

Visual-Motor Perceptual and Reading Processes of Schoolchildren With Attention Deficit Hyperactivity Disorder

Isabela Pires Metzner, Simone Aparecida Capellini

São Paulo State University “Júlio de Mesquita Filho” (UNESP), São Paulo, Brazil

Ilária D’Angelo, Noemi Del Bianco, Catia Giaconi

Università degli Studi di Macerata (UNIMC), Macerata, Italia

Objectives: Compare and relate the performance of schoolchildren with Attention Deficit Hyperactivity Disorder (ADHD) and with good academic performance in the visual-motor perceptual and reading processes. **Method:** Twenty schoolchildren, of both genders, aged between nine and 11 years old, participated in this study. They were divided into two groups: Group I (GI): comprising 10 students diagnosed with ADHD; and Group II (GII): 10 students with good academic performance paired according to gender, age group, and educational level with GI. All students were submitted to the Developmental Test of Visual Perception (DTVP 3) and Reading Processes Assessment Protocol (PROLEC). **Results:** There was lower performance of GI compared to GII in the subtests of copying, eye-hand coordination, and figure-ground in the standard score of general visual perception and visual-motor integration. GI presented lower performance in all reading processes except for the punctuation marks test. There was a statistically significant difference in the comparison between GI and GII regarding the classification of reading processes. A relationship was identified between the reading and visual perception subtests in the GI students, demonstrating a relationship between the visual perceptual motor skills and the reading processes in the group of students with ADHD. **Conclusion:** Schoolchildren with ADHD performed less well than their peers with good academic performance in the visual-motor perceptual and reading skills; such that the worse their performance in the visual-motor perceptual processes, the worse their performance in the reading processes.

Keywords: reading assessment, visual-motor perception, Attention Deficit Hyperactivity Disorder (ADHD), reading

Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a disorder characterized as a behavioral disorder with manifestations of inattention, hyperactivity, and impulsivity (DSM-5, 2014).

Isabela Pires Metzner, Master in Communication Sciences and Disorders, Department of Speech and Hearing Sciences, São Paulo State University “Júlio de Mesquita Filho” (UNESP), São Paulo, Brazil.

Simone Aparecida Capellini, Full Professor at Department of Speech and Hearing Sciences, São Paulo State University “Júlio de Mesquita Filho” (UNESP), São Paulo, Brazil.

Ilária D’Angelo, PhD student and subject culture in the chair of Pedagogy and Special Teaching at Dipartimento di Scienze della Formazione, dei Beni Culturali e del Turismo, Università degli Studi di Macerata (UNIMC), Macerata, Italia.

Noemi Del Bianco, PhD student and subject culture in the chair of Pedagogy and Special Teaching at Dipartimento di Scienze della Formazione, dei Beni Culturali e del Turismo, Università degli Studi di Macerata (UNIMC), Macerata, Italia.

Catia Giaconi, Full Professor at Dipartimento di Scienze della Formazione, dei Beni Culturali e del Turismo, Università degli Studi di Macerata (UNIMC), Macerata, Italia.

ADHD is the most common neuropsychiatric disorder that manifests during childhood, and is included among the most prevalent chronic diseases in schoolchildren (Faraone, 2003). The main manifestations of students with ADHD are the difficulty to maintain attention, hyperactivity, and impulsivity, consequently affecting several areas of adaptive, interpersonal, academic, familial, and school functioning (Fliers et al., 2008).

During the act of reading, the student needs to perform a refined visual processing of the graphic stimuli, in order to guarantee the textual scanning and identification of the parts that form the words, and this refined visual processing is related to the linguistic processing of reading. Students with ADHD may present difficulties in using this visual processing due to deficiencies in attention that are characteristic of this diagnosis and lead to impairment of phonological access (Oliveira et al., 2013; Cardo et al., 2011; Miranda-Casas, Fernández, Robledo, & García-Castellar, 2010).

National studies (Metzner, Santos, & Capellini, 2021; Okuda et al., 2011; Pinheiro, Lourenceti, & Santos, 2010) reported that schoolchildren with ADHD have visual perceptual motor impairment, corroborating the findings of this study, which demonstrated that GI had a lower performance than GII in copying, eye-hand coordination, and Figure-ground skills, since these activities require use of strategies that involve the visual recognition of shapes and the speed of visual motor coordination.

