

2.2.2. Case 2

The second case is about a male teenager, aged 14, enrolled in the 8th grade of elementary school in a public school in a city in the state of São Paulo. He was referred by the school.

The complaints presented by the mother during the anamnesis interview were: learning difficulties, especially in reading and writing; difficulty concentrating and interpreting text; no history of neurodevelopmental delays. At the time of the anamnesis, the mother also mentioned that the teenager had the behavior of challenging authority figures. In family history, there were reports of learning difficulties and anxiety disorders. Faced with the diagnostic hypothesis of DD, he was referred for an interdisciplinary assessment.

2.3. Instruments

For the interdisciplinary assessment process, the following instruments were selected.

3. Results

The objective of the study was to compare the cognitive profile of two patients diagnosed with Dyslexia. **Table 1** presents the results of the neuropsychological assessment for cases 1 and 2.

According to the data in **Table 2**, it is possible to verify that in case 1, the child presented significant deficits only in working memory, a skill that composes the executive functions; qualitatively, a verbal repertoire above the expected for age was observed. From a behavioral point of view, the child spoke too much and tended to change the subject when faced with tasks involving reading.

Table 1. Description of instruments.

Area	Instruments		
	Instruments ¹	Objective	References
Neuropsychology	WISC-IV, Rey Complex Figure Test, RAVLT, BPA, FDT, CBCL, ETDAH (verson parents)	Intelligence, memory, attention, executive functions and behavior	Wechsler, 2013; Cruz, Toni, & Oliveira, 2011; Malloy-Diniz et al., 2017; Rueda, 2013; Sedo, Paula, & Malloy-Diniz, 2015; Achenbach & Rescorla, 2001; Benczik, 2018
Psychopedagogy	TDE-2, EAME-IJ, EAVAP, THM-2	Academic achievement, motivation, learning strategies	Stein, Giacomoni, & Fonseca, 2019; Martinelli & Sisto, 2011; Oliveira, Boruchovitch, & Santos, 2010
Speech therapy	Reading comprehension of expository text, TENA, TRPP, Phonological Awareness Test by Oral production	Comprehension, automatized naming, retention and retrieval of phonological information, manipulation of speech sounds	Silva, Mecca, & Macedo, 2018; Dias & Seabra, 2012
Pediatrics	Semi-structured anamnesis	Past life history, neurodevelopment data and family history.	Exclusive outpatient material

¹WISC-IV: Wechsler Intelligence Scale for Children; CBCL/6-18: The Child Behavior Checklist for Ages 6 - 18; RAVLT: The Rey Auditory Verbal Learning Test; BPA: Psychological Battery for Attention Assessment; FDT: Five Digits Test; TDE-2: Academic Achievement Test; EAME-IJ: Rating Scale of School Motivation; EAVAP: Evaluation of Learning Strategies from Elementary Level; THM-2: Test of Mathematical Ability; TENA: Rapid Automatized Naming Test; TRPP: Word and Pseudoword Recognition Test.

Table 2. Description of the results of the neuropsychological assessment.

Skills	Score	
	Case 1	Case 2
Intelligence	Average (no discrepancy)	Average (with discrepancy between verbal and non-verbal skills)
Attention	Average	Low average in divided attention
Memory	Average	Average
Visual-spatial	Average	Average
Language	Average	Low average
Executive functions	Low in working memory	Low in working memory, inhibitory control and planning Low average in mental flexibility
Attentional aspects	Average in emotional self-regulation, hyperactivity and adaptive behavior. Higher average in attention	Average in emotional self-regulation, hyperactivity and adaptive behavior. Higher average in attention
Behavioral aspects	Non-clinical	Clinical signs for anxiety and attentional problems.

According to the results of case 2, it was verified that the adolescent presented low average intellectual performance, with discrepancy between verbal and non-verbal skills, with less expressive performance in verbal tests. In addition, it presented impairments in divided attention and executive functions.

According to data shown in **Table 3**, on physical examination, the adolescent is in good physical health, without deformities or limitation of limb movement.

Table 3. Description of the results of the pediatric assessment.

