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## ORIGINAL

# ASSOCIATION BETWEEN SPECIFIC AREAS OF DEVELOPMENT AND DYSPRAXIA IN PRESCHOOL CHILDREN

## ASOCIACIÓN DE ÁREAS ESPECÍFICAS DEL DESARROLLO CON DISPRAXIAS EN PREESCOLARES

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### ABSTRACT

The aim of the study was to evaluate motor development and associate its specific areas with dyspraxia in preschool children. The sample consisted of 436 preschoolers (217 girls and 219 boys) between 2 and 5 years old. Motor development was evaluated in the domains of Coordination, Proprioception and Perception using the Motor Development Scale (EDM) with the results being presented as the motor development age and the motor development quotients. The results show that 57 (13.7%) children have presented general motor

quotient  $\leq 89$ , classified as dyspraxia. Children presented lower scores of general motor quotient and highest developmental delays (greater negative motor age) in the perception area (spatial orientation and temporal orientation). Perception showed a positive correlation with the risk group for dyspraxia. These results are relevant for the establishment of the motor development profile of preschool children and thus, help teachers and professionals in interventions and prevention of future learning problems associated with developmental delays.

**KEY WORDS:** Preschool Child, Child Development, Dyspraxia, Perception, Motor Assessment

## RESUMEN

El objetivo del estudio fue evaluar el desarrollo motor y asociar sus áreas específicas con dispraxias. La muestra fue compuesta por 436 preescolares entre 2 a 5 años. El desarrollo motor fue evaluado en las áreas de Coordinación, Propiocepción y Percepción y los resultados presentados en forma de edad motora y cocientes motores. Los resultados muestran que 57 (13,7%) niños presentaron cociente motor general  $\leq 89$ , siendo clasificados con dispraxia. La Percepción (orientación espacial y temporal) fue el área con más retrasos (edad motora negativa) y con valores de cociente motor general más bajos. Esta área también presentó correlación positiva con el grupo de riesgo para dispraxia. Estos resultados son relevantes para establecer el perfil de desarrollo motor de los preescolares y así, auxiliar profesores y profesionales en intervenciones y en la prevención de problemas futuros del aprendizaje asociados a los retrasos observados.

**PALABRAS CLAVE:** Preescolares, Desarrollo Infantil, Dispraxia, Percepción, Evaluación Motora

## INTRODUCTION

Early childhood is characterized by significant changes in motor development. In this period, becomes eminent the acquisition and performance of locomotion, stabilization and manipulation skills, resulting from the interaction between the genetic inheritance and the influences of the environment (Shonkoff et al., 2012). Establishing and improving motor skills can have a positive impact on cognitive abilities, optimizing general development and the way that children interact with the environment (Örnkloo & Von Hofsten, 2007; Pereira, Valladares, Mieres, Velázquez, & Pichs, 2019). The acquisition of motor skills provides children new opportunities to learn from environmental experiences, both in relation to objects and other individuals (Houwen, Van der Veer, Visser, & Cantell, 2017).

Motor development investigations in early childhood education are essential since evaluations at an early age can identify children at risk, turning out possible to refer them for future interventions to minimize losses related to motor delays (Maggi, Magalhães, Campos, & Bouzada, 2014). It is important to

recognize that harms in motor skills are related to a delayed cognitive development and language (Iverson, 2010), and with social and emotional difficulties (Green, Baird, & Sugden, 2006). In addition, studies related delays in development of motor skills with negative influence on the individual aspects, such as a high prevalence of obesity and lower participation in physical activity (Bucco & Zubiaur, 2015), and a subsequent negative effect on academic performance in adolescents (Kantomaa et al., 2013).

International literature suggests that 5% to 6% of school-age children have a clinical diagnosis for motor disorder (American Psychiatric Association [APA], 2013). However, recent studies in Brazilian context shows that this prevalence can be higher. Silva (2017) when evaluating 265 children aged 3 to 5 years old found 14.3%. Maggi et al. (2014) found 19% of children with motor development delays and Valentini et al. (2012), based on the evaluation of 152 children aged 4 to 6 years old from the three states in the South of Brazil, found a prevalence of 35% with indication of motor disorder. These motor commitments can be categorized as a disorder, varying from severe motor impairment as in cases of cerebral palsy, to less severe as in children with Developmental Coordination Disorder (DCD; Piek, Hands, & Licari, 2012).

