



Comparative study between school and motor performance in children aged 6 to 11 years according to teachers' perceptions

Estudo comparativo entre desempenho escolar segundo a percepção dos professores e performance motora em crianças de 6 a 11 anos

Estudio comparativo entre desempeño escolar y motor en niños de 6 hasta 11 años

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Abstract

Introduction: Motor skills are enlarged during schooling age, with possible relation between motor and school performance. **Objective:** Compare motor skills of children with good and poor school performance, according to the teacher's perception in the classroom. **Method:** School children aged 6 to 11 years were divided into two groups; poor school performance (PSP) and good school performance (GSP) and evaluated using the Motor Development Scale (MDS). The chronological age, general motor age and the motor quotient of each area evaluated were compared between the groups using the Mann-Whitney Test. The Chi-square test was used to associate the motor performance classification and the school performance. **Results:** Chronological age was similar between groups, although the general motor age was smaller in the PSP. The general motor quotient and the motor quotients in the areas of body scheme, spatial and temporal

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organization were significantly smaller in PSP. Most children were classified by the MDS as Low Normal or Medium Normal motor skills in both groups; however in the GSP, 27.5% of the children had a High Normal or Superior motor development and only 2.5% were classified as Very Inferior or Inferior. In the PSP, 12.5% had a Very Inferior or Inferior performance and only 6.25% had a High Normal or Superior performance ($p < 0.05$ – chi-square test). **Conclusion:** Results show a direct connection between poor school performance and motor skill difficulties, which illustrates the relation between motor and cognitive skills.

Keywords: Child Development. Learning. Motor Skills.

Resumo

Introdução: No período de escolarização ocorre aprimoramento e ampliação das habilidades motoras, com possível relação entre desenvolvimento motor e aprendizagem escolar. **Objetivo:** Avaliar e comparar habilidades motoras de crianças com baixo e alto desempenho escolar, segundo percepção do professor em sala de aula. **Método:** Participaram escolares entre 6 e 11 anos, divididos em GBD (baixo desempenho escolar) e GAD (alto desempenho escolar), avaliados através da Escala de Desenvolvimento Motor (EDM). As médias da idade cronológica, idade motora geral e os quocientes motores de cada um dos domínios avaliados pela EDM foram comparados entre os grupos através do Teste Mann-Whitney. O Teste Qui-quadrado foi utilizado para associar a classificação do desempenho motor e o desempenho acadêmico. **Resultados:** A média da idade cronológica foi semelhante entre os grupos, entretanto a média da idade motora geral foi menor no GBD. O quociente motor geral, assim como os quocientes motores: esquema corporal, organização espacial, linguagem e organização temporal foram significativamente menores no GBD. Em ambos os grupos, a maioria dos escolares foram classificados pela EDM como apresentando desempenho motor Normal Baixo ou Normal Médio, entretanto, no GAD, 27,5% dos escolares apresentaram desempenho motor Normal Alto ou Superior e apenas 2,5% foram classificadas como Muito Inferior ou Inferior. No GBD, 12,5% apresentaram desempenho Muito Inferior ou Inferior e apenas 6,25% desempenho Normal Alto ou Superior ($p < 0,05$ – teste qui-quadrado). **Conclusão:** Os resultados direcionam para uma relação direta entre baixo desempenho escolar e dificuldade nas habilidades motora, ilustrando a relação entre o desempenho motor e cognitivo.

Palavras-chave: Desenvolvimento Infantil. Aprendizagem. Destreza Motora.