Exam	Score	
	Case 1	Case 2
Physical Examination	No changes	No changes
General Neurologic Examination	Cranial nerves without alterations Muscle strength grade 5 Normal osteotendinous reflexes Negative Romberg Test Normal gait	Cranial nerves without alterations Muscle strength grade 4, with mild hypotonia Normal osteotendinous reflexes Negative Romberg Test Normal gait
Soft neurological signs	Mild right-gaze nystagmus Fine tremor of extremities at rest	Fine tremor of extremities at rest
Neurologic evolutive	Not performed	Static Equilibrium - Failed 7-Year Tests Appendicular coordination - dysdiadochokinesia, failures in rhythm and sequencing Motor persistence - failure in tests for 7 years Presence of synkinesis
QNST III (Quick Neurological Screening Test)	Not performed	Poor left-right discrimination Loss of reproduction of sound patterns and lack of sequence recognition Impulsivity and distraction

Is overweight (BMI between the 85th and 97th percentiles; Z-score between +1 and +2) and height at the 15th percentile for age (considered normal) [WHO].

The neurological examination showed integrity of the cranial nerves, strength and muscle tone appropriate for age, absence of changes in tactile sensitivity or motor deficits, with intact reflexes and balance; however, two minor neurological signs were noted: nystagmus to the right and fine tremor of the extremities, especially quite evident in the fingers.

In **Table 4**, the results of the psychopedagogical assessment in case 1 identified difficulties in reading, writing in general, mathematics and comprehension, in addition to deficits in learning strategy.

Qualitatively, it was observed difficulty in understanding statements, in establishing strategies for solving problems. In writing, case 1 presented errors related to omission of letters, omission of capital letters at the beginning of the paragraph and in proper nouns, omission of accent marks, spelling and punctuation errors, in addition to noun agreement.

In reading, the child showed omissions and inversions of letters and syllables, besides partial understanding of the textual information previously presented.

Table 4. Description of the results of the psychopedagogical assessment.

Skills	Score	
	Case 1	Case 2
Mathematics	Low average	Low
Reading	Low	Low
Word writing	Low	Low
Spontaneous text writing	Low	Low
Dictation writing	Low	Low
Reading comprehension	Low average (no reader)	Low average (no reader)
Learning strategies	Low	Low
School motivation	Average	Average

On the other hand, in case 2, the adolescent showed impairments in mathematics, reading, writing, comprehension and lack of learning strategies. Qualitatively, in reading, the patient had difficulties in decoding words, which impacted his performance in writing and mathematics. Also, he had trouble reading his own handwriting.

The main errors in writing were related to omissions, exchanges and inversions of letters. Avoidance behavior was observed in textual production tasks. In arithmetic, the teenager presented structuring, organization and calculation errors, with difficulties in the multiplication tables and did not carry out the divisions.

It is noteworthy that the results of the assessment of motivation for studying showed the patient's constant need to receive external stimuli to cope with school demands. With regard to learning strategies, the results identified that the minor has difficulties in planning, organizing and monitoring studies.

In the phonoaudiological aspect, the results described in **Table 5** show that, in case 1, the child presented impairments in tasks that evaluated naming.

Qualitatively, there was difficulty in discriminating the phonemes (p/b, t/d, f/v, k/g). The difficulties observed in naming tasks indicated low speed and accuracy, altering spelling processes and reading.

Specifically, in reading, the child had difficulty decoding low-frequency words and changes in fluency. Still in reading, there was omission of syllables and words, and, also, the child did not respect the accent in some moments. In reading comprehension, although the patient was able to identify the central idea, the answers were considered simple. These alterations are linked to difficulty in decoding, fluency and comprehension, aspects related to efficient reading.

In case 2, the teenager had difficulties in phonological awareness, automatized naming and short-term phonological memory, which are processes involved in the retrieval and maintenance of phonological information. In the qualitative analysis, the adolescent demonstrated slowness in solving tasks and extensive execution time and inattention. The assessment of reading comprehension of expository

Table 5. Description of the results of the speech-language assessment.

Skills	Score	
	Case 1	Case 2
Phonological awareness	Average	Low
Rapid Automatized Naming: colors - time	Low	Average
Rapid Automatized Naming: colors - errors	Average	Average
Rapid Automatized Naming: objects - time	Low	Low
Rapid Automatized Naming: objects - errors	Low	Low
Rapid Automatized Naming: letters - time	Low	Average
Rapid Automatized Naming: letters - errors	Low	Average
Rapid Automatized Naming: numbers - time	Low	Average
Rapid Automatized Naming: numbers - errors	Average	Average
Repetition of words and pseudowords	Average	Low

texts complemented this process, in which the patient demonstrated difficulties in reading aloud, ordering ideas and understanding the entire text read. This proved to be consistent with his performance in phonological awareness, rapid automatized naming and phonological short-term memory skills.

