

## **A study of key cognitive skills in handball using the Vienna test system**

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### **Abstract**

The continuous improvement of athletic performance, pushing physical limits, and the aspiration for ever-better results are some of the most important objectives of athletes. These may not be achieved barely based on innate talent and the acquisition of technical and tactical knowledge. It is just as important to understand mental processes and to be able to develop and support them professionally. Studying the cognitive skills of athletes is especially significant in the case of sports requiring dynamic, complex, and open skills. Handball is one such sport where the environmental conditions require continuous adaptation and decision making. In our research we studied the above-mentioned performance indicators among youth and adult handball players using the relevant tests of the Vienna Test System (VTS). The main advantage of VTS is that it studies the competences of athletes objectively, providing a valid and reliable assessment tool. The paper explores the decision-making strategies of handball players, their reactive stress tolerance, as well as their attention and concentration skills. This enables us to identify those players who are capable of adequately managing stress and who can recognize opportunities and properly make use of them even under pressure.

**Keywords:** Cognitive Skills; Decision Making; Attention and Concentration; Handball; Vienna Test System.

### **Introduction**

Most sports force athletes to improve their human performance as much as possible both physically and mentally even under continuously changing environmental stimuli and ever-increasing pressure in sports. Top athletes aim at overcoming their own limitations and encountered obstacles as well as achieving excellence (Ericsson, 2006). Besides possessing tactical skills and social competences, handball players also need to have special cognitive skills (Wagner, et al., 2014). Just as physical preparation has sport-specific requirements, priorities of cognitive skills also vary for each type of sport or even for different situations within a particular sport. Handball is a complex and multi-factorial team sport where players need to coordinate their own movement, have to be able to handle the ball excellently, implement adequate technical and tactical elements as precisely as possible, not to mention the consideration of external stimuli and proper reactions given to these. The main objective of this paper is to explore and analyze the key cognitive skills of handball players that enables us to identify those players who are capable of selecting the best solution even at the very last moment of a match, who can handle stress adequately, maintain their attention throughout the match, and perfectly implement proper positioning and take possession of the ball.

### **Psychological Studies in Handball**

Handball is one of the most popular sports not only in Hungary but also globally and especially in Europe. Using findings in sport sciences, the sport has been developing dynamically, resulting in improving quality and increasing professional recognition. Nowadays it has become widely accepted that it is not enough for an athlete to have excellent physique, physiological features, a healthy lifestyle and proper diet, motor skills, technical and tactical knowledge, and social network but they also need to have adequate mental and psychological features (Barreiros, Da Silva, Darte & Da Fonseca, 2011). The possession of sport-specific skills may bring an additional competitive advantage for handball players. According to Janelle and Hillman (2003), athletes need to perform outstandingly in at least four dimensions, including the following areas: physiological, technical, cognitive (tactics and strategy, perception and decision-making), and emotional (coping, control of emotions) sphere. Usually, cognitive skills are measured based on the speed of processing information and the quantity and quality of information processed over a unit of time. These three cognitive characteristics make a sharp distinction between players and place them in completely different athletic dimensions while all having the adequate physical and technical abilities. Despite the fact that even today sport activities are determined primarily by motor skills, the key to achieving the highest level of athletic performance may be found in the possession of cognitive skills at a high level (Tenenbaum, Basevitz & Gutierrez, 2015). Among cognitive skills,

when talking about the success of players, attention, anticipation, decision-making, and executive functions appear as important psychological determinants. Williams (2000) argues that athletes can be effective both during a match and training session if they anticipate the environment where they are going to play. Moreover, athletes should also pay attention to critical stimuli and recall from their memory the information needed for problem solving at the right time even under time pressure (Vaeyens, 2008). In terms of the handball-specific mental abilities, concentration, anxiety management, self-confidence, and motivation are central (Mahoney, Gabriel & Perkins, 1987; Thomas, Murphy & Hardy, 1999). Gonzales et al. (2013) found that more experienced handball players exhibit a significant difference in terms of mental abilities compared to their less experienced peers. Silva (2006) and Wagner and Dawo (2012) collected the special mental abilities of professional handball players; among these active acting and decision-making skills in competitive situations play a central role, besides high emotional stability, patience, discipline, finding the optimal balance between selfishness and altruism, as well as a special sense of the court.