The low performance of students with ADHD in tasks that involve visual motor perception can be explained due to the fact that students in this population have attention deficits that can cause changes in perception and in the processing of visual information (Miranda, García, & Jara, 2001; Rabiner & Malone, 2004). Considering that the visual-motor perception skills are fundamental for reading, since they coordinate the visual information with the programming of the motor act during the reading process (Germano, Pinheiro, Okuda, & Capellini, 2013), thus the presence of this disorder causes considerable harm to these children's school performance.

According to the national literature, schoolchildren with ADHD present visual-motor perceptual deficits. The findings of this research corroborate studies carried out by Okuda et al. (2011), Pinheiro, Lourenceti, and Santos (2010), and Metzner, Santos, and Capellini (2021) that pointed out the visual-motor perceptual difficulties present in schoolchildren with ADHD when compared to the control group.

The same occurs when comparing performance in reading processes in which the group with ADHD presented difficulty in all reading processes, except for the punctuation marks test, showing a statistically significant difference in relation to the control group. Such data demonstrate that these students have lower performance in relation to students with good academic performance in tasks that involve the four reading processes (letter identification, lexical, syntactic and semantic processes), corroborating a study by Oliveira et al. (2013), and this lower performance can be explained by their difficulty in using the refined visual processing that is required during these tests.

In view of the above, the hypothesis of this study is based on the fact that impaired visual-motor processes in students with ADHD can compromise performance in decoding skills at the levels of words, phrases, and text, thus compromising their reading comprehension abilities.

Objectives

- Compare the performance of students with ADHD and with good academic performance in the visual-motor perceptual and reading processes.

- Relate the performance of students with ADHD and those with good academic performance in the visual-perceptual and reading processes.

Material and Method

This study was approved by the Research Ethics Committee of Faculty of Philosophy and Sciences, Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP), Campus de Marília, under Protocol Number 3.233.904.

This is a prospective observational cross-sectional study with comparison between groups. The sample was collected between August and December 2020 at the Laboratory of Investigation of Learning Deviations (LIDA) of the Department of Speech Therapy, located at the Specialized Center for Rehabilitation II (CER II), Faculty of Philosophy and Sciences, Universidade Estadual Paulista “Júlio de Mesquita Filho”-FFC/UNESP-Marília-SP.

Twenty children (13 males and seven females) participated in this study, aged nine years to 11 years and 11 months, who attended the 4th and 5th years of Elementary Schools in the Municipality of Marília-SP, Brazil. The students were divided into two groups:

- Group I (GI): composed of 10 students with an interdisciplinary diagnosis of ADHD.
- Group II (GII): composed of 10 students with good academic performance paired according to sex, age group, and education with GI students and selected from the normality database of the LIDA Laboratory.

The students in the group with ADHD were selected based on an evaluation carried out by the multidisciplinary team of the Laboratory for the Investigation of Learning Deviations (LIDA) of FFC/UNESP, composed of speech, neuropsychological and occupational therapy evaluations. As inclusion criteria, we considered the parents’ authorization by signing the informed consent form, the use of medication (methylphenidate) for six consecutive months and not undergoing speech therapy, pedagogical or psychopedagogical intervention at the time of conducting this study.

The sample size of this study was determined by the flow of patients diagnosed with ADHD at LIDA FFC/UNESP without presenting other neuropsychiatric conditions, such as Developmental Coordination Disorder (DCD), anxiety, depression, or others, thereby constituting a convenience sample.

The students were evaluated outside their school hours in individual consulting rooms with a distraction free, well lit, quiet and comfortable environment at the Specialized Center for Rehabilitation-CER II/FFC/UNESP-Marília-SP.

Data collection was carried out individually during the Covid-19 pandemic yellow-phase period and following all current safety rule directives.

The procedures of this research were applied in person and in accordance with the guidelines described in Normative Instruction Prope No. 1 (<https://www2.unesp.br/portal#!/prope/apoio-ao-pesquisador/orientacoes-covid-19/>) in relation to the Covid-19 virus transmission and in accordance with World Health Organization recommendations, regarding the correct use of Personal Protection Equipment (PPE) by the researcher.

