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Original articles

Attention-Deficit Hyperactivity Disorder (ADHD) versus Specific Learning Disorder-Reading Subtype (Dyslexia): performance in writing tasks

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ABSTRACT

Purpose: to analyze and compare the writing performance between students with attention-deficit/hyperactivity disorder (ADHD) and students with dyslexia.

Methods: altogether, 27 children participated in the study, divided into the groups G-ADHD and G-Dyslexia. Their writing was assessed with a test that uses word and pseudoword dictation. The analysis addressed their writing level, word/pseudoword writing performance, and misspelling types. The groups were compared with the two-proportion z-test between two samples and the Mann-Whitney test ($\alpha = 0.05$).

Results: only one child in G-Dyslexia out of the 27 participating children was classified at the syllabic-alphabetical level. The others were classified at the alphabetical level, with no statistical difference between the groups in this item. The analysis of word/pseudoword writing performance revealed a difference between mean total scores, in which G-ADHD performed better. This group also had a higher percentage of children whose performance was classified as adequate for their age. There was a difference in misspellings between the groups in the omission of syllables, omission/addition of letters in complex syllables, and total performance – G-dyslexia made such errors more often.

Conclusion: children with ADHD performed better in writing than the ones with dyslexia. However, writing cannot be used as a diagnostic marker between these conditions.

Keywords: Language Development; Handwriting; Neurodevelopmental Disorders; Attention Deficit Disorder with Hyperactivity; Dyslexia

A study conducted at Medical School of Ribeirão Preto, Universidade de São Paulo - FMRP-USP, Ribeirão Preto, São Paulo, Brazil.

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INTRODUCTION

Writing, just like reading, is a skill built gradually, according to neurological maturation and social demands[1]. Its development begins in early childhood, with the development of basic cognitive skills (linguistic skills, metalinguistic skills[2], and executive functions[3]), and reaches its peak during the first school years, when the child begins to acquire the phoneme-grapheme correspondence and, later, the spelling system[1,4].

In order to read, individuals must have adequate visual attention, trace symbols to their phonological representations, extract meaning from words, update mental representations of the text, inhibit unimportant associations, and make appropriate inferences[3]. These same skills are necessary for writing, whose dictation tasks (with auditory input) specifically require attention, executive functions, visuo-constructive skills, and visual-motor coordination, in addition to linguistic/metalinguistic skills.

The foremost objective of teaching written language is to build a quick and efficient orthographic-phonological mapping, and difficulties in this learning process can arise from many sources[5]. Failures in learning to read and write may be associated with various neurodevelopmental disorders, such as attention-deficit/hyperactivity disorder (ADHD)[6,7], or be used as diagnostic criteria for primary disorders involving written language, such as specific learning disorder (SLD).

According to the Diagnostic and Statistical Manual of Mental Disorders revised 5th edition (DSM-5 revised)[8], ADHD is a neurodevelopmental disorder defined by detrimental levels of inattention, disorganization, and/or hyperactivity-impulsivity. Its worldwide prevalence in children and adolescents is estimated at approximately 5%[8,9], and it is one of the most prevalent diagnoses (40%) in children with complaints of difficulties at school[10].

The disorder is subdivided into three behavioral phenotypes: ADHD with a predominance of inattention, ADHD with a predominance of hyperactivity/impulsivity symptoms, and combined ADHD. The combination of groups of symptoms is defined as inattention and disorganization (in which the person seems not to persist in tasks, not listen, and lose objects at levels inconsistent with their age or level of development) and hyperactivity-impulsivity (in which they intrude into the activities of others and are excessively active, restless, and unable to remain seated or wait). Regarding neuropsychological aspects, studies indicate that individuals with ADHD have deficits in executive functions[11,12], such as working memory[13,14] and processing speed[15,16].

The SLD-reading subtype (SLD-reading) – which may alternatively be referred to as dyslexia, according to DSM-5 revised[8] – indicates a pattern of learning difficulties characterized by problems in accurate or fluent word recognition, decoding, and/or spelling. Another diagnostic criterion is that these changes persist even with adequate stimulation/intervention (intervention response strategy)[8]. This condition requires that the intellectual estimate be classified as adequate – i.e., ruling out the diagnosis of intellectual development disorder (intellectual disability). It must be also analyzed whether learning difficulties at school are not due to any other neurodevelopmental condition, such as ADHD[17]. This article used dyslexia as an alternative term for children with SLD-reading.