### ***Decision-Making Skills***

The ability to make decisions is a fundamental expectation in the majority of sports, especially in the case of fast and dynamic team sports like handball. Decision-making is a cognitive operation during which we choose the option most suitable for the situation and deemed best at the time while considering the optional alternatives presenting themselves in the given environment. The speed of the decision-making process varies. It may take place slowly when there is no constraint or need from the environment to make a decision but its pace may speed up under pressure or stress (Tenenbaum & Gershgoren, 2015). Several factors may influence decision making, including athletic expertise, past experience, temporal or other pressure, but environmental stimuli or the current mental status of the athlete may also play a key influence (Tenenbaum, 2003). It is not easy, however, to become an expert; according to Ericsson's definition (2003), those athletes belong to this group who have spent around ten years in their sport, during which they have invested more than ten thousand hours into acquiring technical and tactical elements (Ericsson, 2003). This expertise enables the effective operation of the cognitive system by enabling them to make fast and effective decisions with higher probability, reducing the chance of making a mistake that could have a negative impact on performance (Tenenbaum, 2003). Athletes need to make decisions continuously, they need to select environmental stimuli, noises, sounds that play any significance, they have to assume a certain degree of risk, moreover, they often need to do these under psychological stress (Tenenbaum & Bar-Eli, 1993). The level of decision-making skills of athletes draws a sharp borderline between successful and unsuccessful athletes. Professional athletes are often under pressure due to the stakes or the disturbing presence of the audience, the opponents or the coach; thus the process of mental representation is disturbed, interference appears in the process of thinking, moreover, the processes of perception and cognition are also damaged, while the motor reactions given to these also dysfunction. This is especially true when the environment is significantly stressful emotionally. When the perceptual cognitive system does not work properly, athletes are more likely to make incorrect decisions. The development of effective strategies for coping with stress contributes to effective decision-making by athletes (Tenenbaum & Gershgoren, 2015).

### ***Reactive Stress Tolerance***

Reactive stress tolerance is the ability of athletes that enables them to react effectively, quickly, and adequately to the given situation even in an overburdened environment (Neuwirth & Benesch, 2012). This construct assesses the ability of the athletes to maintain their attention if they are under pressure that they experience as stress (Ong, 2017). How athletes react under heavy pressure has a significant effect on the outcome of their performance (Anshel & Anderson, 2002; Craft, Magyar, Becker, & Feltz, 2003; Jones, Hanton, & Connaughton, 2007). Patmore (2006) argues that the key to success lies in the effective management of stressful stimuli. In order for athletes to manage stress effectively, they need to be able to focus their attention adequately (Krohne & Hindel, 1988), possess an adequate level of motor coordination (Anshel, Kim, Kim, Chang, & Eom, 2001) and an excellent decision-making ability (Anshel, 1990). So far there have only been a few studies in the field of sports that have studied the reactive stress tolerance of athletes. The overview of relevant publications, however, reveals three factors that may have an impact on the level of reactive stress tolerance; these factors are gender, age, sport and competitive level. When studying female football players, it was found that women experience stress with higher intensity and perceive the situation to be controlled by themselves to a less extent (Kaiseler, Polman, & Nicholls, 2012), and they use problem-focused solutions at a much higher percentage than men, including the tools of communication and planning (Nicholls, Polman, Levy, Taylor, & Copley, 2007). Moreover, there are differences between types of sport also as sports requiring open skills (handball, basketball, football) take place in constantly changing environments and the athletes have to adapt to changing conditions and thus make decisions quickly and effectively. As opposed to this, sports that require closed skills (gymnastics, archery) take place under predictable environmental conditions and the performance of the athletes rather depends on the precise execution of the activity, during which they focus their attention more on internal processes than on external stimuli from the environment (Highlen & Bennett, 1983). At the same time, numerous other psychological constructs may be associated with the level of reactive stress tolerance, including, for example, the intensity of anxiety, reduced ability to act in a situation (Wilczyńska,

2016), the athlete's determination (Patócs, et al., 2016), the extent of perceived performance (Nederhof, Visscher, & Lemmink, 2008), and the perceived extent of control over the activity (Craft et al., 2006).

### ***Attention and Concentration***

We face selection problems of important pieces of information every moment. How do we select certain information for further processing while we ignore others? Attention helps us select relevant information coming from the outside world that are in harmony with our internal feelings (Moran, 2015). Let us consider an example from handball; when we listen to the instructions of the coach before the start of the match, we focus our attention not on defeating the opponent but on understanding the communication as precisely as possible. Attention is a multidimensional term that has three types. Selective attention enables us to filter the situational factors that are important for the task, while ignoring the effect of disturbing stimuli. Divided attention is a form of the mental ability of time sharing that contributes to the simultaneous performance of two or more activities. Finally, concentration is the athlete's own decision on the extent and time of mental effort used for the consideration of certain information. We may also look at the concept of concentration as persistent attention or deep focus on a given factor during which the ability to focus and maintain attention creates a sharp distinction between athletes (Moran, 2012). In studies of cognitive psychology conducted in the field of sports some of the most widely used tools are paper and pencil tests, with Robert Nideffer's "Test of Attentional and Interpersonal Style (TAIS)" being the most popular. The test distinguishes the players' attentional direction along two dimensions (Nideffer, 1976). In terms of the width of attention (the quantity of information processed) it distinguishes between broad and narrow attentional focus. In terms of the direction of attention, it differentiates between internal and external types. (Taylor, 2005). In his theory Nideffer also emphasizes that there might be a need to switch between these types of attention even during a match to achieve successful performance.

