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STUDY ON GENDER AND AGE DIFFERENCE AND THE DEVELOPMENT OF SPACE-TEMPORAL SKILLS IN STUDENTS AGED 8-11 YEARS

BĂLĂNEAN Denisa-Mădălina[1,*], NEGREA Cristian[2], PETRACOVSCHI Simona[3,*]

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ABSTRACT. Introduction: Understanding the mechanisms leading to the development of spatial and temporal skills is a topic of current interest, especially since they can predict academic performance. **Objectives**: The objective of this study was to improve space orientation skills with the help of specific exercises. **Material and methods**: 148 children aged between 8.1 and 11.9 years participated in this study (M= 9.70; SD= 0.79). They were subjected to 2 tests that measure spatial orientation skills (the Piaget Head Test and the Bender Santucci Test). The samples were applied both in the pre-test and post-test period. The participants in the experimental group, underwent a specific program for a period of 12 weeks. The participants in the control group did not benefit from any manipulation of this variable. **Results**: The results showed that there is a statistically significant difference between the control group and the experimental group as recorded by the Piaget Head post-test results (M-W=2166.0, p=0.02). Moreover, differences were also recorded in the age categories, for both samples. Children aged between 10.6-11.9 years registered significantly higher scores, compared to the others (p.008/p.013). There were also differences between the gender categories, but they were not significant. **Conclusions**: In conclusion, the intervention program had the expected effect**.**

Keywords*: space-temporal orientation, intervention, gender, age*

[1] *PhD Student, Faculty of Physical Education and Sports, West University of Timișoara, Timișoara, Romania*
[2] *Faculty of Physical Education and Sports, West University of Timișoara, Timișoara, Romania*
[3] *Faculty of Physical Education and Sports, West University of Timișoara, Timișoara, Romania*
[*] *Corresponding authors: denisa.balanean@e-uvt.ro; simona.petracovschi@e-uvt.ro*

Introduction

Psychomotricity promotes the integral development of the person (Briceño-Pérez, 2021). It is made up of 3 dimensions that influence each other: motor, psychic and emotional (Bustillos-Martínez, 2022). In a child's life, psychomotor components play a very important role, contributing not only to physical development, but also to cognitive, social, and affective development (Arufe-Giráldez et al., 2021). Psychomotor activities relate one's body to others, objects, space, and time (Acosta Bravo, 2021). In addition to the components that influence the stage of psychomotor development, the learning of the concept of space and time plays an essential role in cognitive development (Díaz-Segura, 2022; Herrera, 2021), and has been an important area of research in educational psychology for nearly 100 years (Rittle-Johnson et al., 2019). Spatial skills are the ability to mentally manipulate shapes, objects, and dimensions, visualize the location of objects and their paths, and remember them. (Herbst et al., 2022; Nazareth et al., 2019). Although it is an essential cognitive skill, some authors believe it is limited and can only be partially improved through education (Yang et al., 2020; Rimfeld et al., 2017). According to Boggio and Omori (2017), they mentioned that in the everyday and educational environment, children face possible situations related to orientation and localization. The study of time and space concepts at children is currently a trending topic for researchers (Oqueso-Huanaco, 2019). This is a point of interest that has been growing in the scientific environment over time, numerous studies identifying its importance due to the link with mathematics (Atit et. al, 2021; Casey & Ganley, 2021; Reyes-Flores, 2022). To the same extent, it has been demonstrated that the child's ability to orient him/herself in a surrounding environment influences writing and reading, because the same spatial thinking processes intervenes in the two activities (Garcia, 2022; Salazar-Armijosm, 2022; Wang, Hu & Zhang, 2021). A positive aspect is that spatial skills are malleable and can be developed in people of all ages through a variety of approaches (Hawes, Gilligan & Mix, 2022).

Objectives and hypotheses

This study is part of a larger research, which directs its direction to the link between academic performance and orientation ability. The main objective is the development of space-temporal orientation ability in primary school students, through specific exercises in the physical education and sports lesson.

1. It is assumed that the total scores on the Piaget Head spatial orientation test, but also on the Bender Santucci test, in the post-test period, are significantly different for the two groups, as a result of the intervention applied to the experimental group.

2. There are statistically significant differences in spatial orientation tests according to age groups (8.1-10.5 years and 10.6-11.9 years). Children aged 10.6-11.9 will score higher on spatial orientation.
3. There is a statistically significant difference between boys and girls, in terms of scores on the Piaget Head spatial orientation test, but also on the Bender Santucci test.