Among the motor disorders, Dyspraxia is characterized as a neurodevelopmental disorder that affects the ability to plan, organize and coordinate and automate oriented gestures (Boxus, Denis, & Pitchot, 2018). Dyspraxia can be defined as a disturbance in planning intentional, conscious and learned movements (De Ajuriaguerra, 1977), represented as a motor disorder. Each movement that does not become automated by the child demands more attention, competing with the execution of other motor tasks. Thus, Dyspraxia is a cognitive disorder of motor activity and its mental representation, and it occurs not only depending on the neurological aspects that regulate psychomotor factors (such as muscle tone, posture control, laterality, spatial and temporal organization) but also to the environmental aspects, family, educational and social factors (Fonseca, 2009).

According to Baxter (2012), the origin of the term is based on the relationship with praxis, where Dyspraxia is described as a disorder related to difficulties in learning and performing motor tasks. Individuals with Dyspraxia have as a characteristic difficulty in combining simple motor tasks for the performance of more complex motor acts, such as writing. In addition, expressions of motor difficulties can vary from fine movements, such as eye-manual coordination, facial motor control of lips and tongue and speech, to gross movements such as gait (Anderson-Mooney, Schmitt, Head, Lott, & Heilman, 2016). These motor skills can be classified into different areas of motor development, such as coordination, proprioception and perception, and be represented by specific domains, for example, gross motor skills (skills such as jumping, running and walking), fine motor skills (precision and fine motor integration, and manual dexterity), balance, body scheme and spatial and temporal organization. These categories are associated with different areas of neurological development and the need for attention to specific interventions and stimuli. Therefore, the aim of this study was to evaluate motor development in preschool children and

associate the delays identified in specific areas of development with Dyspraxias.

## **MATERIAL AND METHODS**

### **Sample**

Sample was composed of 436 children (217 girls and 219 boys) randomly selected by conglomerates in 70 schools. Age of children: 100 preschoolers were 2 years old; 103 were 3 years old; 124 were 4 years old; and 109 were 5 years old. To estimate sample size, we used as a reference the population of children enrolled in Early Childhood Education according to the data from the *Florianópolis* Municipal Education Department: 7062 students. We chose to evaluate 5% of children at each early childhood education stage, considering a 95% confidence interval in the Open Source Epidemiological Statistics Program for public health (OpenEpi; Dean, Sullivan & Soe, 2013).

Were considered the following inclusion criteria: a) to have the Term of Consent signed by the parents or guardians; b) present age within the target range for the study by the time of the evaluation; c) be regularly enrolled in early childhood education in municipal public education; d) agree to participate in the investigation and sign the assignment term by the time of the evaluation. As exclusion criteria, were excluded from this study children with clinical diagnosis of disabilities (motor, physical, visual, auditory and / or intellectual) and / or developmental disorders (example: autism spectrum disorder).

### **Instruments**

To assess children's motor development and its specific areas, we used the Motor Development Scale (EDM; Rosa Neto, 2018). The EDM divides the evaluation into three main areas and each area is composed of two specific domains: coordination (fine and global motricity), proprioception (balance and body scheme) and perception (spatial organization and temporal organization). Each child performs at least twelve motor tasks appropriate for your age range. The tasks present complexity that increases according to age, from level 2 to level 11, as presented in figure 1. To applicate the motor tasks, we follow the instructions of the Manual of Motor Assessment (Rosa Neto, 2018).