### ***Introduction of the Vienna Test System and Its Use in Sport Psychology***

The Vienna Test System (VTS) is a computerized, objective assessment tool consisting of interactive tests, which is capable of analyzing various constructs that are important for athletes from various aspects of sport psychology. One of the main advantages of the Austrian VTS test system is that it provides a valid and reliable testing procedure that can identify the characteristic personality traits of athletes and their cognitive and psychomotor activities (Schuhfried, 2013). Studies conducted with VTS have so far focused on the factors that distinguish between top athletes and those not doing sports, while they also studied those parameters that may impact the performance of athletes (Ong, 2015). Zwierko et al. (2010) compared the response time and peripheral sight of volleyball players with those of non-athletes and they found significant differences that showed that athletes have a significantly better response time and visual field of view than people who are not athletes. VTS, however, also has its limitations. During experimental arrangement, the age, sport and competitive level of athletes has to be considered as results may show significant differences between the groups listed. Moreover, there is no consensus whether the results can be applied to athletic careers as the tests are not developed in a sport-specific manner. Overall, however, there are more pros than cons considering VTS as it is a unique objective assessment tool that is capable of studying the different psychological constructs of athletes, thus including the efficiency and speed of decision-making, as well as the quantitative and qualitative aspects of attention and concentration, which are key areas of study in the case of handball players.

### **Objectives**

In order for the athletes and sport teams to maximize their performance, the utilization of findings of sport psychology is a must. So far, no publication has studied handball players in Hungary. Our objective is to examine the skills of handball players specifically related to their sport, explore the correlations between competences, and study the differences between age groups, gender groups and competitive levels in as much detail as possible. Ultimately, we would like to create a performance diagnostics system related to handball based on the complex understanding and development of the examined competences, the involvement of additional testing tools, and the creation of targeted training methods. The practical benefit of our research is that it may contribute to the development of a holistic selection system for sport teams and the preparation of suitability studies. The Vienna Test System provides an opportunity for studying the competences of athletes objectively and exploring psychological factors, which represents the first step in our long-term series of sport psychological studies.

### **Material and Method**

#### ***The Sample***

The test sample was filled in by 92 male and female, youth and adult competitive handball players. The sample is introduced in the chart of distribution of handball players (Table 1).

Table 1. Distribution of the test sample

Gender		Age			Distribution of handball players				Position			
					Competitive level							
Male	Female	Min.	Max.	Average	Spread	NB1	NB1/B	Goalkeeper	Playmaker	Back	Winger	Pivot
45	47	14	37	19.3	5.012	54	38	9	17	26	28	12

### *Circumstances of Data Collection*

The three sub-tests selected within the Vienna Test System were filled in by some of the handball players (74 people) in the laboratory of the Institute of Psychology at the University of Debrecen. The other 18 players included in the sample were tested at a designated site where the players completed the tests under the same conditions and in the same order. The test took place in a quiet and closed room with computers, where the athletes could conveniently focus on the execution of the tasks. Prior to testing, the investigator introduced the course of the work orally, then testing started after signing the necessary ethical authorizations. The VTS was filled in in Hungarian. The selected tests are supported by input devices, an answer pad and pedal, the use of which enables the measurement of response time, reactive stress tolerance, and decision-making with milliseconds precision. The investigator was present during the entire time of completing the tests and provided assistance for the respondents if it was needed (encountered technical issues, interpretation of tasks, having breaks, etc.). The time of completion for the tests was half an hour including the breaks.

### *Tests Used*

The test package compiled for handball players was developed as part of preliminary research work. The basis of the survey was made up by interviews conducted with experts, coaches, and athletes, where we asked them about those key competences that are considered as key factors in successful athletic performance. The interview questions addressed the following issues: the most important psychological factors of handball players, differences between successful and unsuccessful athletes, decisive factors in the outcome of a victorious match. The test package was compiled by us from the VTS tests based on the 5 interviews conducted: DT (determination test), COG (concentration and attention test).