4. Discussion

The aim of the study was to describe the cognitive and behavioral profile of individuals with Developmental Dyslexia (DD). The main findings indicated that individuals with DD differed not only in terms of their academic difficulties, but also in the level of specific cognitive skills and behavioral aspects.

The aim of the study was to compare the cognitive and behavioral profile of two individuals with Developmental Dyslexia (DD). The main findings indicated that individuals with DD differed not only in terms of their academic difficulties, but also in the level of specific cognitive skills and behavioral aspects.

In the assessment of the intellectual profile, despite the level of intelligence within the average in both cases, in case 2, there was a discrepancy between the indices, with less expressive performance in verbal skills, as described in some studies (Quintino et al., 2018; Toffaline, Giofré, & Cornoldi, 2017). However, it is observed that discrepancy is not a rule, since the cognitive profile can vary according to the level of difficulty (Giofré et al., 2019; Toffaline, Giofre, & Calnoldi, 2017).

The assessment of intelligence in Dyslexia is essential to rule out the presence of Intellectual Development Disorder, which also presents with learning difficulties. Individuals with DD must have an intelligence quotient > 80 (Ciasca et al. 2015).

With regard to attention, in case 2 a lower performance was observed when compared to case 1 in divided visual attention, reinforcing the evidence that deficits in visual attention can accompany impairments in the phonological

processing of language (Taran et al., 2022). Another study with dyslexic individuals also demonstrated attentional impairments, with a pattern of slower responses in visuospatial attention tasks (Gabay et al., 2020).

Studies show that the development of visual attention in preschoolers can predict the acquisition of reading and that children with difficulties in attentional tasks are more likely to have difficulties in reading (Franceschini, Gori, Ruffino, Pedrolli, & Facoetti, 2012; Vidyasagar & Pammer, 2010).

In line with the cited studies, Abreu et al. (2017), showed in their research that attention is an important factor in academic performance and that children with school difficulties tend to have attention problems. The authors emphasize the need for evaluation of attention for the diagnosis and treatment of learning disorders and highlight the importance of early intervention to improve children's school performance. The article concludes that the early identification of attention problems can contribute to school success and improvement in the quality of life of these children.

The results also showed deficits in some components of executive functions, mainly in working memory, followed in this study through the Digit Span Backward subtest, showing that in both cases there were losses to store and manipulate verbal information. The results found are consistent and corroborate other studies about deficits in working memory in children with DD (Dahhan et al., 2022; Koltermann et al., 2020; Diniz, Correa, & Mousinho, 2020; Giofré & Cornoldi, 2015). In addition, the difficulties observed in the performance of verbal working memory suggest impairments in phonological processing in individuals with DD (Koltermann et al., 2020).

Impairments in working memory, as observed in this study, contribute to the difficulty of text comprehension, since for this process to occur effectively, it is necessary to store and manipulate the content read (Diamond, 2013; Hebert et al., 2018).

In addition to the attentional and executive deficits demonstrated by the neuropsychological tests, the impact of these deficits on the daily lives of the patients assessed using the ETDAH and CBCL scales was also evaluated.

Although neither of the two participants had ADHD comorbidity, the parents reported attention problems, according to ADHD. Similar results were found by Aro et al. (2022); Lima et al. (2020). In addition, the results are in line with previous studies, which emphasize that attention and executive function problems are part of the cognitive (Smith-Spark & Gordon, 2022; Ferreira, Lima, & Ciasca, 2019) and behavioral profile of DD (Soriano-Ferrer et al., 2018; Smith-Spark, Henry, Messer, Edvardsdottir, & Zięcik, 2016).

On the ADHD scale, we observed that, in both cases, the attention score reached the upper middle range, a score considered alert for clinical deficit. However, when qualitatively analyzing the responses of the attention factor, it is noted that the parents filled in the following alternatives with the maximum score, that is, it means that the behavior happens very frequently: activities that

require prolonged mental effort are avoided (for example: schoolwork) and quickly forgets what was just said. Thus, despite the quantitative score slightly above the average, it is observed that, qualitatively, the two cases showed attentional impairments only when exposed to school content.

