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VISUOMOTOR MEMORY, COGNITIVE PERFORMANCE AND SCHOOL SUCCESS IN 9-YEAR-OLDS

Danielle Aparício dos Santos

Carmen Silva da Silva Martini

Abstract: The aim of this study was to evaluate the visuomotor memory of 9-year-old children who practiced physical education at school. The method was a cross-sectional study with a quantitative, descriptive approach. 21 children of both sexes living in the city of Manaus were assessed. The instrument used was the visuomotor memory test by THINUS-BLANC *et al*. (1996). The results were as follows: Among the 21 children, eleven (11) finished the course with a minimum of 0 errors and a maximum of 23 errors, with a minimum time of 23" and a maximum time of 1'51". However, two (2) children did not finish the course and eight (8) had the test annulled. Conclusion**:** practicing physical activity at school benefits visuomotor memory, improving information through sensory receptors, demonstrating the adaptation of the neuronal network responsible for coding the cognitive-spatial map of children.
Keywords: Visuomotor memory, cognitive performance, school success.

INTRODUCTION

The aim of motor learning is to study the methodologies and mechanisms involved in obtaining skills and the factors that can influence this, from not being able to perform a skill to becoming able to do so efficiently. Learning is a change in the ability to perform a certain skill as a result of a permanent improvement in performance (MAGILL, 2007).

Fitss and Posner (1967 apud MAGILL, 2007) state that motor learning are associative processes that occur at different stage levels (cognitive, associative and autonomous), where the individual acquires experience and directs it towards changes in the capabilities of skillful execution. These changes occur internally and generate an individual's ability to perform certain motor tasks, which can be assessed by observing performance or behavior (MAGILL, 1989 apud FERREIRA, 2009).

To this end, it is possible to state that there is a relationship between motor learning and the control of motor behavior, as they are linked to the individual's experiences, which, by being influenced by current factors, improve motor responses by adapting them to movement (SCHMIDT, 1975 apud TANI, 2004)

Consequently, in motor learning (ML), there is no study highlighting the underlying psychophysiological processes of how individuals apprehend visuomotor information in order to respond effectively to particular spatial and temporal orientation criteria, rarely employing neurophysiological processes (MARTINI, 2009)

A conditioning factor for information processing is memory, which together with attention promotes the storage and retrieval of information. Recovery can then be recalled by long-term memory in order to acquire a sequence of movements (GRIEVE, 2005)

Thus, learning is associated with stimuli sent to the brain to activate assimilation and reasoning. Cognitive stimulation consists of establishing links between certain stimuli and responses, so that the individual can better adapt to the environment (FERREIRA, 2011 apud ZANATA, 2014). Thus, there is a need for cognitive stimulation in children and adolescents (new and different stimuli) to develop their potential (FREIRE, 1997 apud SILVA; CUBAS, 2009).

Cognitive stimulation is favorable for the acquisition of new skills and efficient in learning and relearning, and contributes to improving performance. Cognitive practice is related to the task and helps to consolidate strategies to execute the performance, creating mental images of the possible action (MAGILL, 2007).

To do this, attention must be selective so that the individual can focus on the most important mental resources of information, filtering out unnecessary sensory stimuli (STERNBERG, 2000 apud CARDEAL *et al*., 2013).

According to Gentile (1972 apud FERREIRA, 2009), a theoretical model applied to the teaching of motor skills is the relevant stimuli based on the information most directed towards a particular motor skill, and the non-relevant stimuli related to the external environment, unrelated to movement.

These stimuli will influence school performance, which can be motivated by different factors. These include the teacher's motivation, which will favor the student's learning, as well as the student's motivation, which will influence their school performance (GIL 2011 apud CAVALCANTE; SANTOS JUNIOR, 2013). However, a study focusing on socio-cognitive orientation showed the existence of two motivational orientations: *intrinsic*, considering the child's interest in learning and knowledge, curiosity and challenges, and *extrinsic*, when the child seeks the teacher's approval and/or promotions through the orientation proposed by the activity (HARTER, 1981 apud MARTINELLI; GENARI, 2009).

Consequently, school performance still requires some factors, which are external to the school, such as the family environment, generating favorable conditions through dialogue (BONAMINO *et al*. 2010 apud CAVALCANTE; SANTOS JUNIOR, 2013), and the community environment, which refers to the educational level of the population and income distribution in the municipality (BARROS; MENDONÇA, 2000 apud CAVALCANTE; SANTOS JUNIOR, 2013).

With this in mind, the aim of the study was to assess the visuomotor memory of 9-year-old children practicing physical education at school.