#### 1. DT (Determination Test)

The test studied the attentional capacity, reactive stress tolerance, reaction speed among continuously and quickly changing acoustic and visual stimuli. The test is simple, the difficulty of the task lies in the different modality of the arriving stimuli and their speed. This way we measure those cognitive abilities of the people involved that are needed for the distinction of colors and sounds, the perception of the characteristics of stimuli, their memorization, then the selection of the adequate answer. The stimuli coming during the test are not predictable, they need to react to them randomly (Schuhfried, 2009). We study four key variables: the average value of reaction speed (sec), the number of correct answers (raw score), which reflects the ability of the respondent to precisely and quickly select the adequate answer even under pressure. Moreover, we also examine the number of incorrect answers (raw score) which can show us how likely the athlete is to get confused under stress and pressure; finally, the high number of missed answers (raw score) reveals that the respondent is not capable of maintaining his/her attention under stress and is prone to giving up these situations. (Neuwirth & Benesch, 2012). The internal consistence of the test (Cronbach alpha) shows values between  $r=0.98$  and  $r=0.99$ . The reliability of the test is also convergent, which is supported by former studies in the field of transportation psychology (Karner & Neuwirth, 2000), de Ong (2015) revealed also in comparison of athletes and non-athletes that the test may be deemed a reliable and valid assessment tool. The selected test form is S1, which takes a total of 6 minutes.

#### 2. COG (Cognitore test) concentration measurement test

The basis of the test is provided by Reulecke's (1991) theoretical model. He argues that the ability of concentration may be interpreted along three variables: the energy that is needed for a person to complete his/her task, function that is related to the control of concentration of variable extent connected to the accomplishment of the task, and precision related to the success of the outcome. The variables examined by us are the following: the number of correct answers (raw score), number of incorrect answers (raw score), response time of correct answers (sec), response time of incorrect answers (sec), total score (raw score), their response time (sec). Athletes filled in the S8 test form, in which they need to compare a geometric figure with another four to see if it matches a reference figure in a given amount of time. The reliability value of the test is (Cronbach alpha)  $r=0.98$ . The time needed for filling in the test is 7 minutes (Schuhfried, 2009).

### *Data Processing*

For the processing of data we used version 20.0 of the SPSS statistical program. We used the descriptive statistics method for distribution of the test sample in terms of gender, age, and position. For the characterization of the sample we conducted normality testing with the Kolmogorov-Smirnov test, then after running the probe we used parametric procedures (analysis of variance with a single factor) in the case of

variables following normal distribution, and non-parametric (Mann-Whitney, Kruskal-Wallis) tests in the case of non-normal distribution depending on whether we compared one or two independent samples. We considered a 5% margin of error most often used in social sciences as the significance level. We worked with raw scores in the case of the skill tests of the Vienna test systems (COG, DT). We processed the results in three groups, studying the concentration (COG) and reactive behavior (DT) of handball players according to gender, position, and age group.

### 1. The study of the concentration of handball players in gender and age groups.

Studying the concentration of handball players according to gender, we can state that there is no significant difference between the group of men and women along any of the variables. Men gave somewhat more correct answers and did so with a better response time than women but the number of incorrect answers was also higher in their case. Overall, we can state that men and women make decisions in a balanced way in terms of whether their answer is correct or incorrect.

Studying the concentration of players in terms of age groups, we can see that handball players playing in the adult team react significantly ( $p < 0.042$ ) faster ( $0.685 \pm 0.208$ ) to incorrect stimuli than the youth players and they also give significantly ( $p < 0.005$ ) more incorrect answers ( $45.15 \pm 57.28$ ) when comparing geometrical figures. There are no significant differences between the two examined groups in terms of the number of correct answers, the number of total responses, and the response time needed for correct answers.

Table 2. The average and spread values of concentration in terms of gender and age groups

Concentration	Male mean $\pm$ stand.dev.	Female mean $\pm$ stand.dev.	Adult mean $\pm$ stand.dev.	Youth mean $\pm$ stand.dev.
Mean time "incorrect reactions"	0.711 $\pm$ 0.139	0.701 $\pm$ 0.223	0,685 $\pm$ 0,208	0,735 $\pm$ 0,143
Sum "incorrect reactions"	38 $\pm$ 53	31 $\pm$ 40	45,15 $\pm$ 57.28	18,97 $\pm$ 12.98
Mean time "correct reactions"	0.766 $\pm$ 0.128	0.817 $\pm$ 0.181	0.794 $\pm$ 0.185	0.787 $\pm$ 0.111
Sum "correct reactions"	481 $\pm$ 81	474 $\pm$ 85	474.83 $\pm$ 89.478	488.32 $\pm$ 72.54
Sum "reactions"	525 $\pm$ 90	505 $\pm$ 104	519.98 $\pm$ 109.24	507.30 $\pm$ 77.30
Sum "hits"	145 $\pm$ 26	144 $\pm$ 26	140.23 $\pm$ 27.65	149.70 $\pm$ 21.73