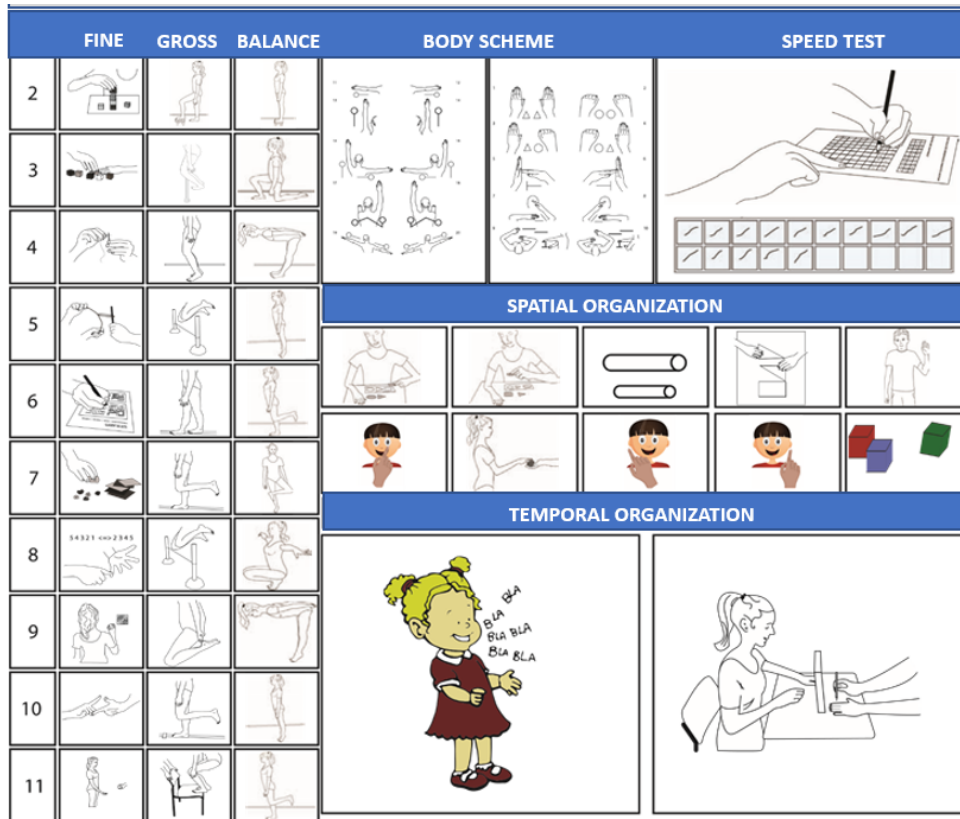


Figure 1. Summary of motor tasks by age. Manual of Motor Assessment (Rosa Neto, 2018).

This instrument was standardized to assess motor development in children based on chronological age, motor ages and motor quotients, being able to identify children with motor delays that might indicate risks to the development. The EDM provides scores for motor ages by the test averages (results expressed in months) and for motor quotient (motor age in each test, divided by chronological age and multiplied by 100). Each final motor quotients score refers to a specific range of classification, which corresponds to a respective level of development that vary from "very low" (equal to or less than 69 points) to "very high" (equal to or up to 130 points), as observed in table 1. Values less or equal to 89 represent a risk for motor development and therefore included as a Dyspraxia for this study.

Table 1. Classification of the General Motor Quotient (GMQ) according to the MDS

CMG score	Classification	Risk factor
130 or more	Very High	None
120 – 129	High	None
110 – 119	Normal High	None
90 – 109	Normal Medium	None
<b>80 – 89</b>	<b>Normal Low</b>	<b>Mild Risk</b>
<b>70 – 79</b>	<b>Low</b>	<b>Moderate Risk</b>
<b>69 or less</b>	<b>Very Low</b>	<b>Severe Risk</b>

GMQ = General Motor Quotient.

Font: Manual of Motor Assessment (Rosa Neto, 2018).

Studies show adequate psychometric properties for the standardization of EDM for Brazilian context (Amaro, Santos, Brusamarello, Xavier, & Rosa Neto, 2009; Rosa Neto, Santos, Xavier, & Amaro, 2010).

## Procedures

Initially the research was approved by the Municipal Department of Education of *Florianópolis* and subsequently approved by the Committee of Ethics for research involving human beings of the Santa Catarina State University (UDESC), under the protocol: CAAE 56427116.1.0000.0118. School and preschool groups were randomly raffled by conglomerate using Microsoft Excel. In the raffle groups, researchers sent the terms of consent to the parents, through the children's school agenda. Once the terms were signed, the schools made available an appropriated place where the assessments were conducted. The tests were performed by trained and qualified researchers, always in pairs (one researcher to conduce the assessment and another to record on the instrument's answer sheet). Assessments took an average of 40 minutes per child.