According to the CBCL results, only in case 2 the parents report attention and anxiety problems. Previous studies have emphasized that children with DD are more vulnerable to the development of affective or anxiety disorders (Xiao et al., 2021; Lima et al. 2020). In this study (Xiao et al., 2021), the authors also pointed out that the time spent on homework and stress can mediate the association between dyslexia and symptoms of anxiety/depression.

Lima et al. (2020) investigated behavior problems and depression through the CBCL scale in 31 dyslexic individuals and 30 controls. The results indicated a higher frequency of behavior problems and symptoms of depression in the first group. Thus, interventions focused exclusively on cognitive and linguistic aspects may not be fully effective and should be complemented with psychological and psychiatric support (Aro et al., 2022; Lima et al., 2020; Hendren, Haft, Black, White, & Hoefft, 2018).

With regard to the neurological aspects, “minor” or “discrete” neurological signs (neurological soft signs, NSS) were identified in both cases, which are clinically detectable alterations that do not have a specific correlation with a lesion or alteration in a directly identifiable brain area. Among these changes, we can mention: tremors, changes in coordination, difficulties in somatosensory perception, and others (Cass & Yeates, 2011; Alamiri et al., 2018).

There is no evidence that the presence of NSS can be attributed to risk factors for any neurodevelopmental disorders in the pediatric age group; however, population assessments have shown that the presence of NSS may be related to lower scores on IQ tests, poor academic performance, and reduced scores on executive function tests (Alamiri et al., 2018), as observed in the two cases evaluated in this study.

In both patients analyzed, only in case 2 were “hard” or “specific” neurological alterations (hard signs) found (Alamiri et al., 2018), with hypotonia and reduced muscle strength in the four limbs in the general neurological assessment and alteration in static balance in the evolutive assessment. For case 1, this demonstrates that tracts and structures of the central and peripheral nervous system are intact; in case 2, the change in strength detected, being global, seems to indicate a reduction in muscle mass due to little use, without change in a specific area. The balance disorder, on the other hand, seems to result, essentially, from dysfunction in the area of integration (between the inner ear or cerebellum and the occipital/visual region), also without damage to a specific structure, which is corroborated by the concomitant presence of changes in rhythm and sequencing.

The presence of NSS in both cases is quite prominent, especially in case 2, in which a more detailed neurological assessment was performed: nystagmus (involuntary eye movement) (Cass & Yeates, 2011), fine tremors of the extremities,

failure in motor persistence (inability to keep body parts stationary for a specified period of time) (Lefèvre, 1972) and synkinesis (involuntary muscle contractions that occur with voluntary movement of a different muscle group) (Cass & Yeates, 2011) were easily observed.

From the psychopedagogical point of view, the difficulties identified in reading comprehension corroborate other studies. Generally, impairments in interpretation are correlated with slowness, inaccuracy during reading, in addition to working memory overload (Rodrigues & Ciasca, 2016).

Still on reading skill, previous studies have pointed out significant impairments in phoneme discrimination, decoding and phonological awareness (Bishop et al., 2017), as those identified in the speech-language assessment of the present study. Furthermore, individuals with DD, on writing, can often make mistakes, omissions or letter inversions, as observed in the two cases presented (Farrell, 2008).

The data obtained in this study showed the different cognitive impairments that individuals with DD may have and that accompany deficits in specific reading and writing skills, corroborating the idea of heterogeneity of this disorder, which reinforces, once again, the importance of an interdisciplinary assessment in DD.

Interdisciplinary assessment is crucial for the diagnosis of DD, since the integration of detailed and comprehensive results helps in understanding the individual's overall functioning, and is not limited to investigating academic performance, this broader view provides an intervention plan more effective and aimed at the real needs of the patient (Back et al., 2020).

And finally, due to the nature of the study (case report) and the small sample size, it is not possible to generalize the data found, which configures a limitation of the present study, so that the results found must be interpreted with caution. In this sense, for future studies, quantitative research is suggested that addresses the different cognitive profiles observed in DD, in an interdisciplinary way.

5. Conclusion

The present study sought to describe the cognitive and behavioral profile of two adolescents with DD assessed at a neuropsychiatric outpatient clinic. The results showed the presence of multivariate profiles from the neuropsychological, psychopedagogical, phonoaudiological and neurological perspective. This reinforces the importance of carrying out careful interdisciplinary assessments, in which the focus is on understanding the individual's global functioning. It is noteworthy that the correct identification of the cognitive profile has important implications regarding the prognosis, in addition to influencing the planning of interventions.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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