Original Article

Artigo Original

Visual-motor perception of students with attention deficit hyperactivity disorder

Percepção viso-motora de escolares com Transtorno do Déficit de Atenção com Hiperatividade

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Keywords

Attention deficit disorder with hyperactivity
Visual perception
Motor skills
Evaluation
Education

ABSTRACT

Purpose: The aim of this study was to characterize and compare the visual-motor perception of students with attention deficit hyperactivity disorder and students with good academic performance. **Methods:** Forty male students (100%) from the 2nd to the 5th grades of an elementary public school, aged between 7 to 10 years and 8 months old participated in the study. They were divided into two groups: GI (20 students with attention deficit hyperactivity disorder) and GII (20 students with good academic performance), paired according to age, schooling, and gender. The students were submitted to the Developmental Test of Visual Perception. **Results:** Students of GI presented inferior performance in spatial position and visual closure (reduced motor) when compared to GII and performance equivalent to lower age students in reduced motor perception. **Conclusion:** The difficulties in visual-motor perception presented by students of GI cannot be attributed to a primary deficit, but to a secondary phenomenon of inattention that directly interferes in their visual-motor performance.

Descritores

Transtorno do déficit de atenção com hiperatividade
Percepção visual
Destreza motora
Avaliação
Educação

RESUMO

Objetivo: Caracterizar e comparar as habilidades de percepção viso-motoras de escolares com Transtorno do Déficit de Atenção com Hiperatividade (TDAH) com escolares com bom desempenho acadêmico. **Métodos:** Participaram deste estudo 40 escolares na faixa etária de 7 anos a 10 anos e 8 meses, do 2º ao 5º ano do Ensino Fundamental de escolas públicas, divididos em GI (20 escolares com diagnóstico interdisciplinar de TDAH) do gênero masculino (100%) e GII (20 escolares com bom desempenho escolar), pareados com o GI em idade, escolaridade e gênero. Os escolares foram submetidos ao Teste Evolutivo de Percepção Visual (DTVP-2). **Resultados:** Os escolares de GI apresentaram desempenho inferior na função de posição no espaço e closura visual (motricidade reduzida) em relação ao GII e equivalente a idade inferior para percepção de motricidade reduzida. **Conclusão:** As dificuldades em percepção viso-motora apresentadas pelos escolares de GI podem ser atribuídas não a um déficit primário, mas a um fenômeno secundário à desatenção que interfere de forma direta em seu desempenho de percepção viso-motora.

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Received: 12/05/2011

Accepted: 08/05/2013

Study carried out at the Laboratory for the Investigation of Learning Disabilities, Education and Health Study Center, School of Philosophy and Sciences, Universidade Estadual Paulista "Júlio de Mesquita Filho" – UNESP – and in the Neurological Infant Outpatient Clinic-Learning Deviance, Hospital das Clínicas, School of Medicine, Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), Botucatu (SP), Brasil.
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Conflict of interests: nothing to declare.

INTRODUCTION

The acquisition of handwriting requires a combination of coordinated visual-motor skills with motor, cognitive planning, and perceptual skills (tactile-kinesthetic abilities, organization in space and time). The visual-motor integration (VMI) is defined as the ability to coordinate visual information and motor programming, thus being an important variable in the development of writing. With that, the student is able to perform a copy or transposition of texts, cursive letter, reproduction of isolated and sequential numbers and letters[1,2].

Visual perception requires the connection of volunteer attention and the programming and reprogramming ability of the organs that are responsible for motor activity. Therefore, the efficacy of programming speed occurs while the tactile-perceptive information adjusts to the visual information[3-5], due to the integrity of cortical structures[6-9].

The student who does not develop this visual-motor integrative skill may present difficulties to write, that is, issues concerning the quality of writing, thus damaging school progress and favoring the appearance of emotional, behavioral, and learning problems[3]. In international[10,11] and national[12,13] literature, the relationship between dyslexia, learning disabilities, and changes in fine and gross motor coordination has been described, as well as the relationship between visual-motor perception and reading development of students with these learning disabilities.

Throughout the years, the literature[14,15] has also described that one of the neurological conditions that compromises the VMI is the attention deficit hyperactivity disorder (ADHD). ADHD is the most common neuropsychiatric disorder in childhood, which affects from 3 to 6% of the children at school age. Its main manifestations are difficulty in paying attention, hyperactivity and/or impulsiveness, usually affecting different areas of adaptive functioning, which is known for being interpersonal, academic, or familiar[16,17].