## Data analysis

First, a prevalence analysis of Dyspraxia was performed. Then, an analysis of associations between the typical development groups versus the risk group for Dyspraxia was performed, using the Chi-square test, for the variables sex, age and delays in the areas of coordination, proprioception and perception. Finally, a correlation analysis was made between the areas of development, coordination, proprioception and perception between typical development groups versus risk group for Dyspraxia, through Pearson's correlation. The results of the analyzes were considered statistically significant for  $p$  value  $\leq 0.05$ , with a 95% confidence interval. Data analysis were performed using the statistical software SPSS version 20.0.

## RESULTS

We evaluated 436 preschoolers, 57 (13.7%) have presented General Motor Quotient  $\leq 89$  (classified within the risk zone for development), considered in this study as the group with Dyspraxias. Table 2 presents descriptive data from motor development assessment performed and the prevalence of Dyspraxia.

**Table 2.** Descriptive data from general motor age, motor quotients and classification of motor development.

	Typical development (n = 379)						Dyspraxia (n = 57)					
	Male (n = 188)			Female (n = 191)			Male (n = 31)			Female (n = 26)		
	M	SD	MC	M	SD	MC	M	SD	MC	M	SD	MC
CA	47,42	13,59	-	48,48	12,79	-	46,61	13,13	-	47,35	11,93	-
GMA	50,17	13,51	-	51,32	12,31	-	38,45	11,11	-	39,00	10,94	-
GMQ	106,8	9,95	NM	107,1	11,63	NM	82,5	6,06	NL	81,92	7,55	NL
FMQ	96,1	15,46	NM	95,6	17,04	NM	79,2	11,81	L	73,82	11,34	L
GMC	117,9	20,08	NH	117,2	21,24	NH	95,5	13,45	NM	91,87	12,79	NM
BMQ	106,4	17,42	NM	106,9	18,86	NM	82,9	11,10	NL	86,56	15,30	NL
BSQ	109,4	17,78	NM	110,6	17,36	NH	82,0	14,37	NL	82,76	14,31	NL
SOQ	108,5	19,97	NM	108,9	19,92	NM	86,9	20,98	NL	82,48	16,98	NL
TOQ	102,3	18,89	NM	103,6	22,99	NM	68,7	20,85	VL	74,01	15,02	L

M = Mean; SD = Standard deviation; MC = Motor development classification; CA = Chronological age in months; GMA = General motor age in months; GMQ = General motor quotient; FMQ = Fine motor skills quotient; GMC = Global motor skills quotient; BMQ = Balance quotient; BSQ = Body scheme quotient; SOQ = Spatial organization quotient; TOQ = Temporal organization quotient; NH = Normal High; NM = Normal Medium; NL = Normal Low; L = Lower; VL = Very Low.

In addition to the lowest scores found, it is possible to observe negative motor ages in relation to chronological age in the Dyspraxia group. In general, the areas with the lowest scores were fine motor skills and temporal orientation.

Table 3 shows results for the Chi-square test that verified the existence of statistically significant difference between groups (TD x Dyspraxia) within sex, age and months of motor delays when compared to chronological chronology.

**Table 3.** Comparison of GMQ within groups for gender, age, and NA/PA in motor development areas

		GMQ		p
		TD	Risk	
Gender	Female	191 (88%)	26 (12%)	0,273
	Male	188 (85,5%)	31 (14,2%)	
Age (years)	2	85 (85%)	15 (15%)	0,298
	3	90 (87,4%)	13 (12,6%)	
	4	108 (87,1%)	16 (12,9%)	
	5	96 (88,1%)	13 (11,9%)	
NA/PA Coord	Positive motor age	241 (86,7%)	37 (13,3%)	0,300
	NA - 2 to 6 (months)	103 (90,4%)	11 (9,6%)	
	NA - 7 to 12 (months)	26 (78,8%)	7 (21,2%)	
	NA - 13 to 18 (months)	26 (78,8%)	7 (21,2%)	
NA/PA Propio	Positive motor age	249 (86,8%)	38 (13,2%)	0,357
	NA - 2 to 6 (months)	91 (89,2%)	11 (10,8%)	
	NA - 7 to 12 (months)	33 (84,6%)	6 (15,4%)	
	NA - 13 to 18 (months)	6 (75%)	2 (25%)	
NA/PA Percep	Positive motor age	228 (95,4%)	11 (4,6%)	≤ 0,00
	NA - 2 to 6 (months)	97 (77,6%)	28 (22,4%)	
	NA - 7 to 12 (months)	39 (73,6%)	14 (26,4%)	
	NA - 13 to 18 (months)	1 (25%)	3 (75%)	

