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Effect of a psychomotor intervention program for children with ADHD

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Abstract

This study verified the effectiveness of a psychomotor intervention program for children with ADHD. The study compared the psychomotor and cognitive performance of children with ADHD submitted and not submitted to psychomotor intervention. Twenty-six male children, 14 with ADHD, divided into experimental group I and II (GE I / GE II), and 12 with typical development grouped into the control group (CG) participated in the study. The children of the GE performed psychomotor and cognitive evaluation at both moments, pre- and post-intervention, and were compared to the CG in the evaluation after the intervention. There were statistically significant differences in the classification scores of the psychomotor profile and in the attention tests and executive functions. It was observed a tendency of improvement indicated by the increase of the means of the functions of body notion, equilibration, temporal space structure, fine praxis, laterality and tonicity, respectively. The results suggest that psychomotor intervention was effective for the treatment of children with ADHD in this study.

Keywords: attention deficit hyperactivity disorder; psychomotor performance; attention; executive functions.

Resumo

Efeito de um programa de intervenção psicomotora para crianças com TDAH. Este trabalho verificou a eficácia de um programa de intervenção psicomotora para crianças com TDAH. O estudo comparou o desempenho psicomotor e cognitivo de crianças com TDAH submetidas e não submetidas a intervenção psicomotora. Participaram do estudo 26 crianças do sexo masculino, sendo 14 com TDAH, divididas em grupo experimental I e II (GE I / GE II), e 12 com desenvolvimento típico agrupados no grupo controle (GC). As crianças do GE realizaram avaliação psicomotora e cognitiva nos dois momentos, pré e pós-intervenção e foram comparadas ao GC na avaliação após a intervenção. Houve diferenças estatisticamente significativas nos escores de classificação do perfil psicomotor e nos testes de atenção e funções executivas. Foi observada uma tendência de melhora indicado pelo aumento das médias das funções de noção de corpo, equilibração, estruturação espaço temporal, praxia fina, lateralidade e tonicidade, respectivamente. Os resultados sugerem que a intervenção psicomotora foi eficaz para o tratamento das crianças com TDAH deste estudo.

Palavras-chave: transtorno do déficit de atenção com hiperatividade; desempenho psicomotor; atenção; funções executivas.

Resumen

Efecto de un programa de intervención psicomotora para niños con TDAH. Este trabajo verificó la eficacia de un programa de intervención psicomotora para niños con TDAH. El estudio comparó el desempeño psicomotor y cognitivo de niños con TDAH sometidos y no sometidos a intervención psicomotora. En el estudio participaron 26 niños del sexo masculino, siendo 14 con TDAH, divididos en grupo experimental I y II (GE I / GE II), y 12 con desarrollo típico agrupados en el grupo control (GC). Los niños del GE realizaron una evaluación psicomotora y cognitiva en los dos momentos, pre y post-intervención y se compararon con el GC en la evaluación después de la intervención. Hubo diferencias estadísticamente significativas en los escores de clasificación del perfil psicomotor y en las pruebas de atención y funciones ejecutivas. Se observó una tendencia de mejora indicada por el aumento de las medias de las funciones de noción de cuerpo, equilibrio, estructuración espacio temporal, praxia fina, lateralidad y tonicidad, respectivamente. Los resultados sugieren que la intervención psicomotora fue eficaz para el tratamiento de los niños con TDAH de este estudio.

Palabras clave: trastorno del déficit de atención con hiperactividad; rendimiento psicomotor; atención; funciones ejecutivas.

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that mainly affects children and adolescents. It is estimated that it affects 3–6% of school-aged children on average (Faraone, Sergeant, Gilberg, & Bierderman, 2003; Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014; Rohde et al., 2001;) being predominant in males (Faraone et al., 2003, Polanczyk et al., 2014) varying proportions, the disorder combines difficulty in attentional control and/or hyperactivity with impulsivity, which generates consequences, such as relationship instability, organizational difficulty, difficulty following rules and completing tasks, talking excessively, and low academic or professional performance (American Psychiatric Association [APA], 2014; Organização Mundial da Saúde [OMS], 2008).

Clinical evaluation reveals differences in the attention, cognitive functions, and executive functions of individuals with ADHD (Biederman, Petty, Evans, Small, & Faraone, 2010). Moreover, between 30% and 40% of children with the diagnosis show psychomotor delays, with greater or lesser incidence depending on the instrument used for review (Fenollar-Cortes, Gallego-Martinez, & Fuentes, 2017; Flier et al., 2009; Magalhães, Missiuna, & Wong, 2006; Polatajko & Cantin, 2005).