Among the clinical physical speech language manifestations presented by the students with ADHD, there is the visual-spatial perceptual deficit, related to executive dysfunctions, psychomotor agitation, and altered writing quality, known as unintelligible writing or dysgraphia. Therefore, due to these manifestations, the student with ADHD presents deficits in the integration of visual-motor perception that can be a result of the attention-related changes and the difficulties in visual-spatial perception, executive function, perceptive organization, synchronism, delayed maturation of coordination, and constructive dyspraxia[18-20].

Besides these changes, students with ADHD tend to find difficulties in fine motor coordination (picking up objects, buttoning up clothes, playing ball, coloring within the lines of figures, writing onto the line in a uniform size, writing with understandable letter) and global skills (difficulties to run or jump and problems with laterality)[19], and such difficulties may be related to visual-motor perception changes[18-20], which are easy to identify during the speech language pathology evaluation and in the educational context.

Dysgraphia stands out among the most noticeable speech language manifestations in ADHD, since it is defined as a written expression disorder that results in written skills below the expected for the age, associated with legibility (quality of forming and aligning the letters, spaces between letters and words, letter dimension), and reduced speed (production rate)[3,4,10,13,21].

Even though the reasons for dysgraphia are associated with motor planning, eye-hand coordination, visual perception, VMI, kinesthetic perception, fine motor control, sustained attention, and hand manipulation[4,10,20], further and deeper studies are required concerning the role of visual and visual-motor perception skills to determine unintelligible handwriting, that is, the picture of dysgraphia, since these are still limited in the national literature, be it with students at the final stage of school or those with attention and learning disabilities.

Based on this reality, this study aimed to characterize and compare the visual-motor skills of students diagnosed with ADHD and others with good academic performance.

METHODS

This study was approved by the Research Ethics Committee of the institution of origin, protocol number 0149/2011.

Forty students aged between 7 and 10 years and 8 months old participated in this study, with an average socioeconomic status based on the Socioeconomic Development Index[22], from the elementary grades of public municipal schools. Students were divided into two groups:

- Group I (GI): Twenty male students (100%) with interdisciplinary diagnosis of ADHD, according to the proposed criteria[23], on medication (methylphenidate) indicated by the neurologist for at least 6 months. Students in this group presented unsatisfactory academic performance, defined by grades equal or inferior to five in Portuguese (reading, writing, and copy assessment) and Math tests (arithmetical operations with and without title). Evaluations were conducted by the teachers in the classroom, who reported unintelligible writing. Students did not present history of speech language pathology or pedagogical therapies prior to this study and were part of the waiting list for speech language intervention related to reading and writing in the institution of origin.
- Group II (GII): Twenty students with good school performance in 4 months, with satisfactory academic performance, assessed with grades higher than five in Portuguese (reading, writing, and copy assessment) and Math tests (arithmetical operations with and without title), conducted by the teachers in the classroom. Students of GII who participated in this study were indicated by the teachers and paired with GI according to age, schooling, and gender. Only students who presented the signed informed consent could participate in this study, and also those who did not present pre, peri, and postnatal intercurrences or delayed neuropsychomotor and language development described in school records.

All students were subjected to the Developmental Test of Visual Perception (DTVP-2)[24], comprising eight subtests which measure visual-motor skills inter-related with different visual perception abilities. Its reliability and validity were empirically established[23] and the procedure has no basal levels, once the tests begin with the item 1 of each subtest.

DTVP-2 consists of a battery of eight subtests that measure visual-motor and visual-perception skills that are different, but inter-related. Therefore, each of the eight subtests measures one kind of visual-perception skill, be it spatial position (SP), constancy of form (CF), spatial relations (SR), or figure-ground (FG). On the other hand, each subtest can be classified as reduced motricity or complete motricity[24].

Subtests that compound the DTVP-2 are: visual-motor coordination (VMC), SP, copy (C), FG, SR, visual closure (VC), visual-motor speed (VMS), and CF. All subtests measure one type of visual perception skill, and they can be considered as reduced motricity (SP, FG, VC, and CF) and complete motricity or VMI tests (VMC, C, SR, VMS).

Scores are divided into: standard score, which is obtained from the gross score and its conversion with the use of tables, and compounded score, obtained by adding the standard score and its conversion in a classificatory quotient in relation to general visual perception (GVP), reduced motricity perception (RMP), and VMI. All assessed functions lead to the age equivalent (AE) calculation, that is, for each assessed function the obtained score enables the calculation of a "visual perception age".

