v. 1, n. 3, 2021

International Journal of Health Science

THE EFFECTS OF A NEUROPSICO-PEDAGOGICAL LUDOMOTORA INTERVENTION ON THE ACADEMIC PERFORMANCE OF CHILDREN WITH LEARNING DIFFICULTIES

Fabrício Bruno Cardoso
https://orcid.org/0000-0002-0279-6079

Lucianara Braga
https://orcid.org/0000-0002-0279-6079

Deizeane da Costa Abreu
https://orcid.org/0000-0002-0279-6079

Vitor da Silva Loureiro
https://orcid.org/0000-0001-5422-9386

João Vitor Galo Esteves
https://orcid.org/0000-0001-8950-9353

Aliny dos Santos Carvalho
https://orcid.org/0000-0002-6004-6815

Alfred Sholl Franco
https://orcid.org/0000-0002-1951-0137

Abstract: The present study aimed to evaluate the effects of a neuropsychopedagogical ludomotor intervention (NLI) on the cognitive and academic development of schoolchildren. 102 children aged between 07 and 08 years old, of both sexes, participated in this study. The protocols used were approved by the UFRJ Ethics Committee (Opinion Number 517,483) and carried out in the school environment. The participants were divided into four groups (A1 - 30 children without learning difficulties who did not take the NLI; A2 - 30 children without learning difficulties who took the NLI; B1- 21 children with learning difficulties who did not take the NLI; B2 21 children with learning difficulties who underwent the NLI), with the NLI carried out in 36 sessions, lasting 10 minutes. To assess the effects of NLI, participants were submitted to the following protocols: a) Rapid Automated Naming Test (RAN); b) Reading Comprehension Assessment C) Academic Academic Performance Assessment. Both groups were evaluated before and after NLI. Our results show that after being submitted to NLI, children from group A2 showed a reduction of ±10% ($p<0.05$) in the mean time of automated naming, when analyzing the results of children with learning difficulties it is possible noticing that children in group B2 had a reduction of ±19% ($p<0.01$). Regarding reading comprehension ability, children A2 showed an increase of ±09% ($p<0.05$) and children in group B2 an increase of ±27% ($p<0.01$) in the number of words read in a way correct per minute. Regarding academic performance, children in group A2 showed an increase of ±12% and children in group B2 an increase of ±38% ($p<0.01$) in the average number of correct answers.

Keywords: Neuropsychopedagogical Intervention, Motor Development, Learning Difficulties, Children.

INTRODUCTION

Childhood is a stage of life in which motor development occurs intensely. The acquisition of Motor Coordination is defined as a set of processes associated with the practice and repetition of relatively invariant actions, which lead to permanent changes in the ability of individuals to move (Stein et al., 2017). These processes involve the formation and consolidation of new memories, through modifications in the patterns of activation of neural networks, resulting from synaptic changes, initially transitory that, through repetition, become permanent (Toto & Limone, 2021). The first years in elementary school coincide with important achievements in children's neurological development, such as the gradual myelination of association areas; lateralization of spatial perception, improvement in the functions of the reticular formation and the functioning of the hippocampus, and beginning of the final stage of maturation of the prefrontal cortex. (Cameron et al., 2016; Hestbaek et al., 2017).

From a neuropsychopedagogical perspective, there are several explanations for the co-occurrence of motor and cognitive performance. First, motor and cognitive functions are coupled using the same brain structures (Diamond, 2000). For example, the cerebellum is involved in motor and cognitive functions and the prefrontal cortex plays an important role in cognitive functioning as well as motor performance through the strong neural connections between these two brain areas. Second, both cognitive and motor development, in their skill acquisition curve, show the period between 03 and 08 years as primordial for a series of predictive skills (Anderson, 2002; Gabbard, 2008; Ahnert et al., 2003). A final factor that may be responsible for the co-occurrence of motor and cognitive development is that both have a number of common underlying processes,

for example, sequences (Hartman et al., 2010), monitoring and planning (Roebers & Kauer, 2009; Sergeant, 2000).

Ludomotor stimulation is an efficient way to promote procedural or procedural memory, which is fundamentally related to the potential increase in performance capable of increasing the precision of motor gestures (Soares et al., 2015). Thus, different approaches consider that factors such as task, individual and environment interact to influence the pace, acquisition and improvement of motor skills (Ludyga et al., 2018 ; Van der Fels et al., 2019).

From the above, this study aimed to evaluate the effects of a neuropsychopedagogical ludomotor intervention on cognitive and academic development of schoolchildren.

