#11 PAPER 15 -
ANALOGICAL TRANSFER CAPACITY AND THE DISCRIMINATION REACTION TIME IN ELITE FEMALE TENNIS PLAYERS

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Abstract
The aim of this research was to analyze the existing correlations between the analogical transfer capacity, the simple reaction time, the discrimination reaction time and the sports performance. The ANALOGE, TR and TRD tests, included into the PSISELTEVA battery, developed by RQ Plus, were used. A number of 8 elite junior female tennis players have participated at the study. Using the Spearman correlation there have been important relations highlighted between the operativity coefficient (the speed of athletes’ answers during tasks demanding analogical reasoning ability), the discrimination reaction time and the sports performance, expressed through the official ranking system.

Keywords: analogical transfer; operativity coefficient; simple reaction time; discrimination reaction time; tennis.

1. INTRODUCTION

The analogical transfer capacity it’s a key component of intelligence (Sternberg, 1977). It refers to those processes which help us to solve new problems based on similarity to already solved problems. Thus, in analogical problem solving, one problem and its solution are already known (Gick & Holyoak, 2004). Analog is one of the multiple mechanisms of transfer identified by the researchers. Analogical transfer involves three components: retrieving a prior exemplar, creating a mapping between it and the current problem or situation, and then using that mapping to draw an inference relevant to the application context (Nokes, 2009). Chen (2002) mentions that the transferred knowledge is typically assumed to be a declarative representation, but it can also include procedural attachments. A source analogue can be similar to another in a number of ways: they can have similarities on the surface (matching object features and context), structurally (matching relations between objects), or both (matching objects and relations). Structurally, the relations can be based on similarity between the relational concepts (semantics) or pure structure (graph) matches (Gentner & Kurtz, 2006). Vosniadou and Ortony (1989) consider that reasoning by similarity and analogy itself can make the knowledge base more flexible and facilitate the learning of new rules and schemata. We mention also, Gick and Holyoak (2004) who argue that the quality of the induced schema is a good predictor for the subsequent transfer performance. Besides the analogical transfer, the researches discuss about knowledge compilation (Andersen, 1982) and constraint violation (Ohlsson, Ernst, & Rees, 1992; Ohlsson, 1996). Knowledge compilation (as a transfer mechanism) will be triggered when one has no accessible exemplar knowledge or when the exemplar requires extensive adaptation in order to be applied. This mechanism interprets prior declarative knowledge (advice, instructions, or tactics) into a set of procedures that can be used to solve new problems. When the declarative instructions or strategies are no longer applicable to the task, the constraint violation will be triggered. In this situation, a person has no accessible exemplars and prior declarative knowledge does not apply. Constraint violation implies that the person use prior knowledge of the domain constraints to evaluate and correct its task performance. If we take an example from tennis, the player, knowing the constraints of the domain (do not hit the ball outside the court or in the net, avoid to hit the ball towards the opponent etc), will generate specific procedures - specific movements and executions in given situations. After these specific movements and executions, the tennis player will evaluate if a constraint was violated (for example, the ball was sent towards the opponent). In the case of a faulty procedure, this would be revised and a new procedure would be generated and evaluated. As a result of multiple attempts, eventually the individual would acquire specific procedures for what move to make in specific situations – when the ball has a specific effect, it comes to fast or to slow, very high over the net or it slightly touches the net etc. We often use a mixture of multiple transfer processes for a given situation. What changes, is

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the relative mix or proportion of transfer processes triggered, depending on the characteristics of one’s prior knowledge and the task environment (Nokes, 2009). Using the computer technology we can evaluate various cognitive and psychomotor dimensions, the precision and accuracy of the registrations being assured. The movements associated with device manipulation (levers, buttons, pedals) are known as instrumental movements (Aniței, 2007). Regarding the reaction time, psychologists have named three basic kinds (Welford, 1980; Luce, 1986): simple reaction time (there is only one stimulus and one response), recognition reaction time (there is only one correct response, the participant must ignore the other stimuli – also called the discrimination reaction time) and choice reaction time (the user must give a response that corresponds to the stimulus – for this complex reaction time, every stimulus has its one specific response). The reaction time is usually measured in milliseconds, just like in the case of the motor reaction. The simple reaction time measures the basic time (the speed of the nervous influx), while the discrimination reaction time measures the basic time combined with the time needed to discriminate if the stimulus is capable or not to generate a motor response. In other words, the discrimination reaction time is the time in which a person identifies and reacts to the significant stimulus. Specialized literature (Cashmore, 2008) mentions the importance of a rapid discrimination between the stimuli, in sport. Thus, the athletes (in most sports) need to be able to react to the important stimuli and to refrain from responding needlessly to dummy auditory or visual stimuli. As specialists of the sports domain (tennis) we were interested in finding the key factors which facilitate high sports performance. We mention that in a previously study on male junior tennis players, Grigore, Mitrache, Păunescu and Predoiu (2015) found no correlation between the simple, the discrimination reaction time and the sports performance (for the decision time – the time needed for the athletes to identify the stimuli, a positively significant correlation was revealed). It was established (Der & Deary, 2006) that the simple reaction time shortens from infancy into the late 20s, then increases slowly until the 50s and 60s, and then lengthens faster as the person gets into his 70s and beyond.

