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Intellectual Abilities in Top Male Junior Tennis Players

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Abstract

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Topographical memory, analogical reasoning capacity and attention represent intellectual abilities. Analogical transfer refers to those mental structures which allow us to solve problems based on similarity to already solved problems. Attention does not have an inherent reflective content, being present in all mental functions (perception, representation, thinking etc.). Topographical memory represents a mental blueprint or a spatial map which enable us to appreciate from memory where an object/ a location exists relative to those around it. The scope of our research was to investigate some intellectual dimensions and the sports performance of elite Romanian male tennis players. 12 male athletes have participated in our study aged between 15 and 17 years, ranked in top 15 players in Romania. To solve the research issues, we used: test – the computerized ANALOGIE, TAC and MT tests, within PSISELTEVA tests, developed by RQ Plus, SPSS 20 (for data interpreting) and observation. Using the Spearman correlation, there were highlighted important relations between the analogical reasoning coefficient, performance coefficient (in the case of ANALOGIE test), learning capacity (concentration of attention test - TAC) and sports performance. The results state that improving learning ability (the ability to quickly adapt attention to new visual conditions) and the analogical transfer capacity can positively influence the evolution of tennis players on the court.

Keywords: Analogical transfer; concentration of attention; topographical memory; tennis.

1. Introduction

Analogical transfer, attention and topographical memory represent cognitive (intellectual) abilities. Researchers have identified multiple mechanisms of transfer, including analogy. *Analogical transfer* involves three components: finding a prior exemplar, creating a mapping between it and the existing situation or problem, and then using that mapping to find a relevant solution in the current context (Nokes, 2009). Chen (2002) asserts that the transferred knowledge are (in generally) declarative representation, but procedural knowledge can be also transferred (data which refer to execution rules, motor skills). An analogue source can be similar to another in a number of ways: they may have

similarities on the surface (matching context), in their structure (matching relations between objects), or both (matching objects and relations). *Attention* (as a mental function) accompanies mental activity, being the one that leads to modelling the nervous tone. Attention represents a gateway to other cognitive (intellectual) processing, being a condition, also, for the developing of motor actions. Before problems solved, visual-spatial relationships perceived, the stimuli must be attended to. Thus, attention optimizes the knowledge of the subjective life or of a sector of the reality (Horghidan, Mitrache, & Tüdös, 2001: 149). Through attention we achieve an important selection of the stimuli. Attention is the capacity to focus cognitive processing on the relevant target and avoid being distracted by insignificant stimuli (Segal, & Hersen, 2010: 81). Specialized literature (Spielberger, 2004: 210) state that the capacity to pay attention to the task in sport is a vital determinant of success. It is known that athletes differ in terms of attention concentration capacity. Furley et al. (2013) showed that athlete's capability to focus attention is based on the situational availability of self-control strength. Regarding the *topographical memory* it requires retaining a certain route for a period of time, supposing intellectual efficiency, orientation in space, risk taking etc. Topographical memory represents a mental blueprint or a spatial map which enable us to appreciate from memory where an object/ a location exists relative to those around it (Mendoza, & Foundas, 2008: 356). Topographical memory appears as spatial representations (Zlate, 1999: 219). This capacity to manipulate and retain data regarding the visual and spatial environment is an essential intellectual process in human working memory, playing an important role in order to adapt to the surroundings (Pearson, Ball, & Smith, 2014). Different researchers (Epuran, Holdevici, & Tonița, 2001: 83) assert the importance of spatial memory in sport based on the understanding of the complex situation related to the athlete's own action.

The purpose of the study consists in investigating the analogical transfer capacity, topographical memory expressed through accuracy and speed in answers, attention concentration (under slow and under fast speed conditions), and sports performance of elite Romanian junior tennis players.

2. Materials and methods

2.1. Participants

Twelve elite tennis players, aged between 15 and 17 years, with a competitive experience comprised between 6 and 9 years, participated in the study. We mention that 11 athletes are right-handed and only one athlete is left-handed. The male athletes are ranked in top 15 junior players in Romania.

2.2. Devices and materials

The devices and materials used in the study were: the computer (only fulfilled the role of support in computerized testing) – the participants did not provide any response to the tests using the keyboard or mouse (the athletes viewed the standardized training on the computer monitor); the computerized ANALOGIE, TAC and MT tests, within PSISELTEVA tests, developed by RQ Plus – these tests involve the use of levers, buttons console and pedals. Today, the use of computer technology ensures the accuracy of registrations. The movements associated with device manipulation (buttons, levers, pedals) are known as instrumental movements (Aniţei, 2007: 123).