METHODOLOGY

Ethics in Research

This study was approved by the Ethics Committee for Research with Human Beings (2,625,379), under the embodied opinion nº 517,483; Prior to the beginning of the study, a Technical-Scientific Cooperation Agreement was signed between the Municipal Education Secretariat of São Fidélis (SMED) and the CENSUPEG Faculty, for the mutual development of research activities.

Universe of Study

The universe of this study initially consisted of 102 children, both aged between 07 and 08 years old, with and without learning difficulties, students from the municipal education system in the city of São Fidélis/RJ.

The inclusion and exclusion criteria for the selection of the respective children were;

- To present indications of proficient or non-proficient school performance, evidenced by legal documents issued by the school's pedagogical team that were enrolled;
- To have an estimated IQ (Wechsler Intelligence Scale for Children - WISC-IV) above 80;
- Not to use psychoactive medications.
- Not to show expressive symptoms of inattention, hyperactivity or impulsivity through the SNAP-IV assessment, proposed by Mattos et al. (2006);
- not to have visual, hearing, heart disease, orthopedic disorders or behavioral disorders (according to medical evaluation throughout the study)

The remaining participants were divided into four groups as follows:

A1 – consisting of 30 children without learning disabilities (LDS) and who did not undergo neuropsychopedagogical ludomotor intervention (ILN);

A2 – made up of 30 SDA children who underwent ILN;

B1 – consisting of 21 children with learning difficulties (LD) and who did not undergo ILN;

B2 - consisting of 21 children with learning difficulties (LD) and who took the ILN;

The division of members of subgroups 1 and 2 of groups A and B happened randomly and randomly (casual/as a draw), using the software : *K_o_n_k_u_r_i_*©.

Assessment Procedures

To achieve that objective, the children were initially submitted to the Rapid Automated Naming Test (RAN). This test continuously measures performance in the sequential naming speed of common stimuli, that is, the speed with which the child sequentially verbalizes a list containing basic symbols. In the present study, only the subtest of colors was used, which is composed of the colors: green, red, yellow, black, blue and yellow, where the individual must name the colors as quickly as possible. The test was only applied

after guidance and verification that the child knew all the colors that would be applied.

Afterwards, the children were submitted to the Test of Assessment of Reading Comprehension of Expository Texts (Saraiva et al, 2006). It is a compilation of texts indicated for each grade of Elementary School, for this study, taking into account the age of the participants and the grade of the same, the text "The Elephant Baby" was used. The children were asked to read the text according to the instructions given by the evaluator, which permeated the following aspects: keep the text on the table throughout the reading; proper body posture during the assessment; start reading and go to the end of the text, avoiding interruptions, otherwise it would be restarted. In this analysis, the total reading time was computed, with pauses due to coughing, throat clearing, or nasal congestion or colds being disregarded. The videos were reproduced in the software and the excerpts that presented pauses were excluded through the resources of that software. Speed was calculated by words read per minute.

Finally, after 24 hours, the children were submitted to a verification of academic performance, through an assessment that consisted of 20 questions: 10 in mathematics and 10 in Portuguese, randomly chosen through the electronic platform "EVALIA" in a personalized way. The aforementioned assessment was carried out with the child comfortably seated in a room that was properly ventilated and lighted. Before starting the evaluation, the team of evaluators informed that the Maximum time to carry out said evaluation was one hundred and twenty minutes.

It is noteworthy that all assessment protocols were carried out in the school environment of the participants.

Intervention Procedures

ILN was expressed by the practice of 24 activities that emphasize the importance of motor development as a strong ally in children's cognitive development. ILN activities consist of different uses of a code system for motor stimulation from the association of different parts of the body with images and colors.

For the application of the ILN, 22 figures were used (squares, circles and triangles), ranging from blue, green, pink, orange, lilac, brown, red and yellow, representing different parts of the body, segmented on the right sides and left, front and back, as proposed by Braga (2016). Therefore, the application of ILN was determined in 36 sessions, lasting 10 minutes each, in a bright and well-lit environment, at a frequency of 3 times a week.

Statistical analysis

Data analysis in this study was performed based on the comparison of statistical results using the GraphpadPrism 9.2 statistical program. The results obtained initially in relation to the RAN, Reading Comprehension and in the evaluation of academic performance were calculated using descriptive statistics, Medium and Standard Deviation. Afterwards, the data obtained initially were tested to verify their normality by the Shapiro-Wilk test, being classified as non-parametric. Thus, the Mann-Whitney test for two unpaired samples was used to compare the experimental groups and controls, and the t-test was used for intragroup comparisons in one direction only pre-test x post-test.

