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THE INVOLVEMENT OF ADVANCED COGNITIVE SKILLS IN VARIOUS FOOTBALL - SPECIFIC TESTS A PILOT STUDY

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Abstract

Sports professionals should encourage the development of cognitive functions as often as possible in training. Stimulating the brain with alternating stimuli can promote concentration, attention, and the development of situational awareness and decision-making skills. The more and more diverse stimuli the player receives, the faster and more effectively he will react to match situations. Our research examined the effect of exercises requiring advanced cognitive skills on the training load. Changes in cardiovascular data were monitored using Polar Verity Sense 4J and Polarflow systems. The pilot study involved a U-16 football player. Our results demonstrated that in addition to increasing speed, duration, and number of repetitions, the gradual inclusion of decision-making situations can also effectively increase the load. The participant completed two sets of exercises. During the second test, more complex exercises required advanced cognitive skills. The average heart rate for the first test was 130 beats per minute. We experienced an increase in the average value (150 beats per minute) during the completion of the second test. We measured an average 15 percent increase in the participants' heart rate.

Keywords: *cognitive skills, football, intensity, training load*

INTRODUCTION

THE ROLE OF MOTOR SKILLS IN FOOTBALL

In football, motor skills are manifested in many ways (BICSKEI, 2010; GÖLTL, 2002; NÉMETH, 2015). Strength, speed, and endurance – and the combination of these skills – are essential for a football player. The ratio varies from player to player regading the position they play. Among sport-specific motor skills, agility plays an increasingly important role (CARLO – TUDOR, 2015). Agility is an indispensable skill, as ball games require adaptation to constantly changing external stimuli (BÍRÓ et al., 2015; SHEPPARD, 2006). For the effective execution of quick changes of direction, stops, turns, and jumps, it is essential to have a high level of dynamic balancing ability, spatial orientation, kinesthesia, and rhythmic ability (GERALD, 2002; PUCSOK et. al, 2018).
Conditioning and coordination, as well as various cognitive skills, are constantly present when performing movements (ANNI et. al., 2004; CSÁNYI – RÉVÉSZ, 2015). During a football game, athletes must react to constantly changing situations. Among cognitive skills, decision-making plays a prominent role, resulting in creative movement execution (CALLIES, 1995; GÁLDI et. al., 2011; . Thanks to their game intelligence, skilled players also have a high anticipation ability (BEV et. al., 2013; BRUSSEAU et. al., 2012). Primary purpose of technical-tactical training is to improve motor and cognitive skills. Implementing increasingly complex movements, techniques, and formations facilitates this adaptation (JARVEI, 2000). The more and more diverse stimuli the player receives,

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the faster and more efficiently they can react to match situations. A higher level of situational awareness and decision-making skills will result in a more efficient movement execution (NÁDASDI, 1996). The skills required for football must be developed and managed in a complex way (GÖLTL, 2002). During the training, it is advisable to develop all four pillars of football simultaneously: technique, tactics, motor skills, and cognitive functions. Football players need to have an "essential developmental background." Theoretical and practical training can only be successful if the player can rapidly process and respond to all kind of stimuli (BORONYAI et al., 2016).

METHODS AND PROCEDURES

We assumed that implementing exercises requiring advanced cognitive skills, such as attention, situational awareness, and decision-making, increases heart rate and, thus, the magnitude of the training load. We implemented two tests (set of exercises) to support our hypothesis. The player had to perform exercises requiring less advanced cognitive skills in the first test. In contrast, the participant had to apply advanced cognitive skills in the second test. We conducted the study in Spring 2023 on the artificial turf field of the University of Debrecen Athletic Club (DEAC). We used the Polar Verity Sense 4J system to assess heart rate data. We recorded the duration of the tests, the distance, the pre - and post-exercise heart rate, the minimal and maximal heart rate, and the average heart rate. The data was transferred to an iPad smart device, where we could track the results using the Polarflow software. The testing area consisted of four - 2x1 m gates, eight - colored cones (two blue, two white, two yellow, two green), and 15 balls. Four volunteers participated in the measurements. They placed the balls at each corner of the testing area and passed them to the player at a given signal. The exercises were performed in a 10m x 10m square-shaped area. We also placed the four gates (Figure 1).