Data collection was carried out with limited personal contact by means of scheduling, with only one student attended at a time, in a properly ventilated and separate room, together with the provision of a surgical mask and 70% alcohol for all participants.

In addition, the participants had their temperature measured before and after the procedures performed in each data collection session. All students were provided a disposable triple surgical mask and the evaluator

used a triple surgical mask, disposable apron and face shield. Disposable equipment was replaced for each new attendance. At the end of each individual attendance, the rooms were thoroughly disinfected by the CER II cleansing team.

Each student in the study was subjected to individual application of the following procedures:

1. Developmental Test of Visual Perception 3 (DTVP 3) (Hammill, Pearson, & Voress, 2014): This test consists of a battery of five subtests that measure different visual-motor and visual perception skills. It can be applied for four purposes, namely: (a) identifying children with visual-motor integration or visual perception problems; (b) determining the degree of severity of these problems; (c) verifying the effectiveness of intervention programs designed to correct these problems; and (d) serving as a measurement tool for investigations and research. Each test measures a type of visual reception capacity and can be considered as subtests for impaired motor skills (figure-ground, visual closure, and form constancy), general visual perception (copying, eye-hand coordination, figure-ground, visual closure, and form constancy), visual-motor integration (copying and eye-hand coordination).

The DTVP 3 Index is divided into: standard score, which is obtained from the gross score and its conversion using tables; and composite score, obtained by adding the standard scores and converting it into a classificatory quotient in relation to the general visual perception, motor-reduced perception skills, and visual-motor integration. All evaluated functions allow the calculation of an Age Equivalent (AE), that is, for each evaluated function, thus the score obtained allows the calculation of an “age of visual perception”. Only an English language version of the DTVP-3 used in this study is available in Brazil.

2. Evaluation of Reading Processes-PROLEC (Capellini, Oliveira, & Cuetos, 2010): This evaluation consists of four blocks distributed for the evaluation of four reading processes, as described below:

- First process: composed of two tests: The letter identification test aims to verify the student’s ability to name the letters and the sound they represent them. The test of equal and different for words and pseudo words aims to verify the student’s ability to identify, discriminate, and recognize real and invented words as being equal/different;
- Second process: lexical processes: composed of four tests. In the lexical decision test, the student must recognize only real words in a list of real and invented words. In the word reading tests, reading of pseudo words and reading of words and pseudo words, the student must perform the reading of real words and invented words, with the first test measuring the ability of the student to read real words and in the second, the ability to read invented words of different syllabic complexities, divided into CCV, VC, CVC, CVV, CCVC, and CVVC. In the third test, the objective is to analyze the use of phonological and lexical routes for reading. For this, words and pseudo words belonging to six categories were used: short high-frequency words, long high-frequency words, short low-frequency words, long low-frequency words, short pseudo words, and long pseudo words;
- Third process: syntactic processes, composed of two tests. In the grammatical structures test, the student’s ability to choose a sentence from different syntactic structures is verified: active voice, passive voice, and focused complement. In the punctuation marks test, the ability of schoolchildren to use punctuation marks in a short text is assessed;
- Fourth process: semantic processes, composed of two tests: comprehension of sentences and comprehension of texts. In these two tests, the student’s ability to understand simple items, phrases, and written texts is evaluated.

The data obtained were analyzed statistically in order to compare the intragroup and intergroup results. The SPSS Statistics (Statistical Package for the Social Sciences), version 20, Minitab 16, and Excel Office 2010 software were used to obtain and analyze the results.

The results were analyzed statistically using the following tests, Mann-Whitney Test, Chi-Square Test with Yates Correction and Spearman's Correlation Analysis, aiming to verify the intergroup differences studied for the variables of interest in the DTVP 3.

In the correlation analysis for variables with non-parametric distributions, Spearman's Coefficient was used in order to measure the degree of association between two quantitative variables of interest. In this analysis, the coefficient varies from -1 to +1; and the closer to these two extremes, the greater the association between the variables. Positive direction indicates a linear relationship, that is, the variables are directly proportional, while negative direction indicates that when there is an increase in one variable, there is a decrease in the other, or that is, the variables are inversely proportional (Zou, Tuncali, & Silverman, 2003).