MATERIAL AND METHOD

This is a cross-sectional, descriptive quantitative study, carried out in 2016 in the room of the integrated health activities center (CAES) of the Aristóteles School Comtes de Alencar, in the morning shift, carried out by the Laboratory of Neuroscience and Behavior Studies of the Faculty of Physical Education and Physiotherapy of the Federal University of Amazonas (UFAM), approved by the Research Ethics Committee with CAEE 31075814.0.0000.5020.

The population consisted of 105 children taking part in school physical education classes, of which 21 children came for assessment, aged 9 years old, living in the city of Manaus/AM, organized into just one group. The inclusion criterion was that the schoolchildren participated in at least 10 months of school physical activity or more and were physically and mentally healthy, as stated by their parents, for the visuomotor memory test to be carried out.

To assess the children, we used the visuomotor memory test by Thinus-Blanc *et al.* (1996), which has been adapted for the normal population and those with special educational needs, respectively by Sobrinho (2004), Azevedo (2005), Martini *et al.* (2006) and Fechine (2007), which establishes a course to be carried out within a 4x4 meter square, delimited by tubular pipe supports and transparent plastic, marked by three points (A,B,C), in a maximum time of five minutes.

Point A is in the middle of one side of the square and is the starting point, point B (placed diagonally across the square) is 40 centimeters from the left corner and point C (also diagonally across the square) is 50 centimeters from the right corner for the following route: AB; BA; AC; CA. Assessing the capacity for orientation and precision of the spatial representation of visuomotor memory (space), defining an internal (allocentric) and external (egocentric) visuo-spatial reference path (the teacher put one? I don't know what he meant).

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Beforehand, two attempts are made to familiarize/acquire the visuo-spatial information (spatial coding) and to retain it in memory. Both will be carried out with eyes open (definition of the "egocentric" perceptual-visual frame of reference, i.e. me and my body), to facilitate mental representation/storage in memory (definition of an "allocentric" cognitive chart, i.e. representations regardless of my placement in space) and definition of strategies.

The test is then performed blindfolded. The execution time is 5 minutes, which must be timed and the errors counted for the evaluation, so whenever the performer deviates from objects, touches the edges of the boundary in space. For people with NNE (what does that mean?), children between 7 and 12 years old and the elderly (over 65 years old) the test time is set at five minutes as the maximum execution time, beyond which the test is considered invalid

The aim of the test is to assess the ability to orient and accurately recall spatial representations (spatial coding) by defining a visuomotor frame of reference, either external (egocentric) or internal (allocentric).

RESULT

Among the students (N=21) who took part in the visuomotor test, the following results were obtained: eight (N= 8) schoolchildren's tests were annulled, due to the use of the edges of the structure as continuous guidance, as the student can only touch the edges beforehand and withdraw their hand, not use them as a reference; eleven (N= 11) managed to finish the test with the lowest number of errors made (minimum= 2; maximum=23), with the execution time (minimum=23", twenty-three seconds; maximum=1'51", one minute and fifty-one seconds) and two (N=2) were unable to finish the test, performing the test in the maximum time (maximum = 5', five minutes), with a certain number of errors (minimum = 58; maximum = 59), as shown in Table 1 below. The teacher asked for the time to be written out in full.

School / School Assessment Items Observation			
	Time	Errors	
1	0'23"	02	He added
2	0'23"	06	He added
3	0'29"	02	He added
4	0'30"	00	He added
5	0'43"	19	He added
6	0'47"	12	He added
7	0'57"	07	He added
8	1'51"	23	He added
9	1'02"	12	He added
10	1'05"	14	He added
11	1'37"	23	He added
12	5'	58	Not completed
13	5'	59	Not completed

Table 1: Results of the MVm test for the children who completed the test.

According to Godinho *et al.* (2002 apud FERREIRA, 2009), memory is essential in the teaching-learning process, because the experiences lived by the person are remembered in order to be adjusted to the experiences of the present. Memory is a system that stores and retrieves information, going through three phases: feeding it with information, known as encoding; preserving information over time and preventing it from being forgotten, known as storage; and recalling information, known as retrieval. Although differentiated, these processes are related and any change in one alters the work of the others (PERÉZ, 1994; BOTELHO, 1998 apud FERREIRA, 2009).

According to Mota and Albuquerque (1998 apud FERREIRA, 2009), the process of retention and encoding is important for memory recovery, as we only remember what we know. Meanwhile, Oliveira (1993) says that forgetfulness is a failure or disturbance linked to the inability to retrieve information stored in memory.