RESULTS

Table 01 shows that children without learning difficulties belonging to group A2 showed a reduction in ±10% ($p<0,05$) in AV2's average Automated Naming time in relation to that presented in AV1. When establishing a comparison between the groups,

a significant difference was revealed for the A2 x A1 comparison of p<0,05, demonstrating the better performance of children who underwent ILN (group A2).

When analyzing the results of children with learning difficulties, it is possible to see that children in group B2 obtained a reduction in ±19% (p<0,01) in the average automated naming time after being submitted to ILN. When we established a comparison between the B2 XB1 groups, a significant difference was revealed for the comparison p<0,01, demonstrating the better performance of children in group B2, which indicates that the improvement in the time of automated naming of these children was not by chance, but probably due to the effects of ILN.

By observing Table 03, it can be seen that children in group A2 showed an increase in ±09% (p<0,05) in the average number of words read correctly per minute in AV2 compared to that presented in AV1. When establishing a comparison between the groups, it is possible to see that the children in group A2 in the second assessment presented a superior performance in ±08% in relation to children in group A1, this performance was significant, since through the Mann-Whitney statistical test a p<0,05, thus demonstrating a possible positive influence of ILN on the reading comprehension capacity of children in group A2.

Regarding children with learning difficulties, it is possible to see that children in group B1 (Table 04) showed an increase ±07% (p<0,05) in the average number of words read correctly per minute in AV2 compared to those obtained in AV1, which tends to a positive effect of the school pedagogical activities that they underwent during this period, as they did not stop attending their classes in any time. When analyzing the results of children in group B2, there is an increase in the average number of words read correctly per minutes of ±27% (p<0,01) when comparing the performance obtained in AV2 in relation to those obtained in AV1, thus showing the positive effects of ILN on the reading comprehension of these children.

Regarding the academic performance of children without learning difficulties (Table 05), it can be noted that although children in group A2 presented an increase in ±12% in the average number of correct answers in AV2 in relation to that obtained in AV1, this was not statistically significant.

When observing the results of children with learning difficulties (Table 06), it can be seen that children in group B1 showed an increase in ±10% in the mean number of correct answers in AV2 in relation to that obtained in AV1, but this increase was not statistically significant. Regarding the results of children participating in group B2, an increase in ±38% (p<0,01) in the average number of correct answers in AV2 in relation to that obtained in AV1. Still looking at table 06, it is possible to see that children in group B2 presented in the second assessment a superior performance of ±17% in relation to children in group B1, this performance proved to be significant, since through the Mann-Whitney statistical test a p<0,01, thus showing the superiority of children who underwent ILN (B2) in relation to children in the B1.

DISCUSSION

Our results are consistently corroborated with the findings of different studies (El-Maksoud et al., 2016; Jahani et al., 2016; Gapin et al., 2011; Ahmed & ShahI, 2010). Gomez-Pinilla (2011) concluded, as well as other authors, that motor training has an important role in the plasticity of the CNS, and it can significantly contribute to the cognitive improvement of individuals, increasing data processing performance, increasing data efficiency. neurotransmitters,

Categories	A1 (AV1)	A1 (AV2)	A2 (AV1)	A2 (AV2)
Minimum	26,00	25,52	26,54	25,18
Maximum	33,46	32,55	34,10	30,88
Medium	28,75	28,62	29,62	27,49*
Standard Deviation	2,451	2,250	2,023	1,748

Table 01: Description of Children's Results Without Learning Disabilities in Automated Naming Time

AV1 – 1ª evaluation; AV2- 2nd evaluation; *p<0.05 for comparison between AV2 X AV1.

Categories	B1 (AV1)	B1 (AV2)	B2 (AV1)	B2 (AV2)
Minimum	36,13	36,87	38,50	25,44
Maximum	52,88	53,13	51,09	49,21
Medium	43,81	43,65	44,61	36,12**
Standard Deviation	4,772	4,464	3,764	7,121

Table 02 : Description of Results of Children with Learning Disabilities in Automated Naming Time

AV1 – 1ª evaluation; AV2- 2nd evaluation; **p< 0.01 for comparison between AV2 X AV1.

Categories	A1 (AV1)	A1 (AV2)	A2 (AV1)	A2 (AV2)
Minimum	54,00	55,00	52,00	61,00
Maximum	72,00	71,00	71,00	74,00
Medium	62,08	62,38	61,62	66,85*
Standard Deviation	6,525	6,318	6,552	4,413

Table 03: Description of results in relation to reading comprehension of children without learning difficulties.

AV1 – 1ª evaluation; AV2- 2nd evaluation; *p<0.05 for comparison between AV2 X AV1.