The obtained results were statistically analyzed with the Mann-Whitney test in order to check for possible different performances in tasks among the studied groups, and the Likelihood ratio-test was used to compare the performances between the subtests of both groups in this study. The adopted significance level (p-value) was 5% (0.050), marked with an asterisk. The software Statistical Package for the Social Sciences, version 17.0, was used for data analysis.

RESULTS

Table 1 presents mean, standard deviation, median, and p-value regarding the comparison between GI and GII and the results of visual-motor perception subtests analyzed with the Mann-Whitney test.

In Table 1, it was possible to observe that there were differences between GI and GII concerning performances per subtest, which demonstrates that GI presented inferior performance in the function SP and VC, and GII in the function VMS.

Table 2 presents mean, standard deviation, and significance of the comparison between GI and GII in subtests of GVP, RMP, VMI, and in relation to the mean of AEs in each of the functions, for each group, analyzed with the Mann-Whitney test.

In Table 2, it was possible to notice differences between GI and GII when comparing their general performances, which demonstrates that GI presented inferior performance in tests of RMP and lower AE for RMP in relation to GII.

Table 1. Performance comparison beween GI and GII in visual-motor perception subtests

Variable	Group	n	Mean	Standard deviation	Median	p-value*
VMC	I	20	145.60	18.63	146.50	0.725
	II	20	145.35	28.19	150.00	
	Total	40	145.48	23.58	147.50	
SP	I	20	14.05	6.67	15.00	0.015*
	II	20	18.45	6.85	20.50	
	Total	40	16.25	7.03	17.50	
C	I	20	26.80	5.51	26.50	0.171
	II	20	28.65	5.53	30.50	
	Total	40	27.73	5.53	28.50	
FG	I	20	8.95	2.74	8.50	0.343
	II	20	9.75	2.88	9.00	
	Total	40	9.35	2.81	9.00	
SE	I	20	32.00	11.80	36.00	0.289
	II	20	38.75	6.30	42.00	
	Total	40	35.38	9.94	40.50	
VC	I	20	6.95	4.27	6.00	0.011*
	II	20	10.85	5.35	11.50	
	Total	40	8.90	5.17	8.00	
VMS	I	20	14.40	9.27	13.00	0.009*
	II	20	7.35	3.84	8.00	
	Total	40	10.88	7.86	9.00	
CF	I	20	8.95	3.98	9.00	0.348
	II	20	10.10	3.37	9.50	
	Total	40	9.53	3.69	9.00	

*Significant values – Mann-Whitney test

Caption: VMC = visual-motor coordination; SP = spatial position; C = copy; FG = figure-ground; SR = spatial relation; VC = visual closure; VMS = visual-motor speed; CF = constancy of form

Table 2. Performance comparison between GI and GII in general visual perception, reduced motricity perception, and visual-motor integration subtests in relation to age equivalents in each of the functions

Variable	Group	n	Mean	Standard deviation	p-value*
CA	I	20	8.88	1.06	0.850
	II	20	8.85	1.01	
	Total	40	8.86	1.02	
GVP	I	20	80.70	15.67	0.068
	II	20	86.75	8.93	
	Total	40	83.73	12.96	
AE GVP	I	20	6.65	1.72	0.148
	II	20	7.39	1.77	
	Total	40	7.02	1.76	
RMP	I	20	72.40	16.30	0.005*
	II	20	84.50	12.80	
	Total	40	78.45	15.71	
AE RMP	I	20	5.41	1.69	0.004*
	II	20	6.96	1.95	
	Total	40	6.18	1.97	
VMI	I	20	87.60	18.73	0.735
	II	20	89.95	10.35	
	Total	40	88.78	14.98	
AE VMI	I	20	7.94	2.02	0.903
	II	20	7.85	1.63	
	Total	40	7.89	1.81	

*Significant values – Mann-Whitney test

Caption: CA = chronological age; GVP = general visual perception; AE = age equivalent; RMP = reduced motricity perception; VMI = visual-motor integration

Table 3 shows the comparison of GVP, RMP, and VMI performances between GI and GII.

In Table 3, it was observed that the results of classifications of visual perceptions analyzed by the Likelihood ratio-test demonstrated differences between GI and GII only

Table 3. Comparison between GI and GII in relation to the classification of performance in general visual perception, reduced motricity perception, and visual-motor integration

	Group	Classification of performance					Total	p-value
		1	2	3	4	6		
PVG	I	5 (25%)	5 (25%)	5 (25%)	4 (20%)	1 (5%)	20 (100%)	0.192
	II	2 (10%)	2 (10%)	8 (40%)	8 (40%)	0 (0%)	20 (100%)	
	Total	7 (17.5%)	7 (17.5%)	12 (30%)	1 (2.5%)	1 (2.5%)	40 (100%)	
PMR	I	8 (40%)	8 (40%)	3 (15%)	0 (0%)	1 (5%)	20 (100%)	0.001*
	II	4 (20%)	3 (15%)	4 (20%)	9 (45%)	0 (0%)	20 (100%)	
	Total	12 (30%)	11 (27.5%)	7 (17.5%)	9 (22.5%)	1 (2.5%)	40 (100%)	
IMV	I	5 (25%)	1 (5%)	6 (30%)	6 (30%)	2 (10%)	20 (100%)	0.086
	II	1 (5%)	2 (10%)	5 (25%)	12 (60%)	0 (0%)	20 (100%)	
	Total	6 (15%)	3 (7.5%)	11 (27.5%)	18 (45%)	2 (5%)	40 (100%)	

*Significant values – Likelihood ratio-test

Caption: GVP = general visual perception; RMP = reduced motricity perception; VMI = visual-motor integration; 1 = very weak; 2 = weak; 3 = below average; 4 = average; 5 = above average; 6 = very good

concerning RMP, which demonstrates that the classification obtained by students in GI is inferior to that obtained by the ones in GII.

The classification of performances was converted into numerical forms (1 = very weak; 2 = weak; 3 = below average; 4 = average; 5 = above average; 6 = very good) in order to make statistical data analysis easier. Therefore, when we observe Table 3, there are no analyses related to the classification of visual perception performance with grade 5 (above average) in GVP and in RMP, and also there are no analyses related to the classification of visual perception performance with grade 6 (very good) in VMI, since none of the students reached these classifications.

DISCUSSION

Based on the obtained data, it was possible to observe that students with ADHD presented inferior development in relation to students with good academic performance, concerning functions of SP and VC, related to reduced motricity (visual perception without motor components), thus mostly obtaining the very weak and weak performance classifications, with inferior performances in the skills of SP and VC, when compared to the students with good academic performance.

Feder and Majnemer[3] reported that the SP skill enables the student to realize and identify spaces between letters, words, and lines, while the VC skill enables the student to identify which letters were completely written.

So, it is possible to state that the students with ADHD in this study presented visual-motor perception changes, thus corroborating studies described in international[2,14] and national[13,25] literature. Therefore, we can consider that difficulties to execute visual-motor perception and visual perception skills (reduced motricity) demonstrated in these students may compromise their handwriting performance, leading to dysgraphia, as described in the literature[21,26].

Visual-motor skills are directly related to handwriting, that is, graphic-motor action, and also the reading skill, since they depend on the recognition of details, simultaneous processing, visual-spatial organization, spatial relation between figures, and integration of the parts of a whole, giving meaning to the forms of the letters and, consequently, affecting motor development (graphic-motor) for the production of these letters, causing difficulties to acquire basic school reading and writing skills[20,18,26-28].

Brown, Unsworth and Lyons[2] and Feder and Majnemer[3] reported that the low performance in previously mentioned skills leads to fine and global motor coordination difficulties and perceptual issues, as well as problems with reading, mathematics, and also in other academic fields.

So, for students with ADHD in this study, the inferior performance in fine motor skills corroborates the literature, which reported that such performance can be attributed to the deficit in movement speed and to the immature coordination development, both subjected to the brain coordination of alternated muscle groups[29], thus indicating that the results found in this study may lead the speech language pathologist to reflect more about the relations between visual-motor perception skills and the quality of dysgraphic writing among students with ADHD.

However, we should also consider that besides the visual-motor skills analyzed in this article, other factors, such as impulsiveness or inhibition control and self-regulation, related to the executive functions, are important factors to be analyzed and taken into account, since they are responsible for motor planning; therefore, the investigation of these aspects should also be conducted at the time of the speech language pathology clinical assessment, especially if one of the manifestations of the student with ADHD is unintelligible writing.

CONCLUSION

Students with ADHD in this study presented inferior performance in visual-motor perception skills when compared to students with good academic performance, characterized by changes in RMP (SP, FG, VC, and CF) and by alterations in VMI (VMC, C, SR, and VMS).

**GDG was in charge of the elaboration of the research proposal, analysis of results and writing the manuscript; FHP performed data collection; PMMO performed data collection, tabulation and analysis; SAC was responsible for the study project and design, as well as the general orientation of steps of execution and elaboration of the manuscript.*

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