Research involving assessment of psychomotor skills in children with ADHD showed delays in spatial organization, fine motor coordination, balance and visuomotor integration. The results of the studies have shown that children with ADHD have greater motor skills impairment when compared to control children (Brossard-Racine et al., 2012; Vidarte, Ezquerro, & Giráldez, 2009).

Studies in neurology show smaller brain volume in adults with ADHD in the regions of the frontal lobe, cerebellum, right globus pallidus, caudate nucleus, and corpus callosum (Castellanos & Proal, 2012; Filipek et al, 1997; Hynd et al., 1993). The dysfunction of the central nervous system (CNS) exhibited in ADHD is directly related to the symptoms of inattention, hyperactivity, impulsivity and motor difficulties. Thus, the proposed treatment includes drug combination therapy, psychotherapy (therapies with different foci, which target clinical symptoms), in addition to guidelines for parents and the school (APA, 2014).

As for ADHD, recent literature review indicates higher frequency of studies using behavioral intervention associated with cognitive rehabilitation, involving self-instruction training, self-reinforcement, problem solving, attentional control, working memory, environmental interventions and metacognitive strategies (Arns, Ridder, Strehl, Breteler, & Coenen, 2009; Mesquita, Ribeiro, Rangé, & Ventura, 2009).

The intervention with emphasis on remission of psychomotor changes, although still poorly described, proved to be effective in different studies with ADHD. The research outlined psychomotor stimulation programs, carried out at weekly meetings, with different approaches, developed with children with an average age of 9 years old. Taken as a whole, the results showed improved performance in balance functions, body scheme, spatial organization, fine motor skills, as well as improvements in attention and memory measures (Barbosa & Munster, 2014; Poeta & Rosa Neto, 2005; Sarmento, Braga, Martins, & Almeida, 2008).

Poeta and Rosa Neto (2005), by means of a case study, verified the efficiency of motor intervention in a child with a clinical diagnosis of ADHD. The intervention was carried out by a physical education teacher in an open environment, with 25 sessions, twice a week. The results showed positive developments in motor development, attention, concentration and school performance. Pre and post motor evaluation intervention was observed in motor development level change from “lower” to “low normal”.

In this same perspective, another study proposed stimulation of motor skills, memory, attention and concentration with four children with ADHD in physical education classes. The study was conducted with 40 weekly group meetings. Research has shown that the intervention program was favorable for the development of motor and cognitive skills of the students (Costa, Moreira, & Seabra Júnior, 2015).

Intervention using different strategies, was worked psychomotor reeducation with five children indicative of ADHD using hippotherapy. The intervention consisted of a 24-session program, with 30 minutes’ duration, systematically recorded by filming and data logging. The data analysis showed that the program has influenced significantly the psychomotor skills of children, and the spatial organization of functions, balance, fine motor skills and body schema, functions that showed the influence of the intervention (Barbosa & Munster, 2014).

In the light of foregoing, the objective of this study was to determine the effectiveness of a psychomotor intervention program for children with ADHD. Specifically, the study assessed the psychomotor and cognitive performance (attention and executive functions) of children with ADHD prior to and following a psychomotor intervention program, as compared to children with ADHD not subjected to the psychomotor intervention program and control (typically developing) children.

Methods

The present study deals with longitudinal research, with a control group, with a quasi-experimental design, with non-random allocation of the participants and group comparison. It was approved by the Research Ethics Committee of the proposing institution for the study (nº 842.253 / 14).

Participants

The study included 26 male children aged 7 to 11 years (*M* = 9.00; *SD* = 1,43), including 14 with ADHD and 12 with typical development, attending the 2nd to 6th grade of elementary school in public and private schools. Of the total sample (*n* = 26), five (19%) were enrolled in the second year, four (15%) in the third year, 8 (31%) in the fourth year, four (15%) in the fifth year, and five (19%) in the sixth year.

The children were divided into three groups: Experimental Group I (EGI), composed of children with ADHD who were subjected to a psychomotor intervention; Experimental Group II (EGII), formed by children with ADHD who did not undergo psychomotor intervention; and the Control Group (CG), consisting of typically developing children.

For the selection of EGI and EGII participants, the following inclusion criteria were considered: Signing of the Informed Consent (IC) by parents/guardians and the Consent Statement for the child; Be aged between 06 years and 11 years and 11 months; Children without complaints of visual or hearing impairment, or corrected impairments; Intellectual performance within normal standards (IQ > 80); Children diagnosed with ADHD evidenced by interdisciplinary assessment, based on the diagnostic criteria of DSM-5. Exclusion criteria for EGI and EGII were: Children with learning disorders comorbid with ADHD frame. Children with other neurological and / or psychiatric conditions were excluded from the sample, which could interfere with the results.

For the selection of participants in the CG, the following inclusion criteria were considered: Signing of the Informed Consent (IC) and Consent Agreement; Attending the same school and/or classroom of the EG participants; Similar ages, gender, and socioeconomic level to the participants of GE; No complaints of serious educational or behavioral difficulties. The GC exclusion criteria are: Present neurological complaints as parental reports. Evaluation process interruptions, by withdrawal or excessive unexcused absences.

Children in EGI and EGII were selected via two Reference Services in Neurology serving children with learning difficulties in a city of São Paulo. For the diagnosis of ADHD, children underwent an interdisciplinary evaluation conducted by neuropsychology, child psychiatry, speech therapy, educational psychology, and pediatric neurology professionals. The collected data were the interview, interview with family, contact with the school, clinical observation during the evaluation, and use of specific tools for each domain. The interdisciplinary diagnosis was based on criteria established by the DSM-5. All children diagnosed with ADHD were receiving pharmacological intervention with methylphenidate after diagnosis, and parents were asked to bring them unmedicated for the psychomotor intervention.

Participants in the CG only underwent neuropsychological and psychomotor assessment in one of the reference centers during the post-test evaluation. The meetings took place in a room designed for this purpose, for about two sessions of 50 minutes each.

Instruments

Pre- and post-intervention

Psychomotor evaluation

Psychomotor Observational Battery – POB (Fonseca, 2015). The POB evaluates the psychomotor functions of tonicity, balancing, lateralization, body notion, space-time orientation, global praxis, and fine praxis. The instrument consists of 42 tasks that allow the general classification of the subject in relation to the psychomotor profile (Table 1). A total score is obtained through summing scores on each of the seven psychomotor functions evaluated, with higher scores indicating better performance.

Table 1 . Classification of General Psychomotor Profile

Punctuation	Classification	Changes
7 to 8	Deficit	Moderate or severe
9 to 13	Dyspraxic	Slight (specific)
14 to 21	Eupraxic	No changes
22 to 26	Hyperpraxic	No changes
27 to 28	Superior	No changes

Note. Adapted from Fonseca, 2015.

For each function, children's performance on each task was rated on a scale from 1 to 4 points, and points were summed or averaged (Table 2).

Table 2. Reference Values for Psychomotor Profile Classification

Punctuation	Level of achievement	Praxic level
1 point	Imperfect and uncoordinated achievement (weak)	Apraxic profile
2 points	Achievement with limited control (satisfactory)	Dyspraxic profile
3 points	Adequate and controlled achievement (good)	Eupraxic profile
4 points	Perfect and controlled achievement (excellent)	Hyperpraxic profile

Note. Fonseca (p. 97).

Evaluation of the Attention and Executive Functions

TrailMaking Test – TMT (Lima, Travaiani, & Ciasca, 2009). Part A assesses visual tracking, processing speed, visual attention, and consists of a sheet with numbered circles from 1 to 25 that are placed in randomized locations, and the child must draw a line connecting the numerical sequence as fast as he/she can. Performance is evaluated in terms of "Reaction Time," expressed in seconds, as well as error rate. Part B is considered a mental flexibility test, consisting of circles with numbers ranging from 1 to 13 and letters ranging from A to M (excluding the letter "K"). The child must draw a line connecting the circles, alternating in numeral and alphabetical order between numbers and letters (1 - A - 2 - B - 3 - C...). Performance is evaluated in terms of time (in seconds) and errors (represented by the sum of the errors in sequencing).

Stroop Color Word Test – SCWT (Lima et al., 2009). SCWT is a test that assesses inhibitory control (ability to inhibit automatic response in favor of controlled response) and visual selective attention (switching between relevant and irrelevant information). Four colors (red, yellow, blue, and green) are presented with 24 stimuli in each of the three parts: (i) "Color Card" (C), composed of painted squares in four colors arranged in random order, which the child is asked to name as quickly as possible; (ii) "Card Words" (W), consisting of color names printed in corresponding colors (congruent situation) in which the child says the name of colors as quickly as possible; and (iii) "Card Color-Word" (CW), composed of color names printed in incongruous colors, for example, the printed word green in blue (incongruous situation). The child names the color and not the word as quickly as possible. Performance is measured in time to completion (in seconds) and errors for each card.

Cancellation Test – CT (Lima et al., 2009). The CT assesses sustained visual attention in two tasks: (1) Geometric Figures (CT-GF) comprises a sheet with a random sequence of simple geometric figures, and the child must tick all found circles as quickly as possible; (2) Letters in Row (CT-LR) comprises a sheet with letters randomly distributed, and the child must tick all the "A" letters as soon as possible. Performance is evaluated in runtime criteria expressed in seconds and errors (the sum of the errors committed by omission and addition).

Tower of London – TOL (Lima et al., 2009). The TOL evaluates logical reasoning and planning ability. It comprises a wooden base with three vertical pins and four colored discs of the same size, with a center hole for engaging the pins. The objective is to move the discs in order to match a displayed target figure within a certain number of movements. There are 10 items with increasing degrees of difficulty, and the child must accomplish the task from a starting position in a specified amount of moves. Three attempts to solve the problem are allowed, and the answer is considered correct when the solution is achieved with the correct number of moves. The scores of each item can vary from 0 to 3 points, and the total score is the sum of the scores of all items. Total scores can range from 0 to 30 points.

Wisconsin Card Sorting Test – WCST (Cunha et al., 2005). The WCST is a neuropsychological assessment tool that assesses executive functions: planning, flexibility of thinking, working memory, monitoring, and inhibition of perseverations. This test requires the ability to develop and maintain an appropriate strategy for solving the problem by means of stimuli, in order to achieve a goal. The WCST has four stimulation letters and 128 response cards, which represent figures of different shapes (crosses, circles, triangles, or stars), colors (red, blue, yellow, or green), and numbers (one, two, three, or four). This test can be administered to people aged from 6 to 89 years.

Procedure

Initial contact was made by the referral of children to care services for children with learning and behavioral complaints. After the interdisciplinary evaluation and confirmation of the ADHD diagnosis, the parents were informed of the research objectives. Afterwards, they signed the IC, thus initiating the study.

Subsequently, a meeting was scheduled with all the guardians of the children in the experimental group to provide guidance about the diagnosis and treatment. They received information about the program, including duration, rules of frequency of service, and availability of times.

The program was planned according to psychomotor and neurofunctional development, based on the Luria model (Fonseca, 2015) (Table 3). Children of EGI attended four sessions of cognitive assessment conducted during the diagnostic process and, afterwards, attended three sessions of psychomotor assessment. Children were then divided randomly into two groups. The EGI, after evaluation, underwent 20 individual sessions of psychomotor intervention during a weekly meeting of 50 minutes allocated as follows: 5 minutes for the preparation of the child for early intervention with stretching activities of the upper body, lower body, and torso; 40 minutes of activities focused on the seven psychomotor functions, with emphasis on tonicity and balancing; and 5 minutes to return to the child's resting condition with relaxation and stretching activities. The service took place outside of school hours, according to the family's needs.

After the EGI intervention period, both groups (EGI and EGII) underwent psychomotor and cognitive reassessment. In the same period, the CG children were selected for evaluation. EGII participants were under pharmacological monitoring with a child psychiatrist and psychotherapy during the EGII intervention period. After this period, they were also invited to complete the same intervention program, according to ethical terms of the research.

Table 3. Psychomotor Functions and Activities Developed in Interventions

Psychomotor functions	Performed activities
Tonicity	Stretching, activities with weights of various sizes, Bobath ball, activities with trampoline, activities to roll on the mat, crawl on the ground, among others.
Balancing	Walk straight, balance activities with tennis balls, "living-dead" game, jump rope, trampoline activities, among others.
Laterality	"Turn around game" with left and right commands, circuit focusing on laterality.
Notion of body	Recognition of body parts with mirror, human body design in actual size, sensory activities, activities with hula-hoop, imitation games, among others.
Spatiotemporal orientation	Circuits with obstacles, development of paths, activities of space recognition, play inside and outside with hula-hoop, activities with days of the week and months of the year, among others.
Global praxis	"Dancing, running, and jumping," circuits with activities to roll, crawl, and overcome obstacles; activities with balls of different sizes, among others.
Thin praxis	Tack, opening and closing zipper, buttons, painting with your finger, modeling clay, beads bracelet, handle rods of different sizes, play with puppets.

Note. Elaboration of the author

Data Analysis

The IBM *Statistical Package for Social Sciences* (SPSS *Statistics 22.0 for Windows)*® was used for analysis. For investigated variables, descriptive statistics were computed. To compare the groups in relation to categorical variables, Fisher's exact test was used when the obtained values were < 5. Due to the sample size and distribution of data, non-parametric analyses were used. To compare two paired samples (pre and post) in regard to the numerical variables, the Wilcoxon signed-rank test was used. To compare the three groups in regard to the numerical variables, the Kruskal-Wallis test was initially used. Afterwards, repeated analyses between two groups were performed using the Mann-Whitney test to verify which comparisons explained the obtained differences. The level of significance was $p \leq 0.05$.

To compare the psychomotor performance and cognitive functioning (attention and executive functions) of the groups of children with ADHD pre- and post-intervention, the Wilcoxon signed-rank test was used. To compare the overall ratings of psychomotor performance between EGI and EGII, Fisher's exact test was used.

About the numerical variables, the Kruskal-Wallis test was used. Subsequently, repeated analyses between groups were performed using the Mann-Whitney test to see which explained the obtained differences. The level of significance was $p \leq 0.05$ and $p \leq 0.01$.

Results

Statistical analysis compared performance on psychomotor and cognitive assessments (attention and executive functions) of the EGI and EGII, pre- and post-intervention, and compared the experimental groups with the CG, as shown in Table 4 and 5.

Table 4. Comparison of Mean Pre- and Post-Intervention Scores in Gei And Geii

Scores	GEI					GEII				
	Pre		Post		p^a	Pre		Post		p^a
	M	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*	
TON	2.00	.58	2.14	.38	0.317	1.43	.53	1.57	.53	0.317
QUE	1.43	.53	1.71	.49	0.157	1.43	.53	1.57	.53	0.317
LAT	2.14	.38	2.29	.49	0.317	2.00	.58	2.14	.38	0.317
NC	2.00	.00	2.43	.53	0.083	2.57	.53	2.71	.49	0.317
EET	2.43	.79	2.71	.49	0.317	2.71	.49	2.71	.49	1.000
PG	2.00	.00	2.00	.00	1.000	2.29	.49	2.29	.49	1.000
PF	1.29	.49	1.57	.53	0.157	1.86	.69	1.86	.69	1.000
PC	2.29	.49	2.86	.38	0.046*	2.57	.53	2.43	.53	0.317
TMTA_T	89.00	16.35	88.29	15.33	0.672	59.57	15.24	58.86	16.94	0.596
TMTA_E	1.00	1.00	.29	.76	0.102	.71	1.89	.43	1.13	0.317
TMTB_T	213.71	70.04	194.14	62.73	0.075	134.29	31.15	133.29	32.40	1.000
TMTB_ET	2.71	2.56	1.71	1.89	0.038*	4.29	5.71	4.00	5.92	0.593
TC1_T	102.14	32.17	99.00	32.89	0.061	90.29	13.38	88.86	13.69	0.439
TC1_ET	4.57	1.72	2.71	1.11	0.024*	2.71	2.87	2.14	2.61	0.046*
TC2_T	135.00	44.03	121.57	29.42	0.046*	94.57	7.11	92.86	7.88	0.034*
TC2_ET	8.14	5.01	4.86	4.10	0.017*	3.00	1.83	2.43	1.99	0.194
SCWT1_T	33.14	14.77	31.00	14.24	0.027*	23.43	7.89	25.57	5.83	0.462
SCWT1_E	.29	.49	.00	.00	0.157	.43	.53	.00	.00	0.083
SCWT2_T	28.71	14.19	27.14	14.29	0.176	20.71	8.24	21.29	5.91	0.750
SCWT2_E	.43	.53	.00	.00	0.083	.43	.79	.00	.00	0.180
SCWT3_T	69.14	52.30	60.14	30.53	0.400	45.29	8.56	47.14	8.71	0.680
SCWT3_E	4.43	1.90	3.71	2.50	0.102	3.86	2.04	4.00	2.16	0.666
TOL	19.86	3.98	21.57	3.21	0.023*	21.86	3.67	22.57	4.28	0.197
W_NEA	114.29	14.66	114.86	14.08	0.655	116.00	15.10	114.29	18.08	0.655
W_NTC	76.14	7.06	80.00	4.24	0.043*	74.86	10.48	78.00	10.03	0.865
W_NTE	38.14	18.03	34.86	15.53	0.041*	41.14	22.67	36.29	18.28	0.307
W_PE	32.14	12.10	29.00	10.05	0.042*	33.57	15.73	30.43	12.42	0.445
W_RP	24.71	14.21	21.14	8.28	0.465	33.29	26.98	23.29	14.85	0.138
W_PRP	20.86	10.06	18.00	5.20	0.465	27.14	20.11	19.71	11.19	0.225
W_EP	20.43	10.95	18.86	6.74	0.686	27.43	19.92	20.71	12.35	0.173
W_PEP	17.29	7.72	16.00	4.16	0.686	22.43	14.51	17.57	9.14	0.246
W_ENP	15.86	11.82	15.71	10.89	1.000	13.71	9.03	15.57	10.75	0.916
W_PENP	13.29	8.52	13.29	7.61	1.000	11.43	6.53	12.86	7.69	1.000
W_RNC	55.86	24.86	68.14	7.80	0.138	61.71	15.05	66.29	11.81	0.5531
W_ECPC	25.43	32.32	12.00	2.08	0.273	12.71	2.43	13.00	4.47	0.713
W_FMC	1.86	1.21	1.14	.38	0.131	1.00	.00	1.43	1.51	0.461

Note. M – Average; SD – Standard deviation; Min. – Minimum; Max. – Maximum; TON – Tonicity; QUE – Balancing; LAT – Laterality; NC – Notion of body; EET – Space-time structuring; PG – Global praxis; PF – Thin praxis; *PC - Psychomotor rating*; TMTA/B – Trail Making Test A and B, T – Time, ET – Errors; TC1/2 – Cancellation of geometric figures test and letters in row, T – Time, ET – Errors; St1/2/3 Stroop Word Color Test color, words, and color-words, T – Time E – Errors; TOL – Tower of London; NEA – number of administered tests; NTC – correct total number; NTE – total number of errors; PE – error percentage; RP – perseverative responses; PRP – percentage of perseverative responses; EP – perseverative errors; PEP – percentage of perseverative errors; ENP – non-perseverative errors; PENP – percentage of non-perseverative errors; RNC – conceptual level responses; ECPC – essays to complete the first category; FMC – failure to maintain the context. [a]Wilcoxon signed-rank test, *$p < 0.05$

Table 5. Frequency Distribution for the General Classification of Psychomotor Profile between Groups

	EGI		EGII	
	Pre-intervention	Post- intervention	Pre- intervention	Post- intervention
General classification of psychomotor profile	*f (%)*	*f (%)*	*f (%)*	*f (%)*
Deficit	1 (14.3)	0 (0)	0 (0)	0 (0)
Dyspraxic	4 (57.1)	1 (14.3)	3 (42.9)	4 (57.1)
Eupraxic	2 (28.6)	6 (85.7)	4 (57.1)	3 (42.9)
Good	0 (0)	0 (0)	0 (0)	0 (0)
Superior	0 (0)	0 (0)	0 (0)	0 (0)
Total	7 (100)	7 (100)	7(100)	7(100)

Note. f. frequency; *Fisher's exact test*; value of $p = 0.000$ and $p = 0.143$ (for EGI and EGII, respectively).

Statistically significant differences in post-intervention psychomotor performance were observed between the experimental groups and the control group across all subtests. Significant differences in tonicity were observed between EGI and EGII following the intervention (Table 6).

Table 6. Comparison of Average Post-Intervention Scores in the Egi, Egii, and Cg

Scores	EGI (*n* = 7)		EGII (n = 7)		CG (*n* = 12)		*p*[a]	Differences between groups[b]
	M	*SD*	*M*	*SD*	*M*	*SD*		
Tonicity	2.14	.38	1.57	.53	3.17	.577	.000**	1.2/ 1.3/ 2.3
Balancing	1.71	.49	1.57	.53	3.33	.492	.000**	1.3/ 2.3
Laterality	2.29	.49	2.14	.38	3.83	.389	.000**	1.3/ 2.3
Notion of body	2.43	.53	2.71	.49	3.92	.289	.000**	1.3/ 2.3
S/T structuring	2.71	.49	2.71	.49	3.42	.515	.011*	1.3/ 2.3
Global praxis	2.00	.00	2.29	.49	3.08	.289	.000**	1.3/ 2.3
Thin praxis	1.57	.53	1.86	.69	3.08	.289	.000**	1.3/ 2.3
Class profile	2.86	.38	2.43	.53	3.50	.674	.005*	1.3/ 2.3
TMTA_T	88.29	15.33	58.86	16.94	50.17	15.47	.002**	1.2/ 1.3/
TMTA_E	.29	.76	.43	1.13	.00	.00	.409	Ns
TMTB_T	194.14	62.73	133.29	32.40	114.83	30.89	.022*	1.3
TMTB_ET	1.71	1.89	4.00	5.92	.25	.45	.208	Ns
TC1_T	99.00	32.89	88.86	13.69	88.83	17.82	.896	Ns
TC1_ET	2.71	1.11	2.14	2.61	2.00	1.65	.296	Ns
TC2_T	121.57	29.42	92.86	7.88	99.50	22.61	.031*	1.2/ 1.3/
TC2_ET	4.86	4.10	2.43	1.99	0.33	0.65	.003**	1.3/ 2.3
SCWT1_T	31.00	14.24	25.57	5.83	25.00	6.84	.653	Ns
SCWT1_E	.00	.00	.00	.00	.00	.00	1.000	Ns
SCWT2_T	27.14	14.29	21.29	5.91	22.00	6.67	.704	Ns
SCWT2_E	.00	.00	.00	.00	.00	.00	1.000	Ns
SCWT3_T	60.14	30.53	47.14	8.71	48.08	5.70	.970	Ns
SCWT3_E	3.71	2.50	4.00	2.16	.50	.67	.000**	1.3/ 2.3
TOL	21.57	3.21	22.57	4.28	17.17	3.59	.014*	1.3/ 2.3
W_NEA	114.86	14.08	114.29	18.08	102.42	19.94	.212	ns
W_NTC	80.00	4.24	78.00	10.03	73.33	8.91	.133	ns
W_NTE	34.86	15.53	36.29	18.28	73.75	49.19	.323	ns
W_PE	29.00	10.05	30.43	12.42	71.42	48.71	.246	ns

continue...

Table 6. Continuation

Scores	EGI (*n* = 7)		EGII (n = 7)		CG (*n* = 12)		*p*[a]	Differences between groups[b]
	M	*SD*	*M*	*SD*	*M*	*SD*		
W_RP	21.14	8.28	23.29	14.85	55.50	40.59	.195	ns
W_PRP	18.00	5.20	19.71	11.19	54.00	40.15	.144	ns
W_EP	18.86	6.74	20.71	12.35	52.75	39.82	.290	ns
W_PEP	16.00	4.16	17.57	9.14	51.83	39.82	.224	ns
W_ENP	15.71	10.89	15.57	10.75	64.75	55.24	.197	ns
W_PENP	13.29	7.61	12.86	7.69	62.83	54.34	.123	ns
W_RNC	68.14	7.80	66.29	11.81	64.50	10.99	.517	ns
W_ECPC	12.00	2.08	13.00	4.47	16.58	7.99	.568	ns
W_FMC	1.14	.38	1.43	1.51	.50	.90	.044*	1.3
ICV	94.86	5.21	92.00	8.87	102.00	8.22	.022*	1.3/ 2.3
IOP	94.00	6.24	90.57	7.44	98.00	7.86	.127	ns
IMO	95.71	12.57	87.29	9.88	102.75	8.83	.019*	2.3
IVP	89.57	6.32	81.29	9.81	102.83	9.21	.001**	1.3/ 2.3
QIT	93.43	8.24	89.14	7.90	102.75	6.27	.005**	1.3/ 2.3

Note. EGI – Experimental group I; EGII – Experimental group II; CG – Control group; M – Average; SD – Standard deviation; Min. – Minimum; Max. – Maximum; TMTA/B – Trail Making Test A and B, T – Time, ET – Errors; TC1/2 – Cancellation of geometric figures test and letters in row, T – Time, ET – Errors; St1/2/3 Stroop Word Color Test color, words, and color-words, T – Time, E – Errors; NEA – number of administered tests; NTC – correct total number; NTE – total number of errors; PE – error percentage; RP – perseverative responses; PRP – percentage of perseverative responses; EP – perseverative errors; PEP – percentage of perseverative errors; ENP – non-perseverative errors; PENP – percentage of non-perseverative errors; RNC – conceptual level responses; ECPC – essays to complete the first category; FMC – failure to maintain the context; [a]*Kruskal-Wallis test*, [b]*Mann-Whitney test*, *p<0.05; **p<0.01.

Discussion

Historically, psychomotor stimulation is described in studies on motor education in the school setting, mainly in kindergarten and first grades (Le Boulch, 1988; Tani, 1987). In the current literature, even though most is related to education, existing research already associates motor characteristics to the cognitive, social, and psychological development of the child (Cardeal, Pereira, Silva, & França, 2013; Kashfi et al, 2019; Stein, Auerswald, & Ebersbach, 2017; Valentini, 2002).

In clinical practice, psychomotor interventions have been used by psychomotricians from a re-education standpoint with children with impairments in psychomotor development caused by brain dysfunction, such as in cases of neurodevelopmental disorders and learning disabilities.