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2.3. Procedure

The computerized ANALOGIE, TAC and MT tests were carried out by the athletes on the same day and in the same moment of the day (in the afternoon). Also, the four different tests that assess cognitive abilities were applied in the same order. In the case of junior tennis players, the preferred hand was used, being generally faster. The participants were tested without previously practicing any physical exercises (being in a rest state).

The ANALOGIE test involves that, within a limited time (there are few seconds for each item of the test), the participants push a lever button (the left, centre or right button) according to the response believed to be correct (viewed in the left, centre or right side of the screen). An example of item is the following: "Ignorance is for Learning what Poverty is for: School – Wealth – Hope". The coefficients provided by the battery software are: analogical reasoning coefficient (it refers to the number of correctly issued responses and failed responses); performance coefficient (a qualitative measure statistically calculated by relating the correctly issued responses to the test time). The TAC test consists in giving a pre-established response for each signal-stimulus identified among insignificant stimuli. When designing the test, the creation of the following problematic situations was taken into consideration: the fast appearance of visual stimuli in a limited visual field, the random appearance (time and space) of significant visual stimuli, the appearance of a disturbing factor (by alternating light), the combination of significant visual stimuli with irrelevant visual stimuli. The image that can be observed on the monitor contains a rectangle inside which there are seven letters (the error warning window is placed in the lower right extremity). Response device - the lever. Inside the rectangle, rows of seven black letters are running; the rows appear vertically from up to down, in a constant rhythm; randomly, one of the rows may contain the letter S or Z – a phenomenon representing the appearance of signal-stimuli; unpredictably, the brightness of the rectangle changes. The assessment takes place under slow speed conditions (speed 1) and under fast speed conditions (speed 2). The task of the subject is to give a response when the signal-stimulus S or Z appears, by pressing the left button of the lever. The test lasts about 10 minutes. Among all coefficients provided by the battery software, we shall present the following parameters: correctly issued responses for speed 1 (under slow speed conditions); correctly issued responses for speed 2 (under fast speed conditions); learning capacity (fast adaptation of attention to new visual conditions); resistance to disruptive factors (when facing a problem – unpredictable appearance of signal-stimuli, distraction, the subject gives correct responses). The MT test is designed as a labyrinth itinerary, which offers many possibilities to move across the space between two points placed in the extremities of the image. The test consists in giving, within a limited time, responses based on the memorized information. The image implies the existence of a labyrinth itinerary, a starting point and an arrival point. As response devices, one can notice a desk with three central buttons and a side button. The task of the athlete is to memorize the itinerary offered by the computer soft and to issue a response for retracing it forward - backwards, from memory. The responses are given by pushing the desk buttons according to the established program. The coefficients provided by the battery software are: Cmt (topographical memory coefficient) – it refers to the correctly issued responses and failed responses; performance coefficient (a qualitative measure

statistically calculated by relating Cmt to the test time); test time (seconds in which the participant has executed the test).

The results registered by the tennis players at the ANALOGIE, TAC and MT tests were correlated to those obtained by the athletes in competitions, expressed through their ranking position in Romania.

3. Results

Preliminary data analysis (stem and leaf and box-plot charts) has emphasized that, in the case of results registered for ANALOGIE, TAC and MT tests, there were no outliers found.

Through the Spearman correlation we checked if there were any relations between the analogical transfer capacity, concentration of attention, topographical memory and the sports performance..

Table 1. Scores for the computerized ANALOGIE, TAC and MT tests and the results obtained by the tennis players

Variables	Athletes	Mean	Standard Deviation	Standard Error	Sports performance Spearman's rho Correlation Coefficient
sports performance	12	6.50	3.606	1.041	1.000
analogical reasoning coefficient	12	579.17	146.874	42.399	-0.588*
performance coefficient	12	474.08	172.347	49.752	-0.634*
correct speed 1	12	57.17	8.222	2.374	0.219
correct speed 2	12	55.83	10.223	2.951	0.106
learning capacity (TAC)	12	748.25	163.160	47.100	-0.641*
resistance to disruptive factors	12	1574.25	655.420	189.204	0.176
topographical memory coefficient	12	891.00	84.168	24.297	0.370
performance coefficient (MT test)	12	2487.08	801.663	231.420	0.113
MT test time	12	38.62	9.653	2.786	-0.106

*. *Correlation is significant at the .05 level (2-tailed).*

The analysis of the results indicated in Table 1 emphasizes that there is a negatively significant correlation (-0.588, respectively -0,634) between the analogical reasoning coefficient (it refers to the correctly issued responses and failed responses), the performance coefficient (a qualitative measure statistically calculated by relating the correctly issued responses to the test time) and the performance obtained by the tennis players in competitions ($p< 0.05$);

As to the correlation, a proper indicator for the effect size index is the determination coefficient (r^2), whose value is 0.34 (analogical reasoning coefficient), respectively 0.40 (performance coefficient). We can say that 34%, respectively 40% of the variation of the two variables is common, while the remaining is due to other influences. This means that the relation between the analogical reasoning coefficient and the sports performance, respectively the relation between the performance coefficient and the sports performance, is moderate to strong.

There is a negatively significant correlation (-0.641) between learning capacity (fast adaptation of attention to new visual circumstances) and the performance obtained by the tennis players in competitions ($p< 0.05$).

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The determination coefficient (r^2) has the value 0.41, meaning that the relation between the results for attention concentration in new perceptual conditions and the performance of the tennis players is moderate to strong.

4. Discussions and conclusions

This study demonstrates the existence of different significant statistical correlations between the results obtained by the tennis players for some intellectual abilities and the sports performance. There is a negatively significant correlation between learning capacity (attention concentration test) and the performance obtained by the tennis players in competitions. If the junior tennis players having a competitive experience between 6 and 9 years register a fast adaptation of attention to new visual circumstances, this aspect is related to a better performance of the athletes on the tennis court. Through an adequate mental preparation completed by modelling the competition in training, the tennis players will improve their ability to give more correct responses when confronted with new perceptual conditions. Also, there is a negatively significant correlation between the analogical reasoning coefficient, the performance coefficient (analogical transfer test) and the performance obtained by the athletes. If the tennis players give more correct and faster responses during tasks demanding analogical transfer capacity, this aspect is associated with a better performance of the athletes. This can be explained through the interaction between the transfer mechanisms. Thus, besides the analogical transfer, research studies discuss about knowledge compilation (Anderson, 1982) and constraint violation (Ohlsson, Ernst, & Rees, 1992; Ohlsson, 1996). Knowledge compilation (as a transfer mechanism) will be triggered when the athlete has no accessible exemplar data or when the exemplar requires important adaptation in order to be applied. This mechanism translates prior declarative knowledge (advices, tactics or instructions) into a set of procedures that can be used to solve new situations or problems. For example, a tennis player, knowing about different tactics, can apply them to a wide variety of game situations. But the athletes must figure out if the implications of the tactics are suitable for a particular situation or problem encountered. When the declarative instructions or strategies are no longer applicable to the task, the constraint violation will be triggered - the athletes have no accessible exemplars and tactical knowledge does not apply.

Constraint violation involves that the athletes use prior knowledge of the domain constraints to evaluate and correct their task performance. In our case, the tennis players, knowing the constraints in tennis (avoid hitting the ball towards the opponent, hitting the ball with a particular effect influences its direction etc.), generate specific procedures - specific movements and executions in given situations. After a specific movement and execution, the tennis player will evaluate if a constraint has been violated (for example, the ball has been sent towards the opponent, outside the court or in the net). The problematic procedure would be revised and a new procedure would be generated and evaluated. After multiple episodes, eventually the athlete will acquire specific procedures for what move to make in a specific situation (when the ball comes too fast or very high over the net, having a specific effect etc.). We often use multiple transfer processes to solve a problem. What is different - the proportion of the transfer mechanisms which are triggered (Nokes, 2009). The development of analogical reasoning capacity (a key-component of intelligence – Sternberg, 1977) influences the capacity to transfer data in

various situations that require procedural memory (movements, executions). This may positively influence the evolution of the players on the tennis court (during the competition), considering the existence of different situations which require fast and accurate movements and executions. We also mention Vosniadou and Ortony (1989: 14), who specify that analogy make us more flexible when we solve problems. Also, reasoning by similarity facilitates the learning of new rules and schemata. This paper can be considered a starting point for further deeper research – for a better understanding of the impact of knowledge transfer to sports performance. Our research was limited by the physical and mental state of the subjects during testing (fatigue, affective-motivational factors), which may cause variations in the motor responses. Another limitation is constituted by the sample of athletes. The situation might be different with a sample made up, for example, only of female athletes. Conversation and observation support the value of our research. The research data will be used by the sport psychologist and coaches who will design stimulation programs for the characteristics: learning capacity (in the case of attention concentration), analogical reasoning coefficient and performance coefficient (the specialist will develop the ability of the athletes to give more correct and faster responses during tasks demanding analogical transfer). The ANALOGIE, TAC and MT tests may be used as complementary means of psychological preparation and can provide information with respect to the analogical transfer capacity, topographical memory and concentration of attention. Also, some of these cognitive abilities may represent an element of selection of the junior tennis players for the representative team.

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