### 2. The study of the concentration of handball players in terms of positions.

Studying the concentration of handball players according to position, it is seen as a tendency based on average values ( $p < 0,065$ ) that the goalkeepers ( $0.683 \pm 0.082$ ), wingers ( $0,669 \pm 0,228$ ), and playmakers ( $0.669 \pm 0.155$ ) react faster to incoming stimuli along the response time related to correct and incorrect answers than handball players in the pivot ( $0.837 \pm 0.207$ ) and back ( $0.719 \pm 0.140$ ) positions. There was no significant difference between the number of correct and incorrect answers in the comparison according to positions.

Table 3. The average and spread values of concentration according to positions

Concentration	Goalkeeper mean $\pm$ stand.dev.	Wing mean $\pm$ stand.dev.	Back mean $\pm$ stand.dev.	Middle back mean $\pm$ stand.dev.	Line mean $\pm$ stand.dev.
Mean time "incorrect reactions"	0.683 $\pm$ 0.082	0.669 $\pm$ 0.228	0.719 $\pm$ 0.140	0.669 $\pm$ 0.155	0.837 $\pm$ 0.207
Sum "incorrect reactions"	22 $\pm$ 17	42 $\pm$ 63	39 $\pm$ 51	28 $\pm$ 23	25 $\pm$ 26
Mean time "correct reactions"	0.797 $\pm$ 0.70	0.763 $\pm$ 0.172	0.762 $\pm$ 0.130	0.820 $\pm$ 0.187	0.870 $\pm$ 0.166
Sum "correct reactions"	475 $\pm$ 48	504 $\pm$ 93	483 $\pm$ 81	469 $\pm$ 69	442 $\pm$ 92
Sum "reactions"	497 $\pm$ 44	546 $\pm$ 125	522 $\pm$ 81	497 $\pm$ 78	466 $\pm$ 88
Sum "hits"	143 $\pm$ 20	149 $\pm$ 29	146 $\pm$ 27	142 2	135 5

### 3. The study of decision making and reactive stress tolerance of handball players according to gender and age group

During the study of the decision-making and reactive stress tolerance of handball players according to gender, we have found several significant differences between men and women. Under time pressure, women disregarded significantly ( $p < 0.020$ ) more ( $49 \pm 20$ ) of the incoming stimuli than men, they are also more impulsive ( $491 \pm 75$ ) and react to significantly ( $p < 0.000$ ) more stimuli. There was no significant difference

between the two groups in terms of correct and incorrect answers but it can be seen based on the average results that women gave more correct answers compared to their male peers, however, women processed significantly ( $p < 0.000$ ) more ( $521 \pm 58$ ) stimuli while filling in the test.

The comparison of handball players according to age group in terms of decision-making and reactive stress tolerance revealed several significant differences, according to which the adult, youth age handball players react to more ( $p < 0.000$ ) stimuli ( $471.62 \pm 73.334$ ), and do so with more ( $p < 0.007$ ) errors ( $39.31 \pm 23.123$ ). As opposed to this, the youth age players react to fewer stimuli ( $361.51 \pm 134.741$ ) and the number of ignored stimuli ( $31.49 \pm 16.385$ ) and incorrect answers ( $28.57 \pm 19.751$ ) is significantly ( $p < 0.000$ ) lower. Moreover, there is a significant difference ( $p < 0.005$ ) in terms of the reaction speed, according to which younger players react faster ( $0.715 \pm 0.051$ ) to stimuli, as opposed to adult players ( $0.756 \pm 0.665$ ). Finally, it can be seen that in terms of the correctness of the decisions there is no significant difference between the two groups, they exhibit a balanced image along the variables.