Considering the reading/writing domains, the prevalence of dyslexia in schoolchildren is approximately 3%[8,10]. A study[18] found that 1.3% of children with learning difficulties were diagnosed with dyslexia. Dyslexic children have changes related to phonological processing skills (difficulties in phonological awareness skills, working memory/phonological loop, and slow phonological lexical access) – i.e., changes in some aspects of representing or processing speech sounds[19]. They may also have failures in visual processing.

Both ADHD and dyslexia children have signs and symptoms related to delay and/or difficulties in the process of learning to write. Hence, this study aimed to analyze and compare the performance in writing tasks between students with ADHD and students with dyslexia.

METHODS

This analytical-descriptive observational cross-sectional study was registered on Plataforma Brasil under the Certificate of Presentation for Ethical Appreciation (CAAE) number 13728119.9.0000.5440 and approved by the Research Ethics Committee of the Clinics Hospital of the Medical School of Ribeirão Preto at the Universidade de São Paulo (HCFMRP – USP), Brazil, under evaluation report number 5608/2019. Data collection began only after the Research Ethics Committee's approval and the children's parents/guardians' consent.

Selection and characterization of the sample

The study initially analyzed 102 electronic medical records of children whose language had been assessed in speech-language-hearing therapy and who attended two interdisciplinary outpatient clinics at this institution between June 2016 and June 2019. This period was chosen because of the systematic use of standardized and updated instruments for speech-language-hearing and neuropsychological assessments. All these children were treated at the same public institution and were assessed by a pediatric neurologist, a speech-language-hearing pathologist specializing in language, and a psychologist specializing in neuropsychology. Each child's final diagnosis (ADHD, dyslexia, intellectual development disorder, or others) was only concluded after each professional had assessed them and the team had discussed their case.

The following inclusion criteria were defined for the medical record analysis: children diagnosed with ADHD, regardless of the type (inattentive, hyperactive, or mixed); children diagnosed with SLD-reading (dyslexia), regardless of whether it was comorbid with dyscalculia; not having other neurodevelopmental disorders (intellectual development disorder, autism spectrum disorder, childhood apraxia of speech, and language development disorder); not having ADHD and dyslexia as comorbidities; not having moderate/severe psychiatric disorders (e.g., suicidal ideation); not having genetic syndromes; not being diagnosed with hearing loss, regardless of its type or degree; and being 7 to 11 years old.

The exclusion criteria for both groups were children with a history of speech-language-hearing therapy for learning/speech difficulties and/or cognitive rehabilitation; children taking specific medication for attention at the time of the writing assessment; patients who did not perform all the tests used for this study; and children whose writing sample was incomplete or not obtained with the Writing to Dictation Test-short version (PED-vr, in Portuguese)[20].

The total sample, after applying the inclusion and exclusion criteria, comprised 27 children, divided into the following two groups:

- G-ADHD: 19 children diagnosed with ADHD, with a mean age of 8.9 years and a standard deviation of 1.1 (79% of them were males).
- G-Dyslexia: Eight children diagnosed with dyslexia, with a mean age of 9.1 years and a standard deviation of 0.6 (75% of them were males).

Data collection instruments and procedures:

The analysis to select and characterize the sample included the assessment reports of speech-language-hearing therapy, neuropsychological assessment, and medical clinical progress (all these documents were included in the patients' electronic medical records). Their writing was assessed based on the assessment record sheets of the speech-language-hearing therapy, appropriately filed at the institution.

The written texts were obtained with PED-vr[20]. It has 36 stimuli (24 words and 12 pseudowords), with varied lengths (two or three syllables), frequency (low or high frequency), and regularity (regular, rule-dependent, or irregular stimuli). The standard procedure is to give the child a blank sheet of paper with a table having three columns and twelve lines and ask them to write each dictated stimulus in a space. One stimulus is dictated at a time, but they are not repeated.

This study analyzed the children's written material in the following stages:

1st – Analysis of the writing level: This first analysis classified the 27 children's writing level, using the classification proposed by Ferreiro and Teberosky and reported in the article by Pestun et al.[21] with the following score correspondence: 4 points – alphabetical level; 3 points – syllabic-alphabetical level; 2 points – syllabic level; 1 point – pre-syllabic level; and 0 points – scribbles. The statistical analysis compared the percentage of children in the pre-syllabic, syllabic, and alphabetical levels and each group's mean score (the sum of scores equivalent to the writing level).

2nd – Analysis of writing performance: The writing performance was analyzed only on samples classified at the alphabetic (score 4) and syllabic-alphabetic levels (score 3). Children's performance in writing words and pseudowords was assessed with PED-vr[20].

The test analysis calculates each child's number of spelling errors in the dictation of words, pseudowords, and the total. These data were used to calculate error frequencies, and the latter defined standard scores, based on reference tables provided by the test.