GMQ = General Motor Quotient; PA = Positive motor age; NA = Negative motor age; Coord = Coordination; Propio = Proprioception; Percep = Perception; TD = Typical development children.

It was possible to observe difference between chronological age and motor age (EN / EP) however only delays in the area of perception have showed statistical differences between children with and without risk of Dyspraxia.

It was decided to verify the associations between the motor quotients in the areas of coordination, proprioception and perception, and the risk group, through the Pearson correlation test, as presented in Table 4.

**Table 4.** Correlation between GMQ and Negative motor ages in Coordination, Proprioception and Perception

	G. at risk	NA Coord	NA Propio	NA Percep
G. at risk	-	0,029	0,022	0,246**
NA Coord	-	-	0,582**	0,423**
NA Propio	-	-	-	0,484**
NA Percep	-	-	-	-

\*\* Significant correlation  $p \text{ value} \leq 0,00$ ; NA = negative motor age; Coord = Coordination; Propio = Proprioception; Percep = Perception; G. at risk = Group risk for Dyspraxia

Negative motor age in coordination, proprioception and perception are variables that change directly proportionally, thus as more delays a child presents in one of these areas, the greater the deficits in the other areas. The results of the correlation test illustrated in Table 4 also indicate that negative motor age in the area of perception can directly impact the risk of dyspraxia in preschoolers, something that was not observed in the coordination and proprioception.

## DISCUSSION

With the objective of evaluating preschool children motor development and associating delays identified with Dyspraxias, the present study evaluated motor coordination (fine and global motor skills), proprioception (balance and body scheme) and perception (spatial and temporal orientation) of 436 children (2 to 5 years old) regularly enrolled and frequenting the early childhood education of the municipal public education in *Florianópolis-SC*.

Results from motor assessments show that 13.7% of the children have Dyspraxias (general motor quotient  $\leq 89$ ) and the highest indications of motor delays (children classified as “normal low”, “lower” or “very low”) were observed in the area of perception, in the domains of spatial and temporal orientation. It was also observed that tasks that demanded greater effort from cognitive components, such as fine motor skills, spatial orientation and temporal organization, have presented lower mean and minimum scores than those found for global motor skills and balance tasks.

Understanding that the first months and years of life are fundamental to children development, lower the child's age, more relevant is the delay observed. This first period of life is when more neural plasticity is observed, meaning greater capacity of the central nervous system to organize, reorganize and adapt neural networks in response to the requirements of the tasks and the demands of the environment, as well as in the development of internal demands (Johnston, 2009). These motor disorders can interfere in general children's maturity,



affecting the development of their social relationships, the performance of daily basis tasks, the cognitive aspects, learning and language (Lamônica & Picolini, 2009). Araújo (2013) after following the psychomotor development of 77 children (0 to 3 years old) has found that 31.2% of the individuals in the risk for development and language had the highest rate of delays (57.5%). Caetano, Silveira and Gobbi (2005) observed lower values for fine motor and spatial organization in the motor evaluation of 30 children aged between 3, 4 and 5 years old.

Regarding the area of perception (spatial and temporal organization), we have observed greatest delays with children presenting delays – negative motor age – up to 24 months. Also, perception can directly impact the risk of Dyspraxia in preschoolers. As a definition, the perception area, in this case represented by the spatial and temporal organization, implies the ability to mentally represent spatial relationships and anticipate the course and outcome of the transformations applied to those relationships. For example, TD children will be able to use information from distance and reference points to define places, positions and sizes (Rosser, 1994). Temporal organization, represented in this study by language, has a close relationship with motor disorders and learning difficulties. Hill (2001) in a literature review with studies that investigated children with specific language impairment, found that 40 to 90% of these children also had motor disorders. Webster, Majnemer, Platt and Shevell (2005) found in children diagnosed with language disturbances at 3 years later associations (after 4 years) with motor and cognitive difficulties.