Categories	B1 (AV1)	B1 (AV2)	B2 (AV1)	B2 (AV2)
Minimum	33,00	37,00	28,00	35,00
Maximum	53,00	56,00	52,00	63,00
Medium	45,00	48,22*	38,22	48,67**
Standard Deviation	6,205	6,037	8,786	8,775

Table 04: Description of results regarding reading comprehension of children with learning difficulties.

AV1 – 1ª evaluation; AV2- 2nd evaluation; *p< 0,05 for comparison between AV2 X AV1.

**p< 0,01 for comparison between AV2 X AV1.

Categories	A1 (AV1)	A1 (AV2)	A2 (AV1)	A2 (AV2)
Minimum	13,00	14,00	13,00	16,00
Maximum	18,00	18,00	17,00	18,00
Medium	15,46	16,08	15,00	16,85
Standard Deviation	1,450	1,115	1,080	0,8006

Table 05: Description of results in relation to academic performance of children without learning difficulties

AV1 – 1ª evaluation; AV2- 2nd evaluation;

Categories	B1 (AV1)	B1 (AV2)	B2 (AV1)	B2 (AV2)
Minimum	7,000	9,000	7,000	12,00
Maximum	12,00	13,00	12,00	15,00
Medium	10,45	11,55	9,81	13,58**
Standard deviation	1,695	1,508	1,471	0,9342

Table 06: Description of results in relation to academic performance of children without learning difficulties

AV1 – 1ª evaluation; AV2- 2nd evaluation; **p< 0.01 for comparison between AV2 X AV1.

promoting neural adaptations and recovery of the performance of emotional regulation and executive functions in general (Norton et al., 2011; Ellemberge & ST-Louis-Deschenes, 2010)

An important factor to be highlighted is that, in order to have learning retention during the practice of an exercise or physical activity, it is essential to respect the child's biological maturity and avoid exercise overload (Dobbins et al., 2013), therefore in the course of of this study, an ILN was used considering two

Executive Functions (inhibition, and planning) cores to investigate the effects of ILN on improvements in academic performance of students with learning difficulties.

It is worth mentioning that the results obtained in this study are in agreement with studies by other researchers that also show a motor intervention can significantly improve the performance of children in tasks involving working memory and cognitive flexibility. (Rigoli et al., 2012 ; Ludyga et al., 2018 ; Van der Fels et al., 2019).

CONCLUSION

From the results presented, it can be concluded that cognitive development and motor development present a possible interdependence, as children who underwent ILN with and without learning difficulties presented better performance in cognitive tasks when compared to their peers.

Therefore, it is noteworthy that the present study provides new evidence on the interaction between motor development and cognition in children and how they can interfere with their academic performance. However, there are some limitations of the present study, which may inform future directions in this line of research., such as the limitation in relation to age group and the fact that it was not evaluated whether the gains obtained were maintained after a period of at least 04 months after the end of the intervention proposed in this study.

REFERENCES

Ahmed, A.& Shahi, J. (2010) The effectiveness of cognitive exercises - move on to increase motor skills and math for children with autism: study a single subject. J. Princ. Ment. Heal., 2 (46), 534-541.

Ahnert,J. Bös,K. & Schneider,W. (2003). Motorische und kognitive Entwicklung im Vorschul- und Schulalter: Befunde der Münchner Längsschnittstudie LOGIK. Zeitschrift Für Entwicklungspsychologie Und Pädagogische Psychologie, 35(4), 185–199. https://doi.org/10.1026//0049-8637.35.4.185

Anderson, P. (2002). Assessment and Development of Executive Function (EF) During Childhood. Child Neuropsychology, 8(2), 71–82. https://doi.org/10.1076/chin.8.2.71.8724

Braga, L. I. (2016) Coordenando-se metodologia para o desenvolvimento da coordenação motora. Diálogo Comunicação e Marketing.

Cameron, C. E., Cottone, E. A., Murrah, W. M., & Grissmer, D. W. (2016). How Are Motor Skills Linked to Children's School Performance and Academic Achievement? Child Development Perspectives, 10(2), 93–98. https://doi.org/10.1111/cdep.12168

Carl, P. G. (2008). Lifelong Motor Development (Vol. 5th). Benjamin Cummings.

Dobbins, M.; Husson, H. ; Decorby, K.; Larocca, R.L. (2013) School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. Cochr. Dat. Syst. Rev., 02, Art. No.: CD007651.

Diamond, A. (2000). Close Interrelation of Motor Development and Cognitive Development and of the Cerebellum and Prefrontal Cortex. Child Development, 71(1), 44–56. https://doi.org/10.1111/1467-8624.00117

Ellemberg, D.& St-Louis-Deschenes, M. (2010) The effect of acute physical exercise on cognitive function during development, Psychol. Sp. Ex., 3 (11), 122-126.

El-Maksoud, G.M.A.; Abdelmonem, A.M.; Rezk-Allah, S.S. (2016) Effect of individual and group Sensory- Perceptual Motor Training on Motor Proficiency and Quality of Life in Children with Down Syndrome. Intern. J. Ther. Rehabilit. Res., 5 (4), 37-45.

Gapin, J.I.; Labban, J.D.; Etnier, J.L. (2011) The effects of physical activity on attention deficit hyperactivity, disorder symptoms, Evid. Prev. Med., 52, 4-70.

Gomez-Pinilla, F. (2011) The combined effects of exercise and foods in preventing neurological and cognitive disorders. Prev. Med., 52, 75-80.

Hartman, E., Houwen, S., Scherder, E., & Visscher, C. (2010). On the relationship between motor performance and executive functioning in children with intellectual disabilities: Motor and executive functioning in children with ID. Journal of Intellectual Disability Research, 54(5), 468–477. https://doi.org/10.1111/j.1365-2788.2010.01284.x

Jahani, M.; Pishyareh, E.; Haghgoo, H.A.; Hosseini, S.A.; Neda, S.; Sani, G.(2016) Neurofeedback effect on perceptual-motor skills of children with ADHD. Iranian Rehab. J., 14 (1), 43-50.

Ludyga, S., Köchli, S., Pühse, U. Gerber, M., Hanssen, H. (2018). Effects of a school-based physical activity program on retinal microcirculation and cognitive function in adolescents. Journal of Science and Medicine in Sport, S1440244018308703, https://doi.org/10.1016/j.jsams.2018.01.001

Mattos, P., Serra-Pinheiro, M.A., Rohde, L.A., Pinto, D. (2006) A Brazilian version of the MTA-SNAP-IV for evaluation of symptoms of attention-deficit/hyperactivity disorder and oppositional-defiant disorder. Rev. psiquiatr. Rio Gd. Sul, 28, 290-7.

Norton D.J.; Mcbain, R.K.; Öngür, D.; Chen, Y. (2011) Perceptual training strongly improves visual motion perception in schizophrenia, Brain Cogn., 77 (2), 248-256.

Piek, J. P., Dawson, L., Smith, L. M., & Gasson, N. (2008). The role of early fine and gross motor development on later motor and cognitive ability. Human Movement Science, 27(5), 668–681. https://doi.org/10.1016/j.humov.2007.11.002

Rigoli, D., Piek, J.P., Kane, R., Oosterlaan, J. (2012), An examination of the relationship between motor coordination and executive functions in adolescents. Developmental Medicine & Child Neurology, 54: 1025-1031. https://doi.org/10.1111/j.1469-8749.2012.04403.x

Roebers, C. M., & Kauer, M. (2009). Motor and cognitive control in a normative sample of 7-year-olds. Developmental Science, 12(1), 175–181. https://doi.org/10.1111/j.1467-7687.2008.00755.x

Saraiva, R.A., Moojen, S.M.P., & Munarski, R. (2006). Avaliação da compreensão leitora de textos expositivos para fonoaudiólogos e psicopedagogos (2ª ed.). São Paulo: Casa do Psicólogo.

Sergeant, J. (2000). The cognitive-energetic model: An empirical approach to Attention-Deficit Hyperactivity Disorder. Neuroscience & Biobehavioral Reviews, 24(1), 7–12. https://doi.org/10.1016/S0149-7634(99)00060-3

Stein, M., Auerswald, M., & Ebersbach, M. (2017). Relationships between Motor and Executive Functions and the Effect of an Acute Coordinative Intervention on Executive Functions in Kindergartners. Frontiers in Psychology, 8, 859. https://doi.org/10.3389/fpsyg.2017.00859

Toto, G. A., & Limone, P. (2021). The effect of motor development in adolescence on cognition: A cumulative literature review. Journal of Human Sport and Exercise - 2021 - Autumn Conferences of Sports Science. Journal of Human Sport and Exercise, https://doi.org/10.14198/jhse.2021.16.Proc2.51

Van der Fels, I.M.J., Smith, J., de Bruijn, A.G.M., Bosker, R.J., Königs, M., Oosterlaan, J., … Hartman, E. (2019). Relations between gross motor skills and executive functions, controlling for the role of information processing in 8-10 year old children. PLoS ONE 14(10): e0224219. 10.1371/journal.pone.0224219