Then, each sample was classified into deficient or adequate writing performance – deficient with very low or low classification and adequate with medium or high classification. Statistical inference consisted of comparing the percentage of children with adequate performance (medium/high) overall and in each subtask between the groups and comparing the standard score in each task between the groups.

3rd – Assessment of misspelling types[22]*:* The third and final analysis classified each child's types of misspellings, as follows: irregular phoneme-grapheme relationship errors (when a phoneme can be represented by different graphemes); oral support errors (when words are written the way they are pronounced); errors due to difficulty in using nasalization markers (use of the sound *m* at the end of words and before *p* and *b* graphemes, and the use of *n* at the end of syllables in the middle of words); errors due to difficulty in using accent marks (when the accent mark is omitted or incorrectly indicated); syllable omission errors (when there is an absence of syllables that should be part of the words); errors due to improper segmentation (when words are joined or separated incorrectly); errors in switching letters based on sound features (voiceless/voiced); errors due to inversion in relation to its own axis (when letters are mirrored or rotated); inversion errors in relation to the place it should take in the word (when there is a change of position within the syllable or word)[22,23]. The statistical analysis compared the number of errors committed per group.

Data analysis

Descriptive statistics were used to characterize the groups. Inferences were made with the two-proportion z-test between two samples to compare categorical data and the Mann-Whitney test (nonparametric test applied to two independent samples) for quantitative data. In both cases, the significance level was set at $\alpha = 0.05$.

RESULTS

The data collected to characterize the sample (children's mean age, intellectual estimate, sex, and so forth) are shown in Table 1. All the children included in this study attended public schools.

Table 1. Characterization of the sample regarding age, sex, and intellectual estimation

GROUPS	G-ADHD		G-Dyslexia	
Number of children (n)	19		8	
AGE	**Mean**	**SD**	**Mean**	**SD**
	8.95 years	1.1	9.13 years	0.64
SEX	**n**	**%**	**n**	**%**
FEMALES	4	21.1%	2	25%
MALES	15	78.9%	6	75%
WISC IV (TOTAL CLASSIFICATION)	**n**	**%**	**n**	**%**
EXTREMELY LOW	0	0%	0	0%
EXTREMELY LOW/BORDERLINE	1	5.3%	0	0.0%
BORDERLINE	1	5.3%	0	0.0%
LOW AVERAGE/BORDERLINE	1	5.3%	1	12.5%
LOW AVERAGE	3	15.8%	2	25.0%
LOW AVERAGE/AVERAGE	3	15.8%	1	12.5%
AVERAGE	8	42.1%	3	37.5%
AVERAGE/HIGH AVERAGE	1	5.3%	1	12.5%
HIGH AVERAGE/SUPERIOR	1	5.3%	0	0.0%
RAVEN'S COLORED TEST	**n**	**%**	**n**	**%**
EXTREMELY LOW	0	0%	0	0%
BELOW AVERAGE	1	5.3%	0	0.0%
AVERAGE	11	57.9%	3	37.5%
ABOVE AVERAGE	7	36.8%	5	62.5%

Source: Developed by the authors.
Captions: ADHD = attention-deficit/hyperactivity disorder; SD = standard deviation; n = number of children; % = percentage.

Only one child from G-Dyslexia out of the 27 writing samples was classified at writing level 3 (syllabic-alphabetic level); all other writing samples were classified at level 4 (alphabetic level). Thus, there was no difference between G-ADHD and G-Dyslexia regarding their mean score in this item (G-ADHD: mean of 4; SD of 0; G-Dyslexia: mean of 3.9; SD of 0. 3; p-value of 0.1).

Two analyses addressed the performance in the word and pseudoword dictation test – a quantitative analysis, comparing the standard score (Table 2), and the other approaching categorical variables (performance classification – Table 3).

Table 2. Analysis of the standard score in the Word and Pseudoword Dictation Test

DICTATED STIMULI	GROUPS	MEAN	STANDARD DEVIATION	MEDIAN	MAXIMUM	MINIMUM	P-VALUE
WORDS	G-ADHD	78.9	31.8	91	117	1	**0.005***
	G-Dyslexia	27.5	41.1	1	93	1	
PSEUDOWORDS	G-ADHD	92.1	26.9	98	123	21	**0.001***
	G-Dyslexia	36.3	36.2	29.5	90	1	
TOTAL	G-ADHD	82.7	31.7	96	117	1	**0.003***
	G-Dyslexia	26.9	39.2	1	88	1	

Source: Developed by the authors.
Caption: ADHD = attention-deficit/hyperactivity disorder
Mann-Whitney test (α = 0.05); * means there was a statistical difference.