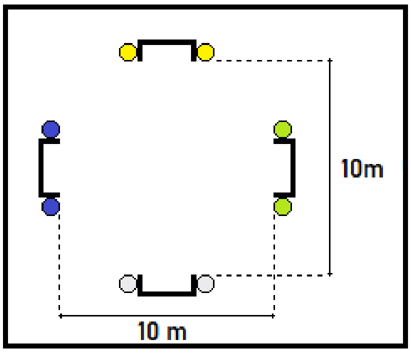

Figure 1: Set up of the testing area
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The first set of exercises**:** The test was performed by a player who was positioned in the area between the gates. His task was to pass through a ball received from the same corner (marked with the number 1) to a predetermined (blue) gate. The player had ten attempts on each gate (Figure 2).

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The second set of exercises: In this test, the player received the ball from various positions (1-4) and always had to pass it through a different gate. The player had to pay attention to the other signals constantly. The volunteer who assisted in the measurement gave instructions regarding the origin of the ball and the specific gate the ball had to be passed through. For example, when the "3 yellow" instruction was heard, 3 represented the volunteer position where the ball was coming from, and yellow represented the specific gate the ball had to be passed through. Thus, the test required continuous attention and high-level concentration (Figure 3).

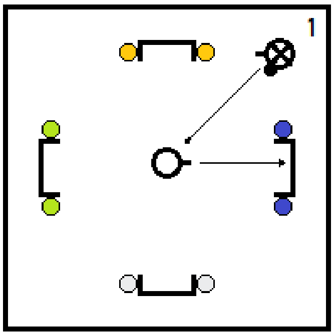

Figure 2: Execution of the first test
Source: own source

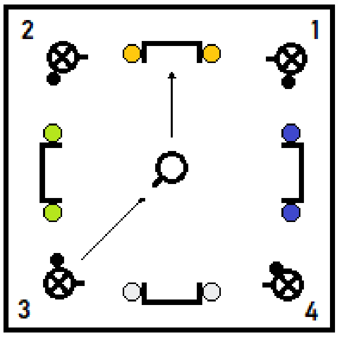

Figure 3: Execution of the second test
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RESULTS

For heart rate assessment, we used the Polar system throughout the entire study. Figure 4. demonstrates the total time range while the system was active. The figure below shows the areas bordered by blue and red lines. During the period marked by blue lines, the first test was performed. Moreover, the test requiring more advanced cognitive skills was performed in the section marked with red lines. The player participating in the study did the warm-up together with his team and then arrived at the practice site. The rest time between the two tests was a constant 6 minutes and 25 seconds. In both cases, the duration of the two tests was 2 minutes 35 seconds. The pre-exercise heart rate was 122 beats per minute in the first test. During the second test, we experienced a rather similar - 119 beats per minute value. In both cases, the goal was to keep the pre-exercise heart rate around 120 beats per minute

RESULTS OF TESTS THAT INVOLVE LESS ADVANCED COGNITIVE SKILLS

The player's pre-exercise heart rate was 122 beats per minute. The total training duration was 2 minutes 35 seconds. What is important to us is that the player's average heart rate was 130 beats per minute during this time. The maximal heart rate he reached was 137 beats per minute. The minimal value was reached at 117 beats per minute. Post-exercise heart rate was 133 beats per minute. As for the intensity zones, we can conclude that the player was in the low-medium range during the exercise (Table 1). The participant completed the test at 50-70% of his maximal heart rate. In the fifty and sixty percent intensity zones, the player

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Figure 4: Heart rate and speed data of the two tests monitored by the Polar system
Source: own source

spent 10 percent of the total training time, 16 seconds, and in the sixty and seventy percent zones, 90 percent of the duration. This was 139 seconds out of 155 seconds. The player worked the most in the 60-70% zone. During the exercise, we found that the player participating in the study completed the test relatively quickly. He had no technical difficulties in passing the received balls into the goal. So, he performed the task with continuous concentration and without technical errors.

Table 1: Results of the first test

<table>
<tr><td>Duration of the test</td><td>2:35'</td><td rowspan="8">Intensity</td><td rowspan="2">90-100%</td><td rowspan="2">0%</td><td rowspan="2">00:00</td></tr>
<tr><td>Distance</td><td>0,03 km</td></tr>
<tr><td>Pre-exercise heart rate</td><td>122 beats/min</td><td rowspan="2">80-90%</td><td rowspan="2">0%</td><td rowspan="2">00:00</td></tr>
<tr><td>Post-exercise heart rate</td><td>133 beat/min</td></tr>
<tr><td>Minimal heart rate</td><td>117 beats/min</td><td rowspan="2">70-80%</td><td rowspan="2">0%</td><td rowspan="2">00:00</td></tr>
<tr><td>Maximal heart rate</td><td>137 beats/min</td></tr>
<tr><td rowspan="2">Average heart rate</td><td rowspan="2">130 beats/min</td><td>60-70%</td><td>90%</td><td>02:19</td></tr>
<tr><td>50-60%</td><td>10%</td><td>00:16</td></tr>
</table>