2. OBJECTIVES AND HYPOTHESES

The scope of our study was to investigate the analogical transfer capacity, the simple reaction time, the discrimination reaction time and the sports performance of elite junior female tennis players. The investigation of the analogical transfer capacity and of the reaction time reveals statistically significant relations between the mentioned dimensions and players performance.

3. METHODS

3.1. Participants

A number of 8 elite female tennis players have participated at the study, aged between 15 and 16 years old and having a competitive experience comprised between 6 and 8 years. The athletes are ranked in top 10 junior players in Romania and half of them were ranked in the top 10 players in Europe under 16 years.

3.2. Procedure

To solve the research issues, we used: observation, conversation, test – ANALOGIE Test, TR and TRD Tests, within PSISELTEVA tests, elaborated by RQ Plus, statistical processing methods - SPSS and data interpreting. The ANALOGIE, TR and TRD computerized tests were carried out by the female athletes in the same day and in the same moment of the day – in the afternoon (the three different tests were applied in the same order). In the case of the junior female tennis players the preferred hand was used, being generally faster. The participants were tested without previously practicing any exercise (being in a repaus state), knowing that (Levitt & Gutin, 1971) the subjects practicing sufficiently to produce a heart rate of 115 beats per minute, register a faster reaction time.

3.3. Instruments

The ANALOGIE test supposes that in a limited time (there are few seconds for every question of the test), the participants have to push a lever button (the left, center or right button) according to the response believed to be correct (viewed in the left, center or in the right side of the screen). An example of a question is the following – “Ignorance is for Learning what Poverty is for: School – Wealth – Hope”. The TR test consists of issuing a pre-established answer at the appearance of 50 signal-stimulus (red circle). The participant is required to push a
lever as fast as he can, every time the red circle appears on the screen. The test supposes promptitude of reactions, the diagnostic scope being the measurement of the simple reaction time. The TRD test is conceived as a dynamic model made of 100 sequences which present in an aleatory manner a significant visual stimulus and a non-significant visual stimulus. At aleatory time intervals and with an improvable succession, in the center of the screen appear, in turns, nine images (red square, green square, yellow square, red circle, green circle, yellow circle, red triangle, green triangle or yellow triangle). The appearance of the red square represents the signal-stimulus. The participant’s task is to issue a motor response by pushing a lever as fast as he can, at the appearance of the signal-stimuli. The test requires: discrimination and identification in due time of the visual signal-stimuli, promptitude and attention.

Among all the coefficients provided by the battery soft, we shall present the following parameters:

ANALOGIE test: the analogical reasoning coefficient (it refers to the number of correctly issued answers and failed answers) and the operativity coefficient (it refers to the time in which the athletes gave their answers);

TR test: the mean of the simple reaction time (measures the speed of the nervous influx);

TRD test: the mean of the discrimination reaction time (measures the speed of the nervous influx combined with the time necessary for the mental operation of identification – the identification of the significant stimuli).

The performance registered by the tennis players at ANALOGIE, TR and TRD have been correlated to the results obtained by the female athletes in competitions, results expressed through the ranking position in Romania.

4. RESULTS

Preliminary data analysis (box-plot charts) has emphasized that in the case of the results obtained at ANALOGIE, TR and TRD, there were no extreme values. Using the Spearman correlation, we have verified if there were any relations between the analogical reasoning ability, the simple reaction time, the discrimination reaction time and sports performance - the results obtained by the female tennis players in competitions, results expressed through the official system ranking.

The following conditions for the application of the Spearman correlation are fulfilled (Labăr, 2008): both variables are ordinal or one of them is quantitative and the other ordinal; the sample does not have a large volume (8 participants); the scores of a variable are monotonously related to the scores of the other variable, meaning that, once the values of a variable register growth, the values of the other variable will also grow (decrease) – but not necessarily in a linear manner.

Table 1. Scores for ANALOGIE, TR and TRD tests and for the results obtained by the female tennis players, expressed through the ranking position

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>m</th>
<th>s</th>
<th>sports performance</th>
<th>Spearman’s rho</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>sports performance</td>
<td>8</td>
<td>4.5</td>
<td>2.44</td>
<td></td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>analogical reasoning</td>
<td>8</td>
<td>768.88</td>
<td>25.50</td>
<td></td>
<td>0.412</td>
<td></td>
</tr>
<tr>
<td>coefficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>operativity coefficient</td>
<td>8</td>
<td>643.13</td>
<td>72.57</td>
<td></td>
<td>0.719*</td>
<td></td>
</tr>
<tr>
<td>simple reaction time</td>
<td>8</td>
<td>167.5</td>
<td>10.07</td>
<td></td>
<td>-0.167</td>
<td></td>
</tr>
<tr>
<td>discrimination reaction</td>
<td>8</td>
<td>232.13</td>
<td>10.30</td>
<td></td>
<td>0.714*</td>
<td></td>
</tr>
</tbody>
</table>

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

Analyzing the results indicated in table number 1, it was highlighted:

There is no correlation between the analogical reasoning coefficient (the total number of correctly issued answers for the ANALOGIE test), the simple reaction time (measures the speed of the nervous influx) and the results obtained by the female tennis players, expressed through the ranking position (p < 0.05);

There is a positively significant correlation (0.719) between the operativity coefficient (the speed of the answers or the time in which the athletes gave their correct answers) and the performance of the female players, expressed through the official ranking system (rho = .71, p<.05);

For correlation, a proper indicator of the effect size index is the determination coefficient ($r^2$). The value of the determination coefficient, in this case, is 0.51. We can say 51% of the variation of the two variables is common, the rest being due to other influences. In other words, the relation between the operativity coefficient (the speed of the athletes’ answers) and the sports performance is very strong.

Also, there is a positively significant correlation (0.714) between the discrimination reaction time (measures the speed of the nervous influx combined with the identification time) and the results registered by the tennis players, expressed through the ranking position (rho = .71, p<.05).

The determination coefficient ($r^2$) has a 0.50 value, meaning that the relation between the results for the discrimination reaction time and the performance of the junior female tennis players is very strong.
5. CONCLUSIONS

Our research demonstrates the existence of significant statistic correlations between the results registered by the female tennis players for the analogical reasoning ability, the discrimination reaction time and the sports performance, expressed through the official ranking system. There is a positively significant correlation between the operativity coefficient (the speed of athletes’ answers) and the performance of the female players. If the junior female tennis players having a competitive experience between 6 and 8 years give faster answers during tasks demanding analogical transfer capacity, this aspect is related to a better performance of the athletes on the court. This can be explained by the fact that reasoning by similarity can make the knowledge base more flexible. Also, as we mention previously in this paper, the new rules and schemata can be learned more easily. We add that people often use a mixture of multiple transfer processes for a given situation – analogy, knowledge compilation and constraint violation (as researches show), so, the transfer mechanisms interact. The top female tennis players, learning through analogy and knowing the constraints in tennis (do not hit the ball towards the opponent, do not hit the ball outside the court or in the net etc), will learn faster to generate suitable movements and executions in given situations (when the ball comes to fast or very high over the net, with a specific effect etc). Consequently, this may positively influence the evolution of the female players in competitions. This paper can be considered a starting point for further deeper researches, for a better understanding of the impact of the knowledge transfer in sport performance. Also, there is a positively significant correlation between the discrimination reaction time (measures the speed of the nervous influx combined with the identification time) and the results registered by the tennis players, expressed through the ranking position. Thus, if the female players combine the speed of the nervous influx with a good time in which they identify the significant stimuli in the environment, this aspect is associated with a better performance of the athletes on the tennis court. Performing an adequate mental preparation and modelling the competition in training, the junior female athletes will develop the vigilance (attention in expectation) in order to quickly identify the important stimuli that may occur and which generate specific motor reactions. The research has been limited by the physical and mental state of the participants during testing (fatigue, affective-motivational factors) which may cause variations of the motor answers. Observation and conversation (as research methods) support the value of our findings. The sample of athletes is another limitation of the study. It is strongly recommended to continue the investigation on a larger number of athletes, being approached players of different ages. These study results give useful information to coaches for scientifically conducting the sports training. The analogical reasoning ability and the discrimination reaction time may represent elements of selection of the junior female tennis players for the representative team. The research data will also be used by the sport psychologist, who will conceive stimulation programs for the characteristics: operativity coefficient and vigilance (attention in expectation), developing athletes’ ability to give faster answers during tasks demanding analogical transfer and to quickly identify the relevant stimuli from the environment.

6. ACKNOWLEDGEMENTS

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7. REFERENCES