Table 3. Analysis of the da proportion of children classified as deficient or adequate in the Word and Pseudoword Dictation Test

DICTATED STIMULI	GROUPS	% OF DEFICIENT			% OF ADEQUATE			P-VALUE
		Very low	Low	Total	Medium	High	Total	
WORDS	G-ADHD	26.3%	15.8%	42.1%	52.6%	5.3%	57.9%	0.059
	G-Dyslexia	75.0%	0.0%	75.0%	25.0%	0.0%	25.0%	
PSEUDOWORDS	G-ADHD	21.1%	10.5%	31.6%	47.4%	21.1%	68.5%	**0.004***
	G-Dyslexia	75.0%	12.5%	87.5%	12.5%	0.0%	12.5%	
TOTAL	G-ADHD	31.6%	10.5%	42.1%	47.4%	10.5%	57.9%	0.059
	G-Dyslexia	75.0%	0.0%	75.0%	25.0%	0.0%	25.0%	

Source: Developed by the authors.
Captions: ADHD = attention-deficit/hyperactivity disorder; % = percentage
Two-proportion z-test (α = 0.05); * means there was a statistical difference.

Table 2 shows higher means in G-ADHD in the categories of words, pseudowords, and total. Table 3 shows a higher percentage of children with deficits in G-Dyslexia in the categories of words, pseudowords, and total – although the groups were statistically different only in pseudowords. In G-Dyslexia, 75% of children had an abnormal writing performance, compared to 42% in G-ADHD.

The misspelling types and mean number of errors per group are presented in Table 4. It shows that practically all types of misspellings occurred in both groups, although the number of errors (significant difference) was greater in G-Dyslexia. Errors in the omission or addition of complex syllables and irregular phoneme-grapheme relationships prevailed in G-Dyslexia. In G-ADHD, the most frequent ones were irregular phoneme-grapheme relationships and difficulties with accent marks.

Table 4. Comparison of the number of misspellings between the two groups

Groups	G-ADHD					G-Dyslexia					p-value
Types of Misspellings	**Mean**	**SD**	**Median**	**Maximum**	**Minimum**	**Mean**	**SD**	**Median**	**Maximum**	**Minimum**	
Irregular phoneme-grapheme relationship	5.2	2.5	6	9	1	6	2	6	9	2	0.5
Orality support	0.8	0.9	1	3	0	0.25	0.4	0	1	0	0.08
Hypercorrection	0.1	0.3	0	1	0	0.25	0.4	0	1	0	0.3
Difficulties with nasalization markers	1.5	2.1	1	8	0	3	2	3	7	0	0.06
Difficulties with accent marks	2.3	0.8	3	3	0	2.9	0.6	3	4	2	0.1
Omission or addition in complex syllables	**2**	**3.4**	**0**	**10**	**0**	**9.6**	**7.2**	**9**	**24**	**0**	**0.004***
Addition in simple syllables	0.3	0.7	0	3	0	0.9	1	0.5	3	0	0.06
Omission of syllables	**0**	**0.2**	**0**	**1**	**0**	**0.9**	**1**	**0.5**	**3**	**0**	**0.006***
Inadequate segmentation	0	0.2	0	1	0	0	0	0	0	0	0.5
Switching based on sound features	0.6	1.2	0	5	0	2	2	1.5	5	0	0.06
Other types	**2.4**	**3.6**	**1**	**16**	**0**	**6.9**	**4.1**	**8**	**12**	**0**	**0.02***
Mistaking "am" for "ão"	0.8	0.7	1	2	0	0.5	1	0	3	0	0.1
Inverting in its own axis	0.1	0.3	0	1	0	0.25	0.7	0	2	0	0.8
Inverting the location in the word	0.2	0.5	0	2	0	0.75	0.8	0.5	2	0	0.06
Unintelligible words	0	0	0	0	0	0	0	0	0	0	0
Total of Misspellings	**16.5**	**10.9**	**15**	**46**	**4**	**34.1**	**14.3**	**38**	**56**	**8**	**0.001***

Source: Developed by the authors.
Captions: ADHD = attention-deficit/hyperactivity disorder; SD = standard deviation
Mann-Whitney test (α = 0.05); * means there was a statistical difference.

DISCUSSION

Even though this study had a convenience sample (children assessed by an interdisciplinary team within a specific time), there was a greater prevalence of children diagnosed with ADHD than with dyslexia – G-ADHD had 19 children, and G-Dyslexia had eight children. This characteristic agrees with the literature concerning the prevalence of these neurodevelopmental disorders, as the worldwide prevalence of ADHD in children is estimated at 5%[8,9], while that of dyslexia is at about 1.3%[18].