Memory can be distinguished into stages: short-term memory (STM); long-term memory (LTM); and sensory memory (SM). This is recognized as the recording of information by the sense organs, and is the link between perception and memory (HABIB, 2005 apud MARTINI, 2009)

According to Wolfe (2004 apud FERREIRA, 2009) the function of sensory memory is to send information through the sensory receptors, which is stored for a few seconds until it is decided what will be done with it by the MCP.

According to Grieve (2005), PCM lasts for seconds, seconds or hours, and Squire and Kandel (2003 apud FECHINE, 2007), it is divided into immediate memory, limited to a maximum of 30 seconds, and working memory, which temporarily stores information and is responsible for manipulating and maintaining the data in memory, and is associated with a variety of cognitive tasks (BADDELEY, 1992 apud FECHINE, 2007).

While MLP lasts for minutes or years, it contains a permanent bank of information on the individual. It contains a variable amount of information, and it is assumed that there are specific systems for each type of information, with infinite and unlimited storage capacity and durability. And all the memories in the memory are adjusted with the new information from the MCP and then sent back to the MLP for use (GRIEVE, 2005).

Consequently, physical exercise provides effective biological and functional improvements, with a major contribution to the cerebral and vascular systems, since regular physical activity improves memory and acts as a protective effect on ageing (ENGESSER- CESAR; GOTMAN, 2002; MCAUKEY; RUDOLPH, 1995 apud FERREIRA, 2009)

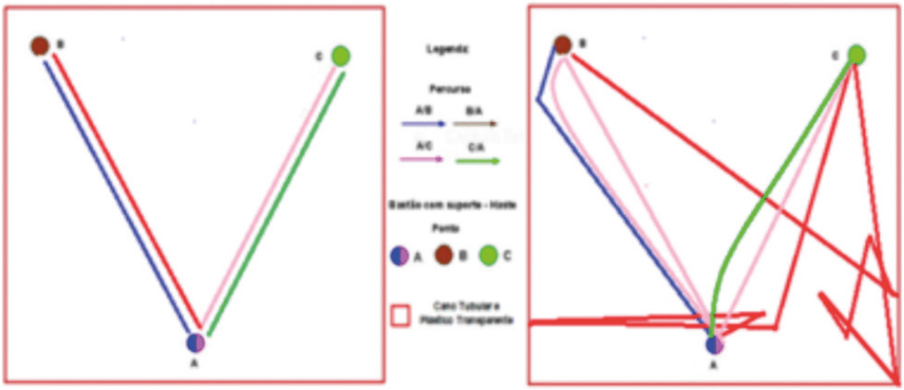
Motor behavior is linked to learning and experiences in order to structure a cognitive map, because by capturing stimuli/information, a given motor task will be carried out. Thus, childhood is the ideal time to store information, so the more varied the stimuli with practice, the greater the ability to retrieve information to perform the motor task (COSTA, 2001 apud FERREIRA, 2009).

Frosting and Horme (1964 apud FERREIRA, 2009) identified a number of different spatial abilities, including visuomotor coordination, defined as the ability to coordinate vision with body movement (DEL GRANDE 1987 apud Ferreira, 2009). While visual memory is defined as the ability to accurately recall an object that is no longer visible, and report its similarities and differences with other objects, whether or not they are in sight (HOFFER, 1977 apud FERREIRA, 2009).

Visual perception is the mental ability to understand, manipulate, recognize or make visual relationships, some authors use other terms such as "spatial perception", defining it as the ability to recognize and differentiate stimuli in a space using previously lived experiences, this perception is not simple and involves complex processes (DEL GRANDE, 1987; TARTRE, 1990; HERSHKOWITZ, 1990 apud FERREIRA, 2007).

Spatial orientation is the ability to make combinations of objects according to a certain pattern, and to maintain accurate perceptions in the midst of a change in direction (BISHOP, 1983). According to Tartre (1990 apud FERREIRA, 2009), the difference between visualization and spatial orientation is that in visualization there is a mental alteration of the object, while in spatial orientation the person's perception is altered.

For Rosa Neto (2002 apud COSTA; SILVA, 2009) visuomotor coordination is a process of action between the motor act and visual stimulation, necessary for an activity that requires muscle and joint control. But for Thinus Blanc (1996), the acquisition of visuomotor information is the retention of the memory of a cognitive map, through perceptual-visual