Resumen

Introducción: En el período de escolarización ocurre ampliación de las habilidades motoras, con posible relación entre el desarrollo motor y el aprendizaje escolar. **Objetivo:** Comparar habilidades motoras de niños con bajo y alto desempeño escolar, según la percepción de los profesores. **Método:** Participaron escolares entre 6 y 11 años, separados en GBD (bajo desempeño escolar) y GAD (alto desempeño escolar), evaluados a través de la Escala de Desarrollo Motor (EDM). La edad cronológica, la edad motora general y los cocientes motores se compararon entre los grupos a través del Test Mann-Whitney. El Teste Qui-cuadrado fue utilizado para asociar la clasificación del desempeño motor por la EDM y el desempeño académico. **Resultados:** La edad cronológica fue similar entre los grupos, sin embargo la edad motora general fue menor en el GBD. El cociente motor general, así como los coeficientes motores en los dominios esquema corporal, organización espacial, lenguaje y organización temporal, fueron significativamente menores en el GBD. En ambos grupos, la mayoría de los escolares fueron clasificados como presentado desempeño motor Normal Bajo o Normal Medio, sin embargo, en el GAD, el 27,5% de los escolares presentaron desempeño motor Normal Alto o Superior y apenas el 2,5% fueron clasificadas como Muy Inferior o Inferior. En el GBD, el 12,5% presentó un rendimiento Muy Inferior o Inferior y sólo 6,25% de rendimiento Normal Alto o Superior ($p < 0,05$ – prueba qui-cuadrado). **Conclusión:** Los resultados se dirigen para una relación directa entre el bajo desempeño escolar y la dificultad en las habilidades motrices.

Palabras clave: Desarrollo Infantil. Aprendizaje. Destreza Motora.

Introduction

Childhood is a phase of life when intense motor development occurs, including abilities, such as movement – gross motor coordination –, which is developed in the first years of life, and the manipulative skills, or fine motor coordination, which is improved later on. The first couple of years in elementary school coincide with important achievements in the children's neurological development, such as the gradual myelination of association areas; lateralization of spatial perception, improvement of the reticular formation and hippocampus functioning, and beginning of the final phase of maturation of the prefrontal cortex [1]. During this phase, the growth is stable and slow, which allows the children to adapt to the changes in their own bodies [2]. Several authors [1-4] have discussed the importance of the development of suitable motor strategies as a fundamental ability in the learning and cognitive development process and improvement of school skills, such as using scissors, drawing or writing. According to the authors, learning is a complex system of associations and depends on the joint action of several motor and cognitive abilities. Skills such as hearing and visual discrimination, spatial organization and orientation, temporal orientation, proprioception, laterality, fine motor coordination, and focused attention should be previously developed by children.

Children use their body and previously acquired abilities to explore and interact with the world. A disorganized body that does not integrate such abilities affects its own intellectual, social and affective-emotional development, which can also result in poor school learning, since some psychomotor abilities are essential to this process [5].

Some researchers have investigated possible causes for school difficulties, such as environmental causes [6, 7], family socio-economic position [8-10], prematurity/previous diagnosis of neuropsychomotor development delay [11-13], and parents' involvement in the schooling process [14].

Previous studies indicated a possible relation between poor school performance and motor development [15-20]. Other studies showed strong statistical significance between academic learning and motor abilities [21-23], and, according to Sumner, Pratt and Hill [24], the literature suggests that

cognitive and motor performance are intertwined and follow a similar development path.

Some researchers have also focused their studies on intelligence and executive functions in school performance and learning [25, 26]. Their findings suggest that the development of a good motor control might be key to the intellectual success, and that stimulation on motor control can prevent school difficulties [15, 21, 27].

The most common learning difficulties found include reading, writing, calculation, paying attention and socializing. Some studies suggest children with learning disabilities have difficulties with integration, elaboration or motor expression, planning, processing (input, output), regulation, and movement control [28]. When such difficulties are not identified, they might interfere in the children's social and emotional behavior [22, 28, 29]. Therefore, it is extremely important to identify such conditions and provide an early intervention with a large number of motor and psychosocial experiences to minimize the difficulties faced by these children. Therefore, it is vital to evaluate and follow the motor development of schoolchildren, considering their learning disabilities [21].

Thus, based on the hypothesis raised in the reference gathered, which suggests a relation between motor and cognitive development in schoolchildren, this study compared motor skills of children attending private and public schools in Campinas – SP who presented high and low school performance, according to the perception and information provided by their teachers.

Methods

Participants

The population comprised schoolchildren aged 6 to 11 years, from the 1st to the 6th year of elementary school in an institution from the State Education System and two schools from the private system in Campinas – SP. The children were divided into two groups, namely, Poor School Performance Group (PSP), which included children with poor school performance and the Good School Performance Group (GSP), comprising children with good school performance appointed by their teachers. The sample collection was intentional, and, to form the groups, the teachers were asked to select six

children based on classroom performance, three with the best performance and three with the worst classroom performance. The teachers reported that the parameters used to select the students were writing/reading and calculation disabilities, difficulty to concentrate and pay attention to the lesson, and behavior.

Children who had physical and/or neurological deficiency, sensorial deficit, behavior disorders, a background of intellectual deficiency or irregularity when filling in the Informed Consent Form (TCLE, Brazilian acronym) were excluded from the study.

Instrument

The instrument used to evaluate the motor development in schoolchildren was the Motor Development Scale (MDS) [30], which evaluates the following areas of development: final and global motricity, balance, body scheme, spatial and temporal organization, and laterality. This instrument determines: General Motor Age (GMA), expressed in months and obtained through the mean of results from each of the motricity areas evaluated, and the Motor Quotient (MQ) in each of the areas evaluated by the scale, obtained by the motor age divided by the chronological age and multiplied by 100.

Motor development was also classified into 7 levels, considering the children's chronological age: very inferior, inferior, low normal, medium normal, high normal, superior and very superior.

Procedures

The study was approved by the Research Ethics Committee of the University of Campinas (Unicamp), with CAAE number 18640913.2.0000.5404.

For the children to participate in the study, previous authorization was obtained from their parents or guardians through the TCLE. In the initial phase, the pedagogical coordination was asked not to reveal the children's school performance before the evaluation, so the results would not be affected, characterizing thus a double-blinded study. The tests were fully applied by three previously trained examiners and took an average of 40 minutes. The children were informed about the procedures and received instructions regarding the possibility of interrupting the test at any time, if they thought it was necessary. A report was written, and one copy of this

summarized report containing the results obtained by the children was sent to their parents/guardians while another copy was sent to the pedagogical coordination of the school.

Statistical Analysis

The statistical analysis was carried out aided by the program SPSS version 16 for Windows. The means of chronological age, general motor age and motor quotient of the areas evaluated by the MDS were compared between groups using the Mann-Whitney test, while the Chi-Square test was used to associate high and low school development with the variables sex, school year, laterality and classification according to the MDS levels. The differences presenting $p \leq 0.05$ were considered significant.

Results

The initial sample included 79 schoolchildren with average age between 6 and 11 years, of both sexes. Three children were excluded due to lack of data in the TCLE, two for previous diagnosis of infant cerebral vascular accident (infant CVA), one child was excluded for refusing to complete the tests and another for presenting foot orthopaedic dysfunction. The final sample comprised 72 schoolchildren, aged between 6 and 11 years, divided into PSP, including 32 children, and GSP, containing 40 children.

The mean of chronological age was similar between the groups; however, the mean of general motor age was significantly higher in the GSP group (Table 1). The association between school performance and the variables sex, school year and laterality did not present significant difference (Table 2).

Motor quotient regarding fine motricity, global motricity and balance did not present significant difference between groups. However, motor quotient regarding body scheme, spatial organization, language and temporal organization, as well as the general motor quotient, were significantly lower in the PSP group (Table 3).

In both groups, the motor performance in most schoolchildren was classified by the MDS as Low Normal or Medium Normal; however, in the GSP group, the frequency (27.5%) of schoolchildren classified as high normal motor performance or superior motor performance was higher, while only

one schoolchild (2.5%) was classified as very inferior or inferior performance.

In the Poor School Performance group, 12.5% presented very inferior or inferior performance and

only two schoolchildren (6.25%) presented high normal or superior performance. No schoolchildren were classified as very superior performance in either of the groups (Table 4).

Table 1 – Mean of chronological age and general motor age

	Poor School Performance Group	Good school Performance Group	P
	Mean \pm SD	Mean \pm SD	
Chronological age (CA)	101.03 \pm 17.76	102.85 \pm 19.27	0.852
General Motor age (GMA)	92.09 \pm 14.85	103.2 \pm 15.69	0.003*

Note: *: $p < 0.05$ – Mann-Whitney Test.