Materials and Methods

Study participants

148 students participated in this study, aged between 8.1 and 11.9 years (M=9.70; SD=0.79), of which 70 were male and 78 were female. Inclusion of participants in the study was done by using convenience sampling. The number of children in each group was equal (N=74).

Research Tools

The students were given two tests that determine the ability of spatial orientation, before and after the actual intervention, both pre-test and post-test.

The Piaget Head Test for determining spatial orientation highlights the perception of space, each age being assigned a series of items that the child is asked to perform (3, 5 or 6).

The Bender-Santucci perceptual-motor test of spatial configuration targets the perceptual-motor function of spatial configuration, thus allowing an evaluation of the level of perceptual-motor organization and structuring of space. The testing was done individually. The necessary materials were represented by five models that the child must copy as faithfully as possible on a sheet of paper.

Research procedure

In order to start the study, an agreement was signed between Secondary School no. 24 from Timişoara, Faculty of Physical Education and Sports from Timişoara and Timiş School Inspectorate. The inclusion of children in the research was carried out after obtaining the consent of the parents or legal guardians. Both tests were applied under the guidance of a specialized psychologist.

Statistical analysis

The results of this research were obtained and processed using the IBM SPSS Statistics 20 program. The Mann-Whitney U test and the t-student test for independent samples were used to identify differences between groups, but also for age categories.

The Intervention

The space-temporal orientation intervention applied to the children in the experimental group was done at the physical education and sports lessons, over a period of 12 weeks. The first category, the space motor perceptual structure, included certain types of tools, done through different exercises and movement games, which included bodily references, notions of size, recognition and operation with spatial notions, but also the estimation of some distances. The second category, the education of perceptual-motor structures of time, included exercises for the education of order, sequence, duration and intervals.

Results

Hypothesis 1

To verify the first proposed hypothesis, the Mann-Whitney U test was used at a level of statistical significance $p < 0.05$.

Thus, there was a statistically significant difference between the control group and the experimental group regarding the Piaget Head Test after the intervention (M-W=2166.0, p=0.02). The experimental group registered higher scores on the Piaget Head Test (82, 23 vs. 66.77). The results can be seen in table 1:

Table 1. Mann-Whitney U Test Results (P. H.)

Independent-Samples	**Mann-Whitney U Test Summary**
Total N	148
Mann-Whitney U	2166.000
Wilcoxon W	4941.000
Test Statistic	2166.000
Standard Error	260.124
Standardized Test Statistic	-2.199
Asymptotic Sig. (2-sided test)	.028

The difference between the control group and the experimental group at the level of the Bender-Santucci Test after the intervention was not recorded (M-W=2347.50, p=0.13), as can be verified in table 2.

Table 2. Mann-Whitney U Test Results (B. S.)

Independent-Samples	**Mann-Whitney U Test Summary**
Total N	148
Mann-Whitney U	2347.500
Wilcoxon W	5122.500
Test Statistic	2347.500
Standard Error	260.382
Standardized Test Statistic	-1.500
Asymptotic Sig. (2-sided test)	.134

Hypothesis 2

There were statistically significant differences in the Piaget-Head post-test according to the age groups (8.1-10.5 years and 10.6-11.9 years), meaning that those aged between 10.6-11 ,9 years old (m=21.57; ds=5.80) registered higher scores for spatial orientation in the post-test than the 8.1-10.5-year-old age group (m=18.89; ds=5.29), according to t=2.710; df=88.32; p.008; d-Cohen=.48. These values that can be seen in the following table:

Table 3. The t-test for the Piaget Head exercise

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Piaget Head-after	Equal variances assumed	1.531	.218	-2.796	146	.006	-2.67244	.95572	-4.56126	-.78361
	Equal variances not assumed			-2.710	88.324	.008	-2.67244	.98607	-4.63194	-.71294

Group Statistics

	Age	N	Mean	Std. Deviation	Std. Error Mean
Piaget Head-after	8.1-10.5 y	99	18.8990	5.29824	.53249
	10.6- 11.9 y	49	21.5714	5.80948	.82993