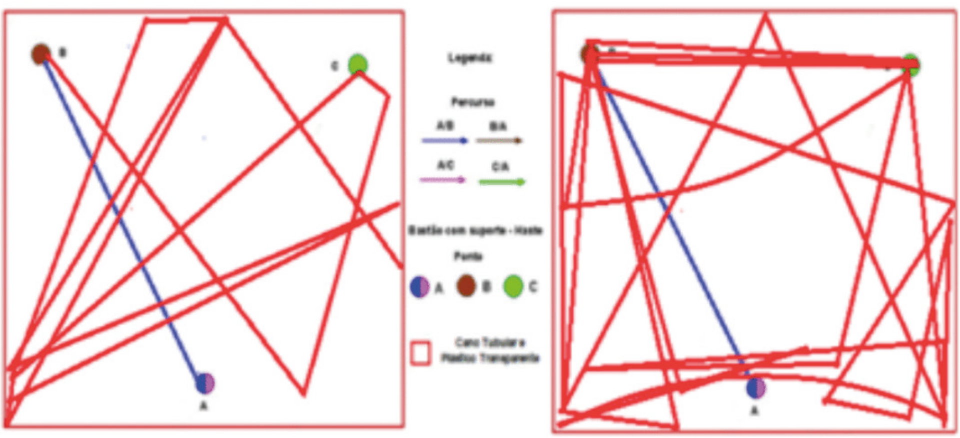


Path of Child (1) aged 9
Time 23" and 2 errors

Path of Child (8) aged 9
Time 1'51" and 23 errors

Figure 1: Path of the MVm test for children who completed the test.

Source: Martini (2009)



Path of Child (12) aged 9
Time 5' and 58 errors

Path of Child (13) aged 9
Time 5' and 59 errors

Figure 2: Path of the MVm test for children who did not complete the test.

Source: Martini (2009)

references (“Egocentric”, me and my body in space, to “Allocentric”, cognitive map of space), regardless of the body’s position in the environment.

With regard to the objective of the study, it was possible to ascertain that the results obtained with the evaluation group of children who were able to complete the test, prove what scholars have said, because at times the children showed a possible disorientation in the evocation of long-term memory, however, with the learning and motor experiences acquired, they were able to rescue the cognitive map and finish the proposed task, some with less time and errors and others with more. In terms of academic performance, these students are applied to the theoretical component of the lessons, handing in all the theoretical exercises on time. On the practical side, they always participate in physical education classes, are attentive, try to solve the tasks in the best way and their final school averages are above 7 points. The time and error, minor and median, was illustrated by drawing

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the children's mind map. The tests were watched and reviewed, and then drawn in Paint to show the course of the MVm test.

Thinus-Blanc *et al.* (1996 apud MARTINI, 2009) state the importance of practicing visuomotor memory, as visual experiences will influence the spatial relationships of the body, space and time, and strategies for recognizing non-visual space, as the visual absence of the external world means that movement will be subject to errors.

In this way, by seeking new experiences, body and spatial awareness, it is possible to acquire new mental representations, which unite the old ones in the formation of an integral body image, presenting new benefits, as well as a better adaptation of the body in space.

As for the children who didn't complete the test in the allotted time, where the number of errors was highest (58 and 59), the route from A to C wasn't carried out because the children seemed anxious and lost focus of their attention, which led to confusion when carrying out the route and spatial disorientation.

However, this action can be explained by the existence of a gap between the representation of the environment and the environment itself, which, with the removal of light, can present problems in the interaction with the work environment. These difficulties can be confused with spatial maps due to cognitive deficits in visuomotor memory. As a result, these children may have problems in their day-to-day lives, in everyday tasks, in moving from one place to another, in subjects that require visuomotor memory and more logical reasoning.

In terms of school performance, these students show the same standard of performance as the rest of their classmates. They hand in all their homework on time, but sometimes they have learning difficulties. In the practical part of the physical education class, the students are inattentive and insecure, and their performance is always below that of other students, even though their final averages are between seven points. The course of the test for these children is a good representation of the cognitive map and the performance of the task that was not evaluated. The cognitive performance and academic success of these children was evaluated in partnership with the school's physical education teacher.

Consequently, memory allows us to learn skills and modify behavior, when we relate it the orientation of space, time, intellectual and mechanical activities, by evoking from memory the spatial cognitive map for performing the motor task (CARDOSO, 1997 apud MARTINI, 2009)

With regard to the objective of assessing the visuomotor memory of 9-year-old children who take part in school physical education classes and the results established by the study sample, where the children were in the same physical and mental condition. The good or bad results of the task may have been due to some children's difficulty in retrieving the cognitive map from long-term memory in order to locate themselves in space and time during the course, which may be due to a lack of experience in integrating and orienting themselves in space and time.

Therefore, it can be concluded that the child's personal experience in practicing physical education classes benefits visuomotor memory, improving information through the sensory receptors, demonstrating the adaptation of the neuronal network responsible for coding the children's cognitive-spatial map.

Thus, visuomotor memory practices influence the relationship between space and time in visual and non-visual recognition strategies in a given task.

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