This study examined the effects of a psychomotor intervention program in a group of seven students with ADHD by the measured psychomotor and cognitive performance. This sample may be considered restricted, but it is no different from other interventional studies involving children with developmental disorders (Cardeal et al, 2013; Niehues & Niehues, 2014).

The application of a psychomotor intervention program for children with ADHD was effective in symptom remission with regard to both psychomotor and cognitive functions. The children referred to the intervention demonstrated improvement in psychomotor performance, represented by increases in mean of total scores, corresponding to the sum of weighted averages of each psychomotor function. A qualitative improvement was observed from pre- to post-intervention in body functions, balancing, timeline structure, fine praxis, laterality, and tonicity.

Children who did not undergo the intervention did not show statistically significant differences in psychomotor performance, although there was a quantitative improvement. This result may be associated with other types of intervention that children of both groups were performing, such as pharmacological treatment; however, this variable was not analyzed in this research. The organization of the psychomotor intervention was aimed at finer motor responses, with gestures, posture, and more precise movements, through strategies that involve the whole body of the individual in rehabilitation, with different methods and techniques (Bueno, 2013).

Others studies of psychomotor intervention in individuals with ADHD have shown changing patterns of psychomotor functions, especially spatial organization, balance, fine motor skills, and body schema, with similar results to this study. However, the methods used have been diversified, including equine therapy, physiotherapy, and physical education (Barbosa & Munster, 2014; Costa et al., 2015; Niehues & Niehues, 2014. The method used in this study, through individual psychomotor therapy, was consistent with these methods, as it involves fun activities and was contextualized to the routine of a child, guaranteeing the best compliance.

The system of psychomotor classification used in this research addresses the characteristic profile of the individual, specifically a dyspraxic pattern, which is associated with neuropsychological disorders of tactile, vestibular, and proprioceptive order leading to difficulties in carrying out control and psychomotor activities; this is in contrast to the eupraxic standard that integrates the normal psychomotor profile, in accordance with the development pattern, in which the individual motor response is adequate and controlled in most psychomotor functions (Lima et al., 2009). With respect to the frequency with which the groups of children with ADHD were classified into these respective psychomotor profiles, those not subjected to the psychomotor stimulation showed a higher frequency of a eupraxic profile in the pre-testing evaluation, while they were more often found to have a dyspraxic profile in the post-test. However, the results of children who completed the intervention were the reverse, with a shift from dyspraxic profiles to eupraxic profiles.

The psychomotor stimulation also was effective for improvement in cognitive performance. The EGI showed statistically significant positive differences pre- and post-intervention in tests that assess cognitive flexibility, capacity of planning, and troubleshooting, components of executive functions and tests that assess sustained attention in the visual modality. The EGII exhibited performance differences only in the attention tests. Other research has shown the benefits of psychomotor practice in cognitive development. A study that correlated cognitive and motor performance among 378 children aged 5 and 6 years examined physical practices with a psychomotor approach; the activities took place twice a week for 50 minutes and the results revealed quantitative improvements in motor and cognitive variables. Additionally, teachers and parents reported improved performance in attention, memory, and learning of these students (Wassenberg et al., 2005).

Similarly, another study found the effect of a motor stimulation school program in executive functioning and attention performance in public school children aged from 6 to 10 years (Cardeal et al., 2013). The study included 80 children, 40 of whom participated in the motor stimulation and 40 of whom did not complete the procedure. The children were evaluated before and after the intervention and the variables assessed included motor skills, executive function, reaction time, and selective attention. The intervention took place over 7 months with regular physical education classes. There was a significant difference between the groups in executive function, reaction time, and selective attention. Thus, the intervention group not only exhibited improved motor skills, but also significantly improved cognitive performance.

The present research also compared the psychomotor and cognitive performance of children from the EG at the time of post testing with children from the CG, in order to verify if the performance of children with ADHD would look like that of typically developing children after the intervention. The children who underwent the intervention increased their average, but still performed below the level expected for their age. This result was expected, as the children with ADHD have a chronic disorder associated with a neurologic dysfunction (Rohde et al., 2001).

Conclusion

Thus, the results presented in this study suggest that the psychomotor intervention program can be effective in the treatment of children with ADHD, since there have been significant changes in psychomotor and cognitive performance (attention and executive functions) in the group of children referred to the program.

Although the results are relevant, some limitations may be cited in this study to guide further research, as the sample can be considered not sufficient to generalize results. In addition, further assessments with children undergoing this intervention are important to analyze the maintenance of the effects.

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