Table 4. The average and spread values of decision making and reactive behavior according to gender and age groups

Decision-making skills, reactive behavior	Male		Female		Adult		Youth	
	mean	± stand.dev.	mean	± stand.dev.	mean	± stand.dev.	mean	± stand.dev.
Omitted	39	± 18	49	± 20	52.25	± 16.921	31.49	± 16.385
Incorrect	36	± 23	34	± 22	39.31	± 23.123	28.57	± 19.751
Correct	409	± 126	426	± 96	433.33	± 90.109	395.92	± 134.973
Median reaction time	0.73	± 0.07	0.74	± 0.06	0.756	± 0.665	0.715	± 0.051
Reactions	459	± 113	491	± 75	471.62	± 73.334	361.51	± 134.741
Number of Stimuli	377	± 118	521	± 58	501.31	± 61.489	376.49	± 137.397

4. The study of decision making skills and reactive stress tolerance of handball players according to position

The comparison of handball players according to position in terms of decision-making skills and reactive stress tolerance reveals a trend ( $p < 0.084$ ), according to which playmakers react with a faster reaction time ( $0.72 \pm 0.05$ ) to the multitude of stimuli arriving under great pressure compared to their peers in other positions. It can be seen in the case of goalkeepers that they tend to react incorrectly ( $42 \pm 22$ ) to an incoming stimuli rather than ignore them ( $31 \pm 10$ ), as opposed to playmakers who react to a lot of stimuli ( $452 \pm 105$ ) and often do so incorrectly ( $35 \pm 18$ ). In the case of those playing in the pivot position it can be seen that they react a fewer times ( $389 \pm 103$ ) to the incoming stimuli, the number of incorrect answers is also lower ( $26 \pm 19$ ) compared to other players.

Table 5. The average and spread values of decision-making skills and reactive behavior according to position

Decision-making skills, reactive behavior	Goalkeeper		Wing		Back		Middle back		Line	
	mean	± stand.dev.	mean	± stand.dev.	mean	± stand.dev.	mean	± stand.dev.	mean	± stand.dev.
Omitted	31	± 10	46	± 20	44	± 21	47	± 19	41	± 21
Incorrect	42	± 22	38	± 21	34	± 28	35	± 18	26	± 19
Correct	321	± 165	443	± 93	427	± 88	418	± 126	412	± 109
Median reaction time	0.75	± 0.05	0.72	± 0.06	0.75	± 0.08	0.72	± 0.05	0.76	± 0.04
Reactions	420	± 135	434	± 127	419	± 115	452	± 105	389	± 103
Number of Stimuli	423	± 134	458	± 122	444	± 113	480	± 115	418	± 112

## Summary of Findings Related to Handball Players

### 1. Concentration and Attention

Based on the raw score of the concentration test, overall, we may state that men and women make decisions in a balanced way in terms of whether their answers are correct or incorrect, with no significant results between the two groups. In the test assessing concentration, attention processes some kind of a trend may be observed when comparing handball players according to the different positions; the goalkeepers, wingers, and playmakers react faster when selecting adequate figures than do those in the pivot or back positions. There seems to be no significant difference between the correctly and incorrectly made answers between handball players in different positions, which is revealed by the effective maintenance of the focus of attention persistently. It is a conspicuous result that adult players give significantly more incorrect answers while completing the task and do so with largely faster reaction time compared to their younger peers. In connection with the key factors, like the

number of correct answers, the number of total responses, and the response time needed for correct answers there are no significant differences between the two examined groups.

## **2. Decision-Making Skills and Reactive Behavior**

During the study of the decision-making and reactive stress tolerance of handball players according to gender, we have found several significant differences between men and women. Women reacted to significantly more stimuli (correct and incorrect answers) than men in the case of stimuli arriving in stressful tasks including a lot of visual and acoustic stimuli. However, there are no significant differences between correct and incorrect responses given to stimuli but in terms of the number of ignored stimuli women players are significantly ahead of men. The comparison of abilities according to position reveals a trend according to which playmakers react with a faster reaction time to the multitude of stimuli arriving under great pressure compared to their peers in other positions. In the case of goalkeepers and playmakers, based on the average values related to the raw scores achieved, we can also see in the tests that they make decisions a lot of times and react to certain situations maybe even incorrectly rather than ignoring an opportunity and missing a reaction to it. As opposed to this, players in the pivot position react to fewer stimuli and at the same time the number of their incorrect answers is also lower compared to other players. In terms of the decision-making skills and reactive stress tolerance there is no significant difference according to positions, they exhibit a balanced image along the variables. The comparison of handball players according to age group in terms of decision-making and reactive stress tolerance revealed several significant differences, according to which the adult handball players react to much more stimuli, and do so with more errors compared to youth players. The players of the youth team reacted significantly faster to arriving stimuli also. However, there is no significant difference between the two groups in terms of the correctness of the decisions, they exhibit a balanced image along the variables based on which we may claim that even though they often react too impulsively and they select fewer from the arriving stimuli but in a large part of them they can make the right decisions.