The commitment of spatial and temporal orientation may be related to dysfunction in the prefrontal cortex, which causes deficits in organization, working memory and attention; and with a dysfunction of the cerebellum - thalamus - which can cause deficits to inhibition and motor control (Goulardins, Marques, Casella, Nascimento, & Oliveira, 2013; Rosa Neto, Goulardins, Rigoli, Piek, & Oliveira, 2015). From the neurological point of view, the prefrontal cortex, basal ganglia and the cerebellum are activated for motor and cognitive tasks (Diamond, 2000). The prefrontal cortex has been associated with cognitive skills and the cerebellum with motor capacity, however, case studies with patients with localized brain damage, along with neuroimaging studies of individuals with typical functioning, have shown an overlap between these two brain structures and the two types of skills (Carlson, Rowe & Curby, 2013; Diamond, 2000).

These findings observed on Dyspraxias in specific motor areas highlight the importance of considering the range of areas and motor domains in early childhood education. Literature shows that motor development delays observed in early ages can indicate impairments in academic performance and even learning disorders in primary education (Westendorp, Hartman, Houwen, Smith, & Visscher, 2011). It is important to emphasize that the sample was formed by children up to 5 years and 11 months, compatible with the end of early childhood education and the beginning of primary education. To get to this further school period, it is necessary that the child has developed elementary skills that will be used as a basis for learning more complex tasks. The study by Pieters, Desoete, Van Waelvelde, Vanderswalmen and Roeyers (2012) showed

that children with motor difficulties also have school difficulties in mathematics, and the underlying skills for mathematical achievement, such as memorization and numerical adequate use in calculation were found with delays when compared to the control group.

It is important to realize that, especially in the preschool and children entering to primary education, motor coordination and executive functions (attention and work memory) do not exist in isolation. It is essential to consider the close relationship within spatial and temporal processes, as well as relationships with each other skills to form the basis for children's successful behaviors in the context of specific learning, such as solving mathematical problems, reading and writing (Cameron, Cottone, Murrah & Grissmer, 2016). Likewise, it must be considered that the lowest development scores in the domains of spatial and temporal organization represent in addition to an indication of motor delay, impairments in the function of attention and memory. This also can be related to attention disorders, such as Attention Deficit and Hyperactivity Disorder (ADHD; Gregorio, Pérez, & Moro, 2019). Poeta and Rosa Neto (2007) found that children diagnosed with ADHD present low classification levels for spatial and temporal organization because motor tasks in these two domains usually involves the processes of location, orientation, visual-spatial recognition, distance perception and speed.

Children between the end of early childhood education and the beginning of primary education must show that they have the proper skills for entry into this new period, such as classroom self-regulation and emerging academic abilities as writing and numbering. Acquiring competence with letters and numbers involves recognizing and reproducing visual representations of higher order concepts (Case & Okamoto, 1996). It is important that children have well-structured visuomotor skills so they can dedicate more of their cognitive resources to the integration of conceptual and perceptual information. Even 4-year-olds children with initial inhibitory control can improve their recognition and copying skills appropriately by adapting their fine motor skills and thus contributing and devoting more attention to the perceptual skills needed in the academic period (Cameron et al., 2016).

Being ready to enter primary education has traditionally been defined by accumulating cognitive and behavioral characteristics that predict later academic achievement and so the delay presented in complex motor skills may represent a negative impact on later academic performance especially in reading, writing, and mathematics (Pagani & Messier, 2012). Skills needed in primary school education, such as perform mathematics and reading, require adaptation in complex perceptual and visual domains. Perceptual skills must be considered one of the most significant factors related to academic performance. As observed in this study, it is possible to notice even in early ages in childhood education indications of significant delays in the domains of spatial and temporal organization, considered predictors of academic performance in later ages.