Regarding intellectual estimation, no child was classified as extremely low in WISC IV or Raven's colored test, agreeing with the diagnostic criteria proposed by DSM 5-revised[8,17]. Also, male children prevailed in both groups, a characteristic that is likewise described in the literature[8].

The initial hypothesis of this study was that the writing performance analysis would classify most children in G-Dyslexia at the syllabic-alphabetic level or lower and those in G-ADHD at the alphabetic level. This was hypothesized because reading/writing impairments are the basic diagnostic criteria for dyslexia[8,19], whereas children with ADHD have executive function impairments[11-15] that may or may not hinder the development of writing. However, the study results show that only one child in G-Dyslexia was classified at the syllabic-alphabetic level.

Nevertheless, the following data (analysis of the number and type of misspellings per group and writing performance classification according to the child's age) demonstrated that children with dyslexia have greater writing deficits than those with ADHD.

The analysis of the standard PED-vr score demonstrated children with dyslexia had lower scores than children with ADHD in all tasks (words, pseudowords, and total) – i.e., children with dyslexia made more errors than those with ADHD. This result is consistent with the study that assessed the performance of Italian children in a dictation test, revealing that the ones with dyslexia made more spelling errors than children with ADHD[24].

The proportion of writing samples classified as deficient or adequate with PED-vr showed that approximately 42% of children with ADHD were deficient, compared with 75% of those with dyslexia. This indicates that children with dyslexia are more likely to fail in writing than the ones with ADHD.

As previously mentioned, the diagnostic criteria for ADHD are mainly based on attentional difficulties and/or agitated/impulsive behavior[8], and their standard neuropsychological profile is that of deficits in executive functions (working memory, cognitive flexibility, impulse control, and so on)[11-16,25]. Hence, when they have deficits in reading and writing, they are generally a consequence of this condition. Even though ADHD is one of the most prevalent diagnoses in children with school/behavioral complaints (approximately 40%)[10], many children with ADHD do not have impairments in reading/writing tasks, as observed in this study (58% of children with ADHD adequately mastered writing). They can use other cognitive and environmental resources, enabling the satisfactory development of written language at basic levels (such as reading and writing words). A study that addressed risk and protective factors for the development of oral/written language concluded that social/maternal variables, such as teenage pregnancy and low maternal education, are the most significant risk factors for oral/written language deficits, rather than the signs and symptoms of attention and/or hyperactivity[26].

As for dyslexia, the diagnostic criterion is a persistent deficit in reading/writing, even with satisfactory intellectual estimation, adequate school education, and specialized interventions. Their underlying neuropsychological profile is mainly failure in phonological processing[8,18,27] – i.e., changes in some aspects of speech sound representation or processing, whose main behavioral symptoms are difficulties in phonological awareness skills and working memory/phonological loop and slow phonological lexical access.

The most prevalent misspellings in the G-Dyslexia writing samples were the omission or addition of graphemes in complex syllables, other spelling errors, and errors due to phoneme-grapheme irregularity. The comparison between G-Dyslexia and G-ADHD found more misspellings in G-Dyslexia in the total items, omission of syllables, omission or addition of graphemes in complex syllables, and other spelling errors.

The difference in misspelling classification between the groups indicates that children with dyslexia are at the initial alphabetic writing level and still have a long way to go to master Portuguese spelling. Children with ADHD have a higher prevalence of phoneme-grapheme irregularity errors and demonstrate that they are already mastering the spelling system.

The authors of a review that approached dyslexia and spelling[28] pointed out that difficulties in writing performance by dyslexics do not result exclusively from failures in phonological processing – they are also secondary to changes in orthographic processing. They also stated that a challenge faced by dyslexics is retaining phonological information to write new orthographic forms.

Analyses focused on misspellings by children with ADHD have found such errors to be at a more advanced level of writing development, such as those caused by irregularities in the language[22,29,30]. Phoneme-grapheme irregularity errors are the last ones "to disappear". Good readers/writers, even as adults, continue to make this type of error, but they resort to alternative ways, such as using a dictionary, to solve their problems. Therefore, remembering that 58% of children with ADHD were classified as performing adequately in writing, it is justified that the most prevalent error in this group is language irregularity errors.

CONCLUSION

Children presented with ADHD performed better in writing than those with dyslexia. However, writing cannot be used as a diagnostic marker between these conditions.

Around 42% of children in G-ADHD were classified with poor performance, as compared to 75% of the ones in G-Dyslexia. The latter also showed more misspellings.

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MTHF: study idea, design, and planning; manuscript final review.