The results were analyzed statistically at a significance level of 5% (0.05). The results that showed a statistically significant difference were highlighted with an asterisk (*).

Results and Discussion

Table 1 shows the data regarding the mean, standard deviation, and p-value for the comparison of the visual perceptual and visual-motor performance of schoolchildren in GI and GII.

With the application of Mann-Whitney Test, it was possible to verify lower performance of GI compared to GII in the subtests of copying, eye-hand coordination as part of the Age Equivalent, copying as part of the Age Equivalent, figure-ground as part of the Age Equivalent, form constancy of as part of the Age Equivalent, and copying as part of the general visual perception.

Table 1

Comparison of the Performance of GI and GII Students in the Subtests of the Developmental Test of Visual Perception 3 (DTVP-3)

Subtest	Group	Mean	SD	P value
EH	I	10	3.3	0.057
	II	10	1.7	
CO	I	11	2.1	0.001*
	II	18	3.3	
FG	I	10	1.8	0.144
	II	11	2.4	
VC	I	10	2.8	0.170
	II	10	1.6	
FC	I	11	3.1	0.156
	II	12	1.9	
EH-AE	I	6	2.7	0.011*
	II	10	2.2	
CO-AE	I	11	2.3	0.003*
	II	13	0.7	
FG-AE	I	9	2.9	0.013*
	II	13	0.3	
VC-AE	I	8	3.0	0.085
	II	10	2.5	

Table 1 to be continued

FC-AE	I	12	3.0	0.002*
	II	13	0.0	
EH-GVP	I	10	3.3	0.057
	II	10	1.7	
CO-GVP	I	12	3.1	0.006*
	II	18	3.3	
FG-GVP	I	10	1.8	0.144
	II	11	2.4	
VC-GVP	I	10	2.8	0.170
	II	10	1.6	
FC-GVP	I	11	3.1	0.156
	II	12	1.9	
FG-MRP	I	10	1.8	0.144
	II	11	2.4	
VC-MRP	I	10	2.8	0.170
	II	10	1.6	
FC-MRP	I	11	3.1	0.156
	II	12	1.9	
EH-VMI	I	10	3.3	0.057*
	II	10	1.7	
CO-VMI	I	12	3.1	0.006*
	II	18	3.3	

Notes. EH: Eye-Hand coordination; CO: Copying; FG: Figure-Ground; VC: Visual Closure; FC: Form Constancy; EH-AE: Age Equivalent in Eye-Hand coordination subtest; CO-AE: Age Equivalent in Copying subtest; FG-AE: Age Equivalent in Figure Ground subtest; VC-AE: Age Equivalent in the Visual Closure subtest; EH-GVP: General Visual Perception in Eye-Hand coordination subtest; CO-GVP: General Visual Perception in the Copying subtest; FG-GVP: General Visual Perception in the Figure-Ground subtest; VC-GVP: General Visual Perception in the Visual Closure subtest; FC-GVP: General Visual Perception in the Form Constancy subtest; FG-MRP: Motor-Reduced Visual Perception in the Figure-Ground subtest; VC-MRP: Motor-Reduced Visual Perception in the Visual Closure subtest; FC-MRP: Motor-Reduced Visual Perception in the Form Constancy subtest; CO-VMI: Visual-Motor Integration in the Copying coordination test; VMI: Visual-Motor Integration.

Table 2 presents the data regarding mean, standard deviation, and p value for comparing performance in the reading processes of the schoolchildren in GI and GII.

With the application of Mann-Whitney Test, it was possible to verify lower performance of GI in comparison to GII in all PROLEC subtests except for the punctuation marks test.