Table 2 – Frequency and percentage distribution of schoolchildren according to sex, school year and laterality

	Poor School Performance Group	Good School Performance Group	P
	n (%)	n (%)	
Sex			
Male	17 (53.1%)	15 (37.5%)	0.185
Female	15 (46.9%)	25 (62.5%)	
School year			
1 st year	11 (34.4%)	16 (40%)	0.260
2 nd year	6 (18.8%)	4 (10%)	
3 rd year	10 (31.3%)	6 (15%)	
4 th year	2 (6.2%)	9 (22.5%)	
5 th year	1 (3.1%)	2 (5%)	
6 th year	2 (6.2%)	3 (7.5%)	
Laterality			
Right handed	16 (50%)	23 (57.5%)	0.366
Crossed	11 (34.4%)	8 (20%)	
Undefined	5 (15.6%)	9 (22.5%)	

Note: No significant difference was found – Chi-Square Test.

Table 3 – Comparison between Motor Quotients in each area and General Motor Quotient

Areas	Poor School Performance Group	Good School Performance Group	P
	n = 32	n = 40	
	Mean \pm Standard Deviation	Mean \pm Standard Deviation	
Fine motricity	90.74 \pm 17.17	98.12 \pm 18.11	0.072
Global motricity	97.75 \pm 17.80	102.96 \pm 20.98	0.548
Balance	99.70 \pm 22.10	100.40 \pm 19.29	0.786
Body scheme	81.05 \pm 18.20	96.00 \pm 13.25	0.000*
Spatial organization	82.10 \pm 15.63	94.58 \pm 19.79	0.012*
Language and temporal organization	101.49 \pm 23.25	116.13 \pm 21.77	0.008*
General motor quotient	92.17 \pm 12.42	101.36 \pm 11.05	0.002*

Note: *: $p \leq 0.05$ – Mann-Whitney Test.

Table 4 – Frequency and percentage distribution of children in both groups, according to the Motor Development Scale

MDS classification	Poor Performance n(%)	Good Performance n(%)	P
Very inferior and inferior	4(12.5%)	1(2.5%)	
Low normal and medium normal	26(81.25%)	28(70%)	0.026*
High normal and superior	2(6.25%)	11(27.5%)	

Note: *: $p < 0.05$ – Chi-Square Test.

Discussion

This study aimed to evaluate and compare motor development of children with and without indication of school difficulties to verify whether motor development is related to learning disabilities or vice versa. The results found support the hypothesis that there is a parallel between motor and school development.

Regarding chronological age and General Motor Age

The mean of chronological age (in months) was similar between the groups; however, the mean of general motor age (obtained through the mean of results from each of the motricity areas evaluated by the MDS), was significantly lower in the Poor School Performance group, indicating a motor development that is in agreement with the lower chronological age in these groups. This finding corroborates the study by Silva and Dounis [31], in which great part of the sample presented motor age lower than the chronological age, emphasizing the relation between motor development delay and low school performance.

Regarding sex and laterality

The association between school performance and the variables sex, school year and laterality did not present significant difference in our study.

However, the schoolchildren evaluated in this study showed higher prevalence of completely right-handed children: 57.5% in GSP group and 50% in PSP group. Laterality, in this context, was discussed in the study by Rosa Neto et al. [17], who used MDS to compare the results of reading and writing performance in schoolchildren, showing that those with complete lateral dominance (in this case, completely right

handed) had better reading and writing performance, which might interfere in the school learning process. These findings indicate a possible relation between laterality and school learning.

Despite not presenting statistical significance, a higher prevalence of boys was observed in the PSP group (53.1%) in comparison with the GSP group (37.5%), which might indicate that learning disabilities are more common among boys. These results are in agreement with those found in the study by Silva, Oliveira and Ciasca [32] in 2017, which evaluated schoolchildren with learning disabilities and found significant difference between sexes (higher incidence of boys (92%) in the group with learning disabilities). In a study [33] with schoolchildren diagnosed with dyslexia, there was also predominance of boys (82%), but those authors support the hypothesis of boys having a worse school performance due to bad behavior in the classroom. This hypothesis can also be associated with our study, since the teachers appointed the students to participate in the groups (low or high performance) using their perception of the students in the classroom (writing/reading and calculation disabilities, difficulty in concentrating and paying attention to the lesson, and behavior).