## **Conclusions and Recommendations**

The primary objective of the paper was to introduce a modern testing tool of sport psychology, which objectively and reliably highlights the key competences important for athletes, including attention and concentration, decision-making skills, and reactive behavior. Several research projects have confirmed the still relatively new fact in Hungary that there is no significant difference between the motor and sport-specific performance of professional and semi-professional players (Rebelo et al., 2010), thus psychological skills need to be mentioned as the criteria of success (Williams, 1998). Thus when identifying talented athletes, we need to consider physical and psychological factors simultaneously and use a holistic approach whereby the motor skills and psychological characteristics are studied and developed simultaneously. During the study of the role of various positions, there were no significant differences in terms of attentional performance, however, based on the study of average values it can be stated that concentration focus can be maintained the least by playmakers and those in the pivot position, which represents an area of improvement in their case. Playmakers need to divide their attention continuously and possess a high concentration ability while maintaining attention, filtering disturbing stimuli and recognizing the essential elements related to the completion of the task. Moving on in terms of the average values, it can be seen in the case of goalkeepers that overall they provide a balanced performance in the attention test.

This result supports compliance with requirements set from early childhood, as it appears as an expectation for goalkeepers that they should dare to make decisions and do so quickly and effectively. Results have also confirmed that the mental training of field players and goalkeepers also requires different preparation and the creation of a different development plan. In connection with comparisons according to gender, there were no significant differences in terms of results achieved in the concentration and attentional tests, however, with regard to decision-making abilities and reactive behavior a significant difference was seen in connection with the number of reactions and stimuli. Based on the results, women are much more impulsive, they react to much more stimuli and it is typical of them that they rather make a decision incorrectly than not to react to it, as opposed to their male peers, who react selectively to the stimuli coming from different modalities. When interpreting the results of age groups, the young group performed better both in terms of concentration as well as decision-making skills and reactive behavior.

We may suppose a motivational deficit for the adult age group, they chose the stimuli of different modality with non-adequate precision and efficiency. Overall, VTS serves as an excellent complement to the development and implementation of the preparation and development program of athletes as besides the improvement of motor skills important from the perspective of the sport, it also highlights the strengths and weaknesses of players in terms of psychological abilities, which results in a more targeted stage of preparation. Thus the test is also suitable for the preparation of the athletes' performance evaluation, development, and career plan. VTS is adequate not only for the suitability study of players on the team but it also functions as a psychological testing tool to be used during selection.

## Outlook

In handball, VTS functioning as a complex computerized psychological test system may support the cooperation of experts with the longitudinal study of athletes whereby the coaches and sport psychologists contribute to the individual and team-related development of players from multiple perspectives with their expertise. In upcoming studies we would like to involve even more handball players in the sample, among others, we would like to explore differences between players on the national team and in the professional league, which may be related to the criteria of success. Moreover, we also set the development of our own sport-specific tests as an objective, as the ones used in the research are general ones and not closely related to handball. In line with this, we would like to further analyze the examined abilities and skills in a more special testing arrangement appearing also at handball trainings and matches, where the VTS results would be used for the validation of the new tests.