Related to fine motor skills, studies have pointed to the close relationship between executive functions and organization in space. Verdine, Irwin, Golinkoff

and Hirsh-Pasek (2014) noted that the spatial skills associated with executive function accounted for about 70% of the variation in the initial and final mathematical performance of children. These data are consistent with the hypothesis that spatial skills can improve children's development of numerical knowledge, helping them acquire a linear spatial representation of numbers (Gunderson, Ramirez, Beilock, & Levine, 2012).

Beyond perception, studies commonly indicate the relationship between lower motor skills in the areas of coordination with learning disorders (Gomez et al., 2015; Jongmans, Smits-Engelsman, & Schoemaker, 2003) and other specific disorders, such as dyslexia (Biotteau, Chaix, & Albaret, 2015; Biotteau et al., 2017). Motor coordination was related to delays in reading and math skills, as reported by Westendorp et al. (2011) where children with learning difficulties obtained lower results in locomotion tests and global control of objects in relation to the typical development children in control group, showing a specific relationship between reading and locomotive skills and a trend for a relationship between mathematics and global object control skills. In Brazilian context, Padilha, Seidel and Copetti (2014) have found that 15.91% of the preschool sample was below average in the area of global motor skills.

Despite this relationship with learning disorders, the global coordination appears to be more related to children's social competencies and physical well-being, functioning as a gateway to development in physical and social activities, including sports and games during the school years (Caçola, 2014; Pagani & Messier, 2012). Children with significant motor coordination delays, designated as children with Developmental Coordination Disorders (DCD), are more likely not to participate in physical activities when compared to their peers, explaining the link between motor and social skills (Wilson, Piek, & Kane, 2013). Children with motor difficulties may be socially rejected or might present lack confidence to participate in sports, as well as have difficulties to do typical childhood activities (such as riding a bicycle, for example) and thus become more sedentary and socially isolated (Caçola, 2014).

Finally, it is emphasized that the main objective of early motor assessment and intervention is to increase levels in all domains of motor development in order to prevent or minimize delays and secondary consequences, such as emotional and academic problems. To highlight the importance of professionals involved with the care of children in early childhood education, Mazeau (2010) states that in conditions of early identification of motor disorders (between 4 to 8 years of age) and well executed intervention by the school itself, the prognosis of children is excellent in terms of schooling, future career choice and social insertion, however, in cases that this does not occur, or if Dyspraxia is not isolated (e.g., associated with dyslexia, hyperactivity, attention deficit and/or psychotic disorders), the child should be routed and accompanied by health professionals and frequent specialized educational attention rooms.

As limitations, the evaluations were carried out in a single opportunity, making it impossible to evaluate skills development over time. This research did not investigate antecedents of neurological risk (pre, peri and postnatal) and also those children with difficulties or delay in development. Finally, the research

suggests expanding the sample for six-year-old so that is more consistent with the age of entry into primary education.

## CONCLUSION

In order to identify Dyspraxias in children in Early Childhood Education associating to specific areas of motor development, this research concludes that the domains of spatial and temporal organization are the most affected, that is, those with the greatest motor deficit. It was also observed that tasks that require more of the cognitive components, such as fine motor skills and spatial and temporal orientation, have presented lower average and minimum scores than those found for the tasks of global motor skills and balance.

In addition, the study highlighted that perception was the area in which children had the most delays (negative motor age) and lower motor quotients. Also, it is related to the greater probability of the child having Dyspraxia. Because they are preschoolers, it is important to reinforce that the acquisition of motor skills is linked to the development of the perception of the body, space and time, and these skills constitute basic domain components for both for motor learning and for school training activities. This corroborates to the relationship between motor and cognitive development of children who, by conquering good motor control, will also be building the basic notions for their intellectual development.

These results are of great relevance to establish a motor development profile for children in early childhood education and, in this way, assist teachers and professionals in the educational area to a better understanding of motor areas and domains with delay indicators so that they can identify key points of development and intervention for future learning problems. The study is also a warning for the existent relationships between the risk factors observed in early childhood education and learning in later age, especially in entry to primary education due to increased demands for mathematical, reading and writing skills.

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