Table 2

Comparison of the Performance of Students From GI and GII in the Subtests of the Reading Processes-PROLEC

Subtests	Group	Mean	SD	P value
LNS	I	20	2.6	0.030*
	II	20	0.0	
ED	I	18	5.5	0.005*
	II	20	0.0	
LD	I	26	8.9	0.000*
	II	30	0.0	
RW	I	30	8.5	0.013*
	II	30	0.0	

Table 2 to be continued

RPW	I	22	10.3	0.001*
	II	30	0.0	
RFW	I	17	4.6	0.002*
	II	20	0.0	
RNFW	I	18	4.8	0.002*
	II	20	0.0	
RPW2	I	17	5.5	0.002*
	II	20	0.0	
GS	I	12	4.5	0.000*
	II	15	0.0	
PM	I	16	5.9	0.103
	II	10	0.0	
SC	I	11	3.2	0.013*
	II	12	0.0	
TC	I	9	4.7	0.001*
	II	14	0.7	

Notes. LNS-Letter Name or Sound; ED-Equal and different; LD-Lexical Decision; RW-Reading Words; RPW-Reading Pseudo Words; RFW-Reading Frequent Words; RNFW-Reading Non-Frequent Words; RPW2-Reading Pseudo Words 2; GS-Grammatical Structures; PM-Punctuation Marks; SC-Sentence Comprehension; TC-Text Comprehension.

Researchers (Åsberg, Dahlgren, & Sandberg, 2008; Miranda, & Soriano, 2011; Cunha et al., 2013) have demonstrated that the reading difficulties presented by students with ADHD could be related to difficulties in autoregulation, which impairs the execution of tests to evaluate their reading skills as well as deficits inattention (Cardo et al., 2011; Oliveira et al., 2013; Miranda-Casas et al., 2010) and alterations in executive function (Lobo & Lima, 2008).

Lobo and Lima (2008), and Germano et al. (2013) have demonstrated that the alterations in reading found among schoolchildren with ADHD are a consequence of a deficit in their sequential and temporal organization of phenomena, which are necessary for reading words and pseudo words.

In addition, the results found in this study corroborate the study by Barkley, & Roizman (2002), which suggested that students with ADHD have difficulties in maintaining attention during the performance of long tasks with many stimuli, since these require high maintenance of the stimulus, as in the case of reading lists of words and text.

The executive function offers an important role in the interaction between visual, linguistic, and auditory processing, and when impaired, as in students with ADHD, it changes the phonological mechanisms of reading, resulting in failures in the automation of phonological decoding (Oliveira et al., 2013; Gallardo-Paúls, Martínez, & Campos, 2010; Lobo & Lima, 2008; Martinussen & Tannock, 2006; Miranda-Casas et al., 2010; Oliveira & Albuquerque, 2009; Papazian, Alfonso, & Luzondo, 2006). This explains the fact that GI students in this study had inferior reading profiles when compared to students with good academic performance.

Table 2 shows the results from the study of the relationship between the performance of GI students in the subtests of the developmental test of visual perception and reading processes.

With the application of Spearman's Correlation Analysis, it was possible to verify that there was a relationship between the subtests of PROLEC with the visual-motor skills of DTVP-3 in the GI students. Correlation analysis was performed only in GI, because in GII there was no variability in the results, making it impossible for a statistical analysis according to two analysts and reviewers in the statistical area.

Table 2 shows the presence of some significant correlations and that all are positive, thus demonstrating that the better the performance in the visual-motor perceptual processes, the better the performance in the reading processes.

Table 3

Distribution of the Correlation Between the Performance of GI Students in the Subtests of the Developmental Test of Visual Perception 3 (DTVP-3) and Reading Processes (PROLEC)