## References

- Anshel, M. H. (1990). Toward Validation of a Model for Coping with Acute Stress in Sport. *International Journal of Sport Psychology*, 21, 58–83.
- Anshel, M. H., Kim, K. W., Kim, B. H., Chang, K. J., & Eom, H. J. (2001). A Model for Coping with Stressful Events in Sport: Theory, Application, and Future Directions. *International Journal of Sport Psychology*, 32(1), 43-75.
- Anshel, M. H., & Anderson, D. (2002). Coping with Acute Stress in Sport: Linking Athletes' Coping Style, Coping Strategies, Affect, and Motor Performance. *Anxiety, Stress & Coping*, 15(2), 193-209.
- Barreiros, A. N., Da Silva, J. M., S. P. Darte, D.T., & Da Fonseca, A. M. (2011). What Portuguese Premier League Coaches Think About the Importance of Psychological Intervention in Professional Soccer?. *Motriz Revista de Educacao Fisica*, 17, 128-137.
- Craft, L. L., Magyar, T. M., Becker, B. J., & Feltz, D. L. (2003). The Relationship Between the Competitive State Anxiety Inventory-2 and Sport Performance: A Meta-Analysis. *Journal of Sport and Exercise Psychology*, 25(1), 44-65.
- Ericsson, K. A. (2003). Development of Elite Performance and Deliberate Practice: An Update from the Perspective of the Expert Performance Approach. In J. L. Starkes and K. A. Ericsson (Eds.), *Expert Performance in Sports: Advances in Research on Sport Expertise* (pp. 49–84). Champaign, IL: Human Kinetics.
- Ericsson, K. A., Hoffman, P., Charness, N., & Feltovich, P. (2006). *The Cambridge Handbook of Expertise and Expert Performance*. Cambridge, UK: Cambridge University Press.
- Gonzales, S. P. I., Coronado, O. J. F., & Rosa, A. R. M. (2013). Assessment of Psychological Skills in Young Elite Female Handball Players. In. European Handball Federation Scientific Conference, *Science and Analytical Expertise in Handball* (pp. 353-357). Vienna: EHF.
- Highlen, P. S., & Bennett, B. B. (1983). Elite Divers and Wrestlers: A Comparison Between Open and Closed-Skill Athletes. *Journal of Sport Psychology*, 5(4), 390-409.
- Janelle, C. M., & Hillman, C. H. (2003). Expert Performance in Sport: Current Perspectives and Critical Issues. In J. Starkes, K. Ericsson (Eds.), *Expert Performance in Sports: Advances in Research on Sport Expertise* (pp. 19-49). Champaign: Human Kinetics.
- Jones, G., Hanton, S., & Connaughton, D. (2007). A Framework of Mental Toughness in the World's Best Performers. *The Sport Psychologist*, 21, 243-264.
- Kaiseler, M., Polman, R. C., & Nicholls, A. R. (2012). Gender Differences in Appraisal and Coping: An Examination of the Situational and Dispositional Hypothesis. *International Journal of Sport Psychology*, 43(1), 1-14.
- Karner, T., & Neuwirth, W. (2000). Validation of Traffic Psychology Tests by Comparing with Actual Driving. In *Proceedings of the International Conference on Traffic and Transport Psychology*. Bern, Switzerland.
- Krohne, H. W., & Hindel, C. (1988). Trait Anxiety, State Anxiety, and Coping Behavior as Predictors of Athletic Performance. *Anxiety Research*, 1(3), 225-234.
- Mahoney, M.J., Gabriel, T.J., & Perkins, T.S. (1987). Psychological Skills and Exceptional Athletic Performance. *Sport Psychologist*, 1, 181-199.
- Moran, A. (2015). Attention Theory. In C. R., Eklund, & R. Tenenbaum (Eds.), *Encyclopedia of Sport and Exercise Psychology* (pp. 39-43). Los Angeles, London, New Delhi, Singapur, Washington DC: Sage.
- Moran, A. P. (2012). Concentration: Attention and Performance. In S. Murphy (Eds.), *The Oxford Handbook of Sport and Performance Psychology* (pp. 117-130). New York: Oxford University Press.
- Nederhof, E., Visscher, C., & Lemmink, K. (2008). Psychomotor Speed is Related to Perceived Performance in Rowers. *European Journal of Sport Science*, 8(5), 259-265.
- Neuwirth, W., & Benesch, M. (2012). *Vienna Test System Manual: Determination Test, (Version 35)*. Moedling: Schuhfried.



- Nicholls, A. R., Polman, R., Levy, A. R., Taylor, J., & Cobley, S. (2007). Stressors, Coping, and Coping Effectiveness: Gender, Type of Sport, and Skill Differences. *Journal of Sports Sciences*, 25(13), 1521-1530.
- Ong, N. C. H. (2015). The Use of the Vienna Test System in Sport Psychology Research: A Review. *International Review of Sport and Exercise Psychology*, 8(1), 204-223.
- Patmore, A. (1986). *Sportsmen under Stress*. London: Stanley Paul.
- Patócs, Á., Melia, L., Kovács, S., Fózser-Selmeci, B., Révész, L., & Tóth, L. (2016). Reactive Stress Tolerance and Personality Characteristics of Hungarian Elite Fencers. *Cognition, Brain, Behavior*, 20(3), 171-184.
- Rebello, M., Smilie, C., Macintosh, S., Lombard, R. (2010). Selectal Physical Attributes of Male Soccer Players: A Comparative Analysis. *African Journal of Physical, Health Education, Recreation and Dance*, 16(4), 85-92.
- Schuhfried, G. (2013). *Vienna Test System: Psychological Assessment*. Moedling, Austria: Schuhfried.
- Silva, J. M. (2008). Psychological Aspects in the Training and Performance of Team Handball Athletes. In J. Dosil (Eds.), *The Sport Psychologist's Handbook: A Guide for Sport-Specific Performance Enhancement* (pp. 211-243). West Sussex: John Wiley & Sons.
- Taylor M. J., & Wilson, G. (2005). *Applying Sport Psychology. Four Perspectives*. Champaign, Human Kinetics, 51-64.
- Thomas, P.R., Murphy, S.M., & Hardy, L. (1999). Test of Performance Strategies: Development and Preliminary Validation of a Comprehensive Measure of Athletes' Psychological Skills. *Journal of Sports Sciences*, 17, 697-711.
- Tenenbaum, G., & Gershