Revista Românească pentru Educație Multidimensională
ISSN: 2066-7329 | e-ISSN: 2067-9270
Covered in: Web of Science (WOS); EBSCO; ERIH+; Google Scholar; Index Copernicus; Ideas RePeC; Econpapers; Socionet; CEEOL; Ulrich ProQuest; Cabell, Journalseek; Scipio; Philpapers; SHERPA/RoMEO repositories; KVK; WorldCat; CrossRef; CrossCheck

2022, Volume 14, Issue 3, pages: 126-138 | https://doi.org/10.18662/rrem/14.3/601
Submitted: April 3rd, 2022 | *Accepted for publication:* July 8th, 2022

Correlation between Attentional Abilities and Spatial Orientation in Children Who Study Chess in School

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Abstract: The role of attention in chess is obvious because the game is an ongoing battle between two players whose main purpose is to checkmate the opponent's king. Every single move represents a decision that cannot be changed and therefore the ability to concentrate and maintain attention for a limited period of time is essential. Compared to other sports, the game of chess can be played on the Internet, so physical presence does not limit its development. By using the computer, chess is played in better conditions because there is no space limit for people involved in the tournament. The main focus of the game is to move slowly but steadily to another direction. Besides the fact that chess helps to develop intellectual abilities, it can also play a role in the psychomotor development. Twenty third-grade children were selected and equally divided into two parts, the experimental group and the control group. The Bender-Santucci test (spatial orientation), Kraepelin test and Toulouse-Pieron test (attentional abilities) were applied to observe the role played by chess in children's learning process. The independent samples t-test was used to highlight the statistical difference between the results. The Pearson correlation was also used for both groups to emphasise the level of correlation between the two tests. The experimental group recorded better results in both tests, and these results were statistically correlated.

Keywords: *chess, spatial orientation, attentional abilities, children.*

How to cite: Stegariu V.-I., & Abalasei, B. (2022). Correlation between Attentional Abilities and Spatial Orientation in Children Who Study Chess in School. *Revista Românească pentru Educație Multidimensională, 14*(3), 126-138. https://doi.org/10.18662/rrem/14.3/601

Introduction

Lately, the popularity of chess has increased substantially and, besides the historical and cultural interest in this game, its motor demands are minimal, which turns it into an easily adaptable activity, especially in the current pandemic context. High performance is the result of synthesis, comprehension and planning skills guided by a well-developed cognitive ability. Chess also has the advantage of a system used to quantify relative values (Elo, 1978), being updated after each game, so every decision made by a player has a crucial impact on how future competitions will take place. This system is used to establish the starting list based on which the pairings for each round will be made. Due to its continuously adjustable relative value, the player's abilities are not contaminated by other external subjective elements (Stafford, 2018). The game of chess can be divided into three distinct phases: tactical motifs, strategy or prophylactic thinking and knowledge of the specific elements of endgames. Tactical procedures are correlated with the ability to solve problems, as they involve achieving a well-defined goal in a complex position. In this situation, one can observe the process of finding a solution to the detriment of the process of retrieval from long-term memory (Unterrainer et al., 2006). Strategic thinking is divergent in nature and involves the process of generalising thinking; thus, starting from a given position, the player is forced to generate several possibilities, most of which are replies against the opponent's moves. The basic elements in the endgame require a lot of attention because they are a combination of the other two phases. Due to the limited number of pieces, most of the endgames are component parts of a well-defined algorithm, but in the case of complex ones, they have a general character and resemble the strategic sequences of the game.

Regarding the blitz game, the existing activity model supports the theory of chunking and all its implications. According to Chase and Simon (1973), grand masters use information from long-term memory by observing how pieces are arranged on the board, so the patterns act as triggers for the retrieval process. Thus, in the blitz game where there is little time for thinking and every move counts as a possible crucial decision, the retrieval mechanism is activated automatically, resulting in an immediate response. Concentration involves a deliberate effort to which the child gets used after repeated attempts; disturbing elements appear every time and are classified as a symptom of attention deficit. Focusing attention, which can be described as the ability to distribute mental energy on a task, should be a

benchmark for the effectiveness of teaching activities and not only (Velea & Cojocaru, 2019). Children have an exceptional ability, namely attention, which is not sufficiently well exploited and has an impact on most activities that they perform. Attention involves selective orientation but also the distribution towards and maintenance of mental energy on a phenomenon to understand its depth (Mitrache & Tudos, 2015). Chess can be correlated with mathematics because it helps to develop problem-solving skills and critical thinking. The only condition for this correlation to be made is given by the age at which chess instruction begins, and in this context, the introduction of chess in school can be a possible solution to the problem. The school management, through its decisional autonomy, can opt for hiring math teachers, who have the necessary knowledge to teach chess. Another possibility would be the introduction of chess elements in the math class so that the playful component streamlines the teaching process (Subia et al., 2019).

Most research shows that the nature of expertise is limited to how memory works and how efficient it is. Another point of view justifies the achievement of mastery in a field rich in notions by developing a search process and instant analysis of a given situation based on already accumulated information. The quality of the retrieval process from long-term memory is given by the high number of hours spent in front of the chessboard. Therefore, chess mastery is not correlated with only one level of the cognitive process, but with both its lower (perception, memory, attention) and higher (thinking, creativity, intellect) levels (Vasyukova, 2012).

The ability of elite players to remember important moments (both familiar and atypical ones) during the game is directly proportional to age. Experienced adults make fewer mistakes in the process of recalling key positions compared to inexperienced players (Gucciardi et al., 2015). Grand Masters process large amounts of information in the form of "chunks" and patterns (Gobet & Simon, 1996) "that are stored in long-term memory but can be rapidly indexed and activated by domain-specific cues held in working memory" (Jastrzembski et al., 2006, p. 401). The thermal environment is important for the behaviour, health and well-being of children. Choi et al. (2019) note that temperature influences players' attention, which is necessary for better learning or work. This aspect should be verified by new studies aimed at identifying the general factors that can influence attentional abilities.

The cognitive processes used by chess players include expertise (Müller et al., 2006), perception (Memmert & Furley, 2007), memory (Dijkstra et al., 2008), anticipation (Aglioti et al., 2008), mental imagery

(Moran, 2009), judgment and decision-making (Bar-Eli & Raab, 2006) and all of them are generated by a good distribution of attention. There are many stimuli that can capture the involuntary attention of children, but keeping it on the disruptive element must be combated from an early age. As in any other sport, the main factor that decisively influences sports performance is the time used for training (Helsen et al., 2000). Competitive chess is similar to any other sport in terms of mental and neural activity, and its effects on metabolism are the same as in the case of marathon runners (Golf, 2015). This is due to the constant long-term pressure exerted on the chess player during a match. As a similarity, the formative character of the game of chess should also be mentioned.

Chess has become a new solution to solve the old problem of education. Chess is considered an innovative method designed to force students to use higher-level cognitive abilities and skill-solving algorithms for their complete multilateral development. There are also a number of researchers who demonstrate the benefits of teaching chess in school. Its presence in primary education appears for the first time at the end of the 20th century in Canada and the United States. In this way, a game invented since antiquity and whose form was polished in the late 19th century begins to adapt to both current educational needs and the fulfilment of teaching objectives. The education of the new generations needs to be focused on adaptation and problem-solving abilities, because the epoch in which we live involves great uncertainty caused by constant change. The nature of the game of chess mimics daily activities, so that each game can be used to discover and form a solid set of principles. Writing about how life imitates chess, Kasparov (2008) emphasises that the tactical motifs and strategic principles of this game require precision and focus because critical moments occur rarely.

Numerous studies (Ferguson, 2000; Ferguson, n.d.; Liptrap, 1998; Margulies, 1991; Palm, 1990; Seymour & Norwood, 1993; Wojcio, 1990) have highlighted the impact of introducing chess in school on the overall development of students. These results came from the need to find new methods to streamline and adapt the educational process to the current needs of society. Adapting the new generation to the current needs of the societies in which they live turns the game of chess into an extremely valuable teaching tool.

Maass et al. (2008) examined the emergence of the stereotype in the game of chess. Using games played on the Internet, they noticed that women recorded negative results when they knew they were playing against men. This study included 84 participants who were equally divided into two

groups, and in the case of men, no difference was observed in their game, regardless of the opponent's gender. If these results were to be generalised on a larger scale, then those presented by Stafford (2016) would be combated. According to Ahmad and Sultana (2021), girls have better selective attention than boys; the reason for the higher selective attention ability among females is biological.

The *purpose* of this research is to observe whether there is any correlation between attentional abilities and spatial orientation in children who study chess in school. Due to the research design, we have also checked whether there is any statistically significant difference between the results of the two groups. By doing this, we were able to highlight the role of teaching chess in school.

Methodology

We tested 20 third-grade children who were equally divided into two groups of 10. Half of them studied chess in school as an optional subject that was directly integrated into the school curriculum, and the other half learned different subjects chosen by the school administration. The mean age of the experimental group was 9.2 years, and the mean age of the control group was 9.5 years. Both groups were evenly distributed by gender, namely 4 boys and 6 girls each. The first group was studying chess since the first year of school with a physical education teacher specialising in teaching only chess, and the control group was studying various subjects such as French and Health education.

Children were assessed to determine their attentional abilities, which are extremely important in the educational process, and spatial orientation, which also plays an important role in the assimilation of notions, especially in the first and second grades.

Attentional abilities were divided into two directions as follows: attention distribution (correlated with fast thinking) and maintaining attention (in the context of a simple routine task). The first test is called Kraepelin and involves identifying pairs of numbers that add up to 10. They should be next to each other horizontally, and the duration of this task is 5 minutes. Children do not know how long the test is supposed to last and the only information received is that they have to find as many pairs as possible before the phone alarm sounds. The second test is called Toulouse-Pieron and does not involve any thought process. On the worksheet, in its upper central area, there are 4 squares that have a small line oriented in different directions. The children's task is to find as many identical squares as possible within a limited time. Similar to the previous test, they do not know how

much time they have for this task and the only way to fight against the superficiality given by the routine is to set a precise goal and follow it until the alarm sounds. An example of a goal described by one of the children in the experimental group is to find all identical squares and not pay attention to the surroundings. The duration of the test is 10 minutes, so the routine plays a significant role and the only way to counteract it is to try to reach that goal.

Results

Following the application of the assessment protocol, the investigated children obtained the results shown in Table 1 and Table 2.

Table 1. *Descriptive statistics – Experimental group*

		N	Minimum	Maximum	Mean	Std. Deviation
Bender-Santucci	Exp	10	27	41	33.90	5.087
	Con		16	31	23.20	4.962
Kraepelin	Exp		13	33	23.00	6.815
	Con		11	31	16.20	7.052
Toulouse-Pieron	Exp		89	178	144.70	30.862
	Con		63	163	107.80	35.169

Source: Authors' own conception

We can see that the experimental group has recorded better results in all three tests. Thus, in the Bender-Santucci test, the difference of 10 units is significant because the values of the two groups fit into two different categories. In addition, the results of the experimental group fall into a category above their age, while those of the control group fall into a lower category. The minimum and maximum values frame in a diametrically opposed way ($27 < 33.90 < 41$; $16 < 23.20 < 31$) the average value of the group, which shows the homogeneity of children's distribution within the groups.

In the Kraepelin test, the situation differs in the sense that minimum and maximum values are approximately equal (11, 13; 31, 33), but the averages show a substantial difference. In this case, we can say that the extremes are similar, but the composition of the groups differs. If the experimental group has a normal distribution within the group because the average value is at an equal distance from both extremes, in the case of the control group, the average is extremely close to the lower limit.

In the Toulouse-Pieron test, the situation is also in favour of the experimental group, but this time the distribution of values does not respect the rule imposed by the previous two. The experimental group recorded an average value (144.70) close to the maximum (178), so we can say that the minimum value (89) is accidental. In order to reach a normal distribution within the group, the minimum value should have been much higher (110). In the case of the control group, the average value (107.80) is closer to the minimum recorded but not by much, with a deviation of 5.2 units. This means that the best result should have been 152.6 instead of 163.

In order to observe whether there is any statistically significant difference between the groups of children, we used an independent samples t-test. As can be seen in Table 2, a p-value lower than 0.05 (0.000, 0.042, 0.023) was recorded in each test.

Table 2. *Independent samples t-test*

Tests	N	Experimental group	Control group	t	p
Bender-Santucci	20	33.90	23.20	4.761	0.000
Kraepelin		23.00	16.20	2.193	0.042
Toulouse-Pieron		144.70	107.80	2.494	0.023

Source: Authors' own conception

Next, we used the Pearson correlation to highlight whether the results of the three tests correlated within the groups. Table 3 shows the results of the experimental group. It can be seen that no pair of results has a strong correlation. The Bender-Santucci test has a low-to-moderate (r = 0.396) correlation with the Kraepelin test and a moderate correlation (r = 0.478) with the Toulouse-Pieron test. The two attentional tests have a strong-to-moderate correlation (r = 0.604).

Table 3. *Pearson correlations – Experimental group*

		Bender-Santucci	Kraepelin	Toulouse-Pieron
Bender-Santucci	Pearson Correlation	1	.396	.478
	Sig. (2-tailed)		.258	.163
	N	10	10	10

Kraepelin	Pearson Correlation	.396	1	.604
	Sig. (2-tailed)	.258		.065
	N	10	10	10
Toulouse-Pieron	Pearson Correlation	.478	.604	1
	Sig. (2-tailed)	.163	.065	
	N	10	10	10

Source: Authors' own conception

In the case of the control group, the three tests do not show any strong correlation (Table 4). The attentional tests moderately correlate with each other (r = 0.471), and the Bender-Santucci test has a low-to-moderate correlation with both tests (r = 0.413; r = 0.327).

Table 4. *Pearson correlations – Control group*

		Bender-Santucci	Kraepelin	Toulouse-Pieron
Bender-Santucci	Pearson Correlation	1	.413	.327
	Sig. (2-tailed)		.235	.357
	N	10	10	10
Kraepelin	Pearson Correlation	.413	1	.471
	Sig. (2-tailed)	.235		.170
	N	10	10	10
Toulouse-Pieron	Pearson Correlation	.327	.471	1
	Sig. (2-tailed)	.357	.170	
	N	10	10	10

Source: Authors' own conception

Discussion

The Bender-Santucci test, which aims to emphasise the level of spatial orientation, showed a normal distribution of the two groups, where the average results were diametrically opposed to the two extreme (minimum and maximum) values. This test highlights the perceptual-motor function, for example, the ability to perceive spatial configurations with fine detail to compare them with each other. It also requires the process of rendering space and shape in order to recall the form that can serve as

content for various future mental operations. We believe that the Bender-Santucci test is viable for the study of visual-motor functional features, which in turn facilitate success in the writing process.

Due to the fact that the average difference between the two groups is obvious, we can say that the game of chess develops the spatial orientation of primary school children. This skill is extremely necessary especially in the first years of school, because it is then that the writing process is taught. Considering the above, we can state that the period when the study of chess begins must coincide with the first day of school. Also, taking into account the psychological characteristics of children, it is recommended to group them in small numbers (maximum 10).

As regards the Kraepelin test, the extremes recorded by the two groups show relatively similar values (11, 13; 31, 33), but the average difference is significant (23 > 16.20). We can say that children in the control group are mainly distributed in the area of the minimum value. Due to the short working time (5 minutes), any disconnection from the task severely affected the result obtained. This indicates that students in the experimental group are more disciplined and task-oriented.

The results of the Toulouse-Pieron test are the most atypical, because there is no order or similarity between the two groups. The average recorded by the children who play chess is closer to the maximum value (89 < 144.70 < 178), but in the case of the other group, the scenario is reversed (63 < 107.80 < 163). The Toulouse-Pieron test has a longer time (10 minutes) compared to the other test of attentional abilities, which is why its routine and simplicity produce more interruptions that lead to a lower score. Due to the significant difference between the two groups, we can say that the distribution and maintenance of attention can be developed by playing chess. During a game of chess, any wrong move (blunder) can lead to defeat, so students are trained to keep their attention on important tasks throughout the game.

The results presented above outline the effects of playing chess on primary school children. Taken separately, the results obtained are promising for the process of introducing chess in school as an optional subject. In each test, the experimental group recorded a significantly better result from a statistical point of view. Given the nature of the tests, we can state that the game of chess decisively influences certain essential cognitive skills that are extremely important in the teaching process.

Taken together, the three results indicate an improvement in cognitive skills as a result of playing chess, which is extremely important in the teaching process. The ease with which external factors manage to

capture the attention of students is a danger to the dynamics of the lesson, so the game of chess helps not only the child but also the teacher. Any interruption implies a disconnection from the given task, and if the moment of the lesson is important, then all the taught material needs to be resumed.

Selective attention involves filtering the processed information and focusing on the relevant one. This ability is improved in early childhood, a period when spatial skills also show improvements (Vasilyeva & Lourenco, 2010). Another key factor in the child's psychomotor development is vocabulary enrichment, because children need new information in order to develop a thought filter allowing its selection. Good academic results, especially in literature and mathematics (Sala & Gobet, 2016), have been strongly correlated with the introduction of chess as a subject included in the school curriculum. Thus, by extending causality, we can state that spatial orientation skills can be improved through chess, a statement that is confirmed by other studies (White et al., 2019). Another variable in the equation of the child's psychomotor development is the outlining of a body schema as faithful as possible to reality. Perceiving space and projecting one's own body into it provides clues that will trigger the maturation process. Allen et al. (2019) highlights that practising physical activities in an organised setting helps the child due to their formative character. From an organisational perspective, chess has all the characteristics of any other sport, so playing it facilitates a good psychomotor development.

Conclusion

Playing chess helps to develop cognitive skills, thus enhancing the child's intellectual development.

There is a moderate correlation between spatial orientation and attentional abilities when it comes to children who study chess weekly.

The limited number of students imposes a limit on the research, which needs to be solved in further research.

The intellectual side of the game has undergone serious changes lately, and the playful aspect combined with the strictness of the rules turns the game of chess into an activity more and more suitable for the current educational process.

Informed Consent Statement: Informed consent was obtained from the tutors of all subjects involved in the study.

Data Availability Statement: Data can be available for consultation when requested from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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