Subtests	Corr. coef. (r) p value	LNS	ED	LD	RW	RPW	RFW	RNFW	RPW2	GS	PM	SC	TC
EH-GVP	(r)	0.243	0.184	0.576	0.402	0.400	0.525	0.458	0.428	0.431	0.771	0.632	0.539
	P	0.498	0.611	0.082	0.250	0.253	0.119	0.184	0.218	0.214	0.009*	0.050*	0.108
CO-GVP	R	-0.061	0.682	0.685	0.105	0.527	0.585	0.531	0.561	0.671	0.553	0.492	0.198
	P	0.867	0.030*	0.029*	0.773	0.117	0.076	0.114	0.091	0.034*	0.098	0.149	0.584
FG-GVP	R	0.305	0.577	0.796	0.275	0.438	0.508	0.487	0.461	0.619	0.739	0.421	0.717
	P	0.392	0.081	0.006*	0.442	0.206	0.134	0.153	0.180	0.056	0.015*	0.226	0.020*
VC-GVP	R	0.482	0.524	0.498	0.720	0.527	0.576	0.614	0.553	0.623	0.634	0.403	0.922
	P	0.159	0.120	0.143	0.019*	0.118	0.081	0.059	0.097	0.054	0.049*	0.248	<0.001*
FC-GVP	R	-0.289	0.044	-0.006	0.000	0.117	0.006	0.037	0.161	0.120	-0.039	0.150	-0.064
	P	0.418	0.904	0.986	1.000	0.748	0.986	0.919	0.657	0.742	0.915	0.680	0.860
FG-MRP	R	0.305	0.577	0.796	0.275	0.438	0.508	0.487	0.461	0.619	0.739	0.421	0.717
	P	0.392	0.081	0.006*	0.442	0.206	0.134	0.153	0.180	0.056	0.015*	0.226	0.020*
VC-MRP	R	0.482	0.524	0.498	0.720	0.527	0.576	0.614	0.553	0.623	0.634	0.403	0.922
	P	0.159	0.120	0.143	0.019*	0.118	0.081	0.059	0.097	0.054	0.049*	0.248	<0.001*
FC-MRP	R	-0.289	0.044	-0.006	0.000	0.117	0.006	0.037	0.161	0.120	-0.039	0.150	-0.064
	P	0.418	0.904	0.986	1.000	0.748	0.986	0.919	0.657	0.742	0.915	0.680	0.860
EH-VMI	R	0.243	0.184	0.576	0.402	0.400	0.525	0.458	0.428	0.431	0.771	0.632	0.539
	P	0.498	0.611	0.082	0.250	0.253	0.119	0.184	0.218	0.214	0.009*	0.050*	0.108
CO-VMI	R	-0.061	0.682	0.685	0.105	0.527	0.585	0.531	0.561	0.671	0.553	0.492	0.198
	P	0.867	0.030*	0.029*	0.773	0.117	0.076	0.114	0.091	0.034*	0.098	0.149	0.584

Notes. LNS-Letter Name or Sound; ED-Equal and Different; LD-Lexical Decision; RW-Reading Words; RPW-Reading Pseudo Words; RFW-Reading Frequent Words; RNFW-Reading Non Frequent Words; RPW2-Reading Pseudo Words 2; GS-Grammar Structures; PM-Punctuation Marks; SC-Sentence Comprehension; TC-Text Comprehension; EH-Eye-Hand coordination; CO-Copying; FG-Figure-Ground; VC-Visual Closure; FC-Form Constancy; GVP-General Visual Perception; MRP-Motor-Reduced Visual Perception; VMI-Visual-Motor Integration.

In Table 3, we observed that there was a strong positive relationship between the skills of punctuation marks and the skills of eye-hand coordination as part of the general visual perception and visual-motor integration, a weak positive relationship between the skills of visual closure as part of the general visual perception and motor-reduced visual perception, demonstrating that for the child to identify and use punctuation marks during reading, visual-motor coordination, recognition of images, and parts of images are necessary to insert the stimulus, in this case the punctuation mark, into a visual sensory context.

In the sentence comprehension skill, it was possible to verify that there was a weak positive relationship with the hand-eye coordination skill as part of the general visual perception and visual-motor integration, demonstrating that the ability to coordinate visual information with motor programming is a skill required in performing a reading task, where it is necessary for the student to perform reading comprehension.

In the equal and different ability it was possible to verify that there was a weak positive relationship with the skills of copying as part of the general visual perception and visual-motor integration, demonstrating that

the ability to identify similarities and differences in words has a relationship, albeit weak, with perception and details, which is a skill presented in copying.

In the lexical decision skill, it was possible to verify that there was a weak positive relationship with the copying skills as part of the general visual perception and visual-motor integration and a weak positive relationship with the figure-ground ability as part of the general visual perception and reduced motor skills, demonstrating that the skill of perception of details, which is a skill required in copying and the figure-ground ability are necessary to quickly decide whether a word is real or invented, when the words are offered simultaneously to the child.

In the grammatical structures ability it was possible to verify that there was a weak positive relationship with the copying skill as part of the general visual perception and visual-motor integration, revealing that the ability to identify sentences grammatically has a relationship, even if weak, with perception and details, which is a skill present in copying.

In the text comprehension ability it was possible to verify that there was a weak positive relationship with the figure-ground ability as part of the general visual perception and reduced motor skills and a strong positive relationship with the visual closure ability as part of the general visual perception, showing that, to understand a read text it is necessary to recognize each part of the letters that form the words in order to perform the decoding, while at the same time it is necessary to select a single image, in this case the word, in a visual sensory context for consecutive extraction of the meaning.

Finally, in the ability to read words it was possible to verify that there was a weak positive relationship with the visual closure ability as part of the reduced motor skills, demonstrating that to perform the decoding task it is necessary to recognize each part of the letters that form the words.

The findings of this study proposed to go beyond a study with comparison between groups to relate the visual-motor perception findings and reading processes, in an attempt to seek an explanation for the reading difficulties among students with ADHD.

The input system for reading is the visual system and therefore, observing through the analysis of this study that there is a relationship between the investigated skills can offer better foundation and knowledge regarding the type of educational or clinical intervention that can be performed to assist students with ADHD.

The poor performance of students with ADHD in tasks that involve the visual-motor perception and the relationship of these tasks with the reading processes found in the results of this study alerts us to the possibility for the need to investigate these visual processes when there are alterations in the reading processes, since visual-motor perceptual skills are necessary to capture visual information for later activation of phonological and lexical routes for the effective processing of reading.

Each time the student correctly reads a word, following the rules of grapheme-phoneme conversion, the orthographic representation of the word is formed. However, if such processing is slow and laborious, it becomes inefficient and prone to errors, and such a task will require considerable cognitive energy from students as described by Buchweitz (2016), Clemens et al. (2020), and Cuetos and Vega (2010). This observation is applicable to the results of this study, since we demonstrated an increase in cognitive demand during the reading processes among schoolchildren with ADHD.

Thus, this study reveals that the difficulties of students with ADHD in the reading processes can be justified by the visual-motor perceptual deficit, which compromises their ability to identify and decode words, causing difficulty in accessing meaning at the level of words and texts.

The positive relationships found in this study showed the parallelism between visual-motor skills and reading; however, the weak or moderate relationships might be revealing the presence of adaptation mechanisms that students with ADHD develop over their school years such that the visual-motor perceptual and reading difficulties are compensated during the execution of tasks with visual-motor and reading processes when measured in isolation.

Based on analysis of the results from this study, we found that the study hypothesis was confirmed, since we demonstrated that there are impaired visual-motor processes in schoolchildren with ADHD and that these can reduce their performance in decoding skills both at the level of real words and pseudo words as in the sentence level, thus compromising reading comprehension skills.

Conclusion

From our results we concluded that students with ADHD presented lower performance compared to students with good academic performance in the subtests of copying, eye-hand coordination as part of the Age Equivalent, copying as part of the Age Equivalent, figure-ground as part of Age Equivalent, form constancy as part of the general visual perception and copying as part of the visual-motor integration.

Regarding analysis of the performance of students in the evaluation of reading processes, it was possible to observe that students with ADHD in this study showed poorer performance in all PROLEC tests, except for the punctuation marks test, when compared to schoolchildren with good academic performance.

It was possible to determine that there was a relationship between the visual-motor perceptual skills and the skills of the reading processes, thus showing that the worse their performance in the visual-motor perceptual processes, the worse their performance in reading processes. Thus, the visual-motor perceptual skills is necessary for the decoding process and consequently for reading comprehension. In addition, this study demonstrated that there are altered visual-motor processes in students with ADHD and that these can impair their performance in reading tasks.

On completion of this study, it is expected that the data presented and discussed here can contribute to guide the diagnosis and differential diagnosis of reading alterations, since the visual-motor perceptual and reading changes found in this study are secondary to the ADHD condition.

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