There were statistically significant differences in the Bender-Santucci test according to age groups (8.1-10.5 years and 10.6-11.9 years). Children aged between 10.6-11.9 years (m=16.32; ds=6.52) registered higher scores for spatial orientation in the post-test than the age group 8.1-10.5 years (m=13.54; ds=6.40), according to t=2.536; df=94.28; p.013; d-Cohen=.43. These values can be seen in the following table:

Table 4. The t-test for the Bender Santucci exercise

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Bender Santucci-after	Equal variances assumed	.079	.779	-2.551	146	.012	-2.87199	1.12563	-5.09661	-.64736
	Equal variances not assumed			-2.536	94,288	.013	-2.87199	1.13238	-5.12026	-.62371

Group Statistics

	Age	N	Mean	Std. Deviation	Std. Error Mean
Bender Santucci-after	8.1-10.5	99	13.4545	6.40675	.64390
	10.6-11.9	49	16.3265	6.52044	.93149

Hypothesis 3

The gender differences according to the results of the scores obtained in the spatial orientation tests, were not statistically significant at the level of the Piaget-Head Test (M-W=2457.0; p=0.29). The Bender-Santucci Test also did not register statistically significant difference between the two groups (M-W=2685.50, p=0.86). These results can be confirmed in tables 5 and 6:

Table 5. Gender Difference in the Bender Santucci Exercise

Test Statistics[a]	
	Bender Santucci
Mann-Whitney U	2685.500
Wilcoxon W	5766.500
Z	-.171
Asymp. Sig. (2-tailed)	.864
a. Grouping Variable: Gen	

Table 6. Gender Difference in the Piaget-Head Exercise

Test Statistics[a]	
	Piaget Head
Mann-Whitney U	2457.000
Wilcoxon W	4942.000
Z	-1.051
Asymp. Sig. (2-tailed)	.293
a. Grouping Variable: Gen	

Discussion

In this study, students in the experimental group scored significantly higher in one of the two space orientation tests, compared to the control group. Contrary to this, a research claims that, compared to teenagers, children between the ages of 10-12 are not as competent in orienting themselves in space, showing a delay in completing the task (Murias, 2019). This shows that although most children of this age develop many of the cognitive skills necessary for successful spatial orientation (Bullens et al., 2010; Negen & Nardini, 2015), increased neural activity in brain areas associated with visual-spatial processing is evident (Liu et. al, 2011). This finding supports the fact that children improve and refine their visual and spatial abilities as they grow older. In addition, another relatively recent study (Costa et al., 2015) confirms that body fat percentage and physical activity level seem to be related to children's cognitive function, an aspect that has also been reported by others (Li et al., 2008; Yu, 2010), as well as to academic performance (Shore et al., 2008),

implying that the outcome of the first two hypotheses of the study could be influenced by these aspects. However, the results of the present study are consistent with previous studies that investigated the effects of a psychomotor program on preschool children's gross motor skills, including spatial orientation (Alesi et al., 2014; Hestbaek et al., 2017).

The context of the results of hypothes 3 lead in contradictory directions compared to other studies that demonstrated that while boys and girls do not differ in terms of general intelligence levels, there were gender differences for more specific cognitive abilities such as the ability of space-temporal orientation (Reilly, Neumann and Andrews, 2017). The results wer particularly favorable for the male gender (Voyer, 2017). Thus, a study focused on mental rotation found a significant gender difference: a small advantage of the male gender in mental rotation performance (Contreras, Rubio & Pena, 2007). While a gender-favoring effect in adults' mental rotation performance is a topic more often found in studies, the respective gender effect in children's performance did not appear in any of the literature (Lauer, Yhang & Lourenco, 2019). Few studies focused on age categories under 10-12 years. However Fernández-Méndez et. al. (2018), was of interest after an experimental study that specified that an intervention that improves spatial ability, in children under the age of 10, could lead to the possibility of maintaining an equality between genders, as differences could only appear in adulthood. Consequently, a number of biological and environmental factors could be involved in explaining gender differences. Of course, more thorough research is needed, as these factors are unlikely to influence spatial orientation ability in children under the age of 10.

Conclusions

The intervention program through specific exercises had the expected effect, so that the differences between the experimental and control groups were highlighted in one of the space-temporal orientation tests. Regarding the second test, there were differences, but not significant. Furthermore, within this program, no gender differences were revealed in any of the tests. This was in contradiction with certain studies mentioned in "Discussions". Thus, after looking for some justifications, I assumed that a determining factor could have been represented by early age, a variable that was found in very few studies with samples under 10 years of age.

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