Source: own source

RESULTS OF TESTS THAT INVOLVE ADVANCED COGNITIVE SKILLS

He successfully implemented perception, situational awareness, and decision-making skills in the second test. The player's pre-exercise heart rate was 119 beats per minute. The average heart rate increased to 150 beats per minute. The maximal heart rate jumped to 170, while the minimal dropped to 113 compared to the previous test. Examining the zones of intensity, deviations from the previous test can be observed (Table 2).The player incorporated more advanced cognitive skills, which also affected the intensity of the tests.

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In the 50-60 percent grey zone, the player spent 16 percent (25 seconds) of the total training time. In the medium-intensity zone marked with red, he worked almost the same, 15 percent. The participant performed in the third zone, marked in green, corresponding to the intensity zone of 70-80 percent. He completed 39 seconds, equivalent to 25 percent of the total training time. Of the 155 seconds, the player spent the most (67 seconds) in the high-intensity 80-90 percent zone. While completing the second test, we noticed that the player demonstrated more and more signs of fatigue. In the second test, physical and mental fatigue were more evident, and the subject considered these exercises more challenging.

Table 2: Results of the second test

<table>
<tr><td>Duration of the test</td><td>2:35’</td><td rowspan="8">Intensity</td><td rowspan="2">90-100%</td><td rowspan="2">0%</td><td rowspan="2">00:00</td></tr>
<tr><td>Distance</td><td>0,03 km</td></tr>
<tr><td>Pre-exercise heart rate</td><td>119 beats/min</td><td rowspan="2">80-90%</td><td rowspan="2">43%</td><td rowspan="2">01:07</td></tr>
<tr><td>Post-exercise heart rate</td><td>170 beat/min</td></tr>
<tr><td>Minimal heart rate</td><td>113 beats/min</td><td rowspan="2">70-80%</td><td rowspan="2">26%</td><td rowspan="2">00:39</td></tr>
<tr><td>Maximal heart rate</td><td>170 beats/min</td></tr>
<tr><td rowspan="2">Average heart rate</td><td rowspan="2">150 beats/min</td><td>60-70%</td><td>15%</td><td>00:24</td></tr>
<tr><td>50-60%</td><td>16%</td><td>00:25</td></tr>
</table>

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Pronounced differences existed between the results of the two measurements (Table 3). The baseline heart rate before exercise was nearly the same for both tests. In terms of pre-exercise, we aimed to keep it close to 120 beats per minute in both cases. During the execution of first and second tests, we recorded 122 and 119 beats per minute respectively

For post-exercise heart rate values, a more noticeable discrepancy was observed. During the first test 133 beats per minute was recorded, while for the second test, it was 170 beats per minute. The difference was 37 beats per minute. The minimal heart rate values (113 and 117 beats per minute, respectively) showed no difference in comparison between the two sets of exercises. We noticed a more pronounced difference in terms of the maximal heart rate values. In the first test, the heart rate went up to 137 beats per minute, while in the second test, the maximal value reached 170 beats per minute. During the first test, the average heart rate was 130 beats per minute for the test, while in the second test, we recorded 150 beats per minute. Since we are discussing average values, it is worth expressing this difference as a percentage. For the more complex exercises (second test), we measured a 15 percent increase in average heart rate.

We experienced substantial differences in intensity zones. When performing a more complex set of exercises, the player spent 9 seconds more in the 50-60 percent zone than during the first test. However, the participant performed only 24 seconds in the 60-70 percent moderate-intensity zone, much shorter (1 minute 55 seconds) than the time measured during the first test. The most noticeable difference was observed in the medium-high and submaximal zones (70-80 and 80-90 percent, respectively). While completing the first test, the player performed exclusively in the lower zones. The training load can be elevated by increasing physical parameters: resistance, speed, duration, and number of repetitions. We suggest, that with a constant duration, distance, and number of repetitions, the training load can be elevated by increasing the complexity of the test.

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The involvement of more complex exercises requiring advanced cognitive skills, resulting in a 15 percent increase in average heart rate.