Regarding Motor Quotients in each domain and General Motor Quotient

The motor performance of children with low school performance was inferior to that of the children with high school performance in the areas: body scheme, spatial organization, and language and temporal organization, which confirms previous studies [21, 29].

Body scheme is the representation and perception the children have of their own bodies, while the spatial organization is the ability to evaluate the relation between body and environment, enabling

the integration of the sensorial information into the environment, such as distance from objects/people around the child to plan suitable motor strategies. The temporal organization refers to the ability to discriminate a succession of events and duration of intervals (notions of rhythm, beat and time). Body and spatial perceptions are essential requirements to a good motor and school performance [34], and reading, writing and calculation disabilities might be directly related to perceptual-motor disorders [27]. Recently, a systematic review involving children aged between 4 and 16 years with typical development, pointed out that better motor abilities were commonly associated with better performance in cognitive tasks [35]. Another study, developed with teenagers from 12 to 16 years old, also found a relation between motor coordination and the executive function in individuals older than the ones in our study, since it showed a positive correlation between motor abilities and visual-spatial working memory [16]. The General Motor Quotient was also lower in the PSP group, confirming the findings of other studies with significant correlation between motor and intellectual development [21, 27, 28].

Sumner et al. [24] compared cognitive performance using the Wechsler Intelligence Scale for Children (WISC-IV) between children with Coordination Development Disorder (CDD) and children in a control group. Despite not finding statistically significant difference in the general mean of the groups, they found poorer performance in children with CDD in the processing speed and working memory tests. They also found different performance between children with CDD in all areas of intelligence evaluated, highlighting the importance of considering the cognitive performance of children with motor coordination deficit individually, in order to propose suitable intervention strategies for each case [24].

Motor difficulties suggest a possible lack of proper stimulation, as observed by Santos et al. [6] and Queiroz [7], who compared pre-school children attending day care in public and private institutions. In both studies, the children attending private institutions obtained better scores, emphasizing better attention skills and motor stimulation in those environments. In a study by Campos et al. [34], the positive effect of therapeutic intervention was demonstrated through plays and ludic activities

on the body and spatial perception and temporal organization in a 4-year-old child.

Regarding frequency and distribution according to the MDS classification of motor performance

In both groups of this study, most schoolchildren were classified by the MDS as low normal or medium normal performance, confirming the findings by Silva and Beltrame [15], who reported that 72.2% of a sample of 231 schoolchildren between 7 and 10 years old had normal motor abilities.

However, the GSP group showed a prevalence (27.5%) of schoolchildren with high normal or superior motor performance, and only one schoolchild (2.5%) with very inferior or inferior performance. In the PSP group, 12.5% presented very inferior or inferior performance, and only two schoolchildren (6.25%) showed high normal or superior performance, obtaining high scores in the MDS in the good school performance group.

The results above show a close relation between school performance and motor difficulties found in children with learning disabilities. It is noteworthy the need to provide children with a more complete learning experience and teachers with a better training, mainly regarding the identification of motor delays, since they might be another obstacle to an efficient pedagogical approach.

Weaknesses and limitations of this study

The subjective evaluation, through teachers' perceptions about the school performance of schoolchildren might be a limiting criterion in this study, since this perception can be mistaken in some cases for not being based on accurate and reliable tests.

Asking a teacher to classify a student with good or bad school performance might also be susceptible to the Pygmalion effect, presented by Rosenthal and Jacobson [36] and inspired by the homonymous old Greek Myth [37]. This effect suggests that teachers' expectations might influence the performance of students for better or worse, since their positive view tend to stimulate them, while students that are considered limited are not encouraged and have their academic performance affected.

We suggest the development of further studies with accurate and validated assessments such as the School Performance Test (SPT) and intelligence evaluations, including socio-familiar and socioeconomic variables so that the whole sample can be chosen homogeneously.

Conclusion

The results obtained led to the conclusion that there is a direct relation between motor and school performance. This relation is still unknown, so an investigation should be conducted by the professionals in the education area, since they are not always prepared to identify motor and cognitive difficulties in schoolchildren. This failure in the identification of disabilities might delay the intervention of specialized professionals in those areas and not minimize the physical and psychosocial damage these children might face due to late diagnosis.

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