Table 3: Results of the two tests

Measures	First test		Second test		Difference	
Duration of the test	2:35’		2:35’		-	
Distance	0.03 km		0.03 km		-	
Pre-exercise heart rate	122 beats/min		119 beats/min		-3 beat/min	
Post-exercise heart	133 beats/min		170 beats/min		+37 beat/min	
Minimal heart rate	117 beats/min		113 beats/min		-4	
Maximal heart rate	137 beats/min		170 beats/min		+33 beat/min	
Average heart rate	130 beats/min		150 beats/min		+15%	
Intensity						
90-100%	0%	00:00	0%	00:00	-	-
80-90%	0%	00:00	43%	01:07	(+) 43%	+01:07
70-80%	0%	00:00	26%	00:39	(+) 26%	+00:39
60-70%	90%	02:19	15%	00:24	(-) 75%	-01:55
50-60%	10%	00:16	16%	00:25	(+) 6%	+00:09

Source: own source

CONCLUSIONS

We may conclude, that, the average heart rate for the first test was 130 beats per minute, this value increased to 150 beats per minute during the completion of the second test. This resulted in a 15 percent increase in average heart rate. The maximal heart rate values supported our preliminary assumptions. More complex exercises requiring greater concentration and attention resulted in an increased maximal heart rate values (from 137 to 170 beats per minute).

Our research was a pilot study, the results cannot be generalized due to the low number of participants. Based on our previous practical experience, prior knowledge, and results, the training load can be increased independently by exercises requiring advanced cognitive skills. Overall, training load can be directly increased by the physical performance indicators of intensity (number of repetitions, speed, distance) and/or increasing the complexity of the exercises.

REFERENCES

Anni, K., Claudio D. & Maja, P. (2004). *Guidelines for Game- Based Learning*. Pabst Science Publishers, Lengerich.

Bev, H., Jeny, G. & Maude, P. (2013). *Teaching Physical Education in the Primary School.* Routledge, Abingdon.

Bicskei, B. (2010). *Kapusok könyve*. Bicskei és fiai Kft, Budapest.

Bíró, M., Juhász, I., Széles-Kovács, Gy., Szombathy, K. & Váczi, P. (2015). Mozgásos játékok Líceum Kiadó, Eger.

Boronyai, Z., Csányi, T., Kun, I., & Vass, Z. (2016). *Labdarúgás az iskolában*. Magyar Diáksport Szövetség, Budapest.

Brusseau, T. A., Darst, P. W., Pangrazi, R. P. & Sariscsny, M. J. (2012). *Dynamic Physical Education for Secondary School Students.* Benjamin Cummings, San Fransisco.

Callies, E. (1995). *Tanulás a játékban. (szerk.): Játékpszichológia. Szöveggyűjtemény*. Eötvös József Könyvkiadó, Budapest.

Carlo, B. & Tudor, B. (2015). *Periodization Training for Sports. Human Kinetics*, Champaign.

Csányi, T. & Révész, L. (2015). *A testnevelés tanításának didaktikai alapjai*. Magyar Diáksport Szövetség, Budapest.

Gáldi, G., Gáspár, M., H., Ekler J., Nádori, L., Rétsági, E., Szegnerné Dancs, H. & Woth, P. (2011). *Sportelméleti ismeretek*. Dialóg Campus Kiadó, Pécs.

Gerald, G. (2002, szerk.). *An introduction to primary physical education*. Routledge, Abingdon.

Göltl, G. (2002). *Labdarúgás lépésről lépésre*. Magyar Sporttudományi Társaság, Budapest.

Jarvei, G. (2000). *Sport, culture and society*. Routledge, Abingdon.

Nádasi, L. (1996*). Játék és tudomány*. Felelős kiadó: Dr. Fürj Zoltán főigazgató, Debrecen.

Németh, Zs. (2015). *A labdarúgás technikai mozgásanyagának oktatás módszertani javaslatai*. PTE TTK Sporttudományi és Testnevelési Intézet, Pécs.

Pucsok, J. M., Lentene Puskas, A., Varga, K., Perenyi, G., Bacsne Baba, É. & Balogh, L. (2018). A multi-disciplinary examination of psycho-physiological performance among youth and junior ball sport athletes: a systematic review. *Exercise Medicine*, *2*,(2) | https://doi.org/10.26644/em.2018.00

Sheppard, J. M., & Young, W. B. (2006). Agility literature review: classifications, training and testing. *J Sports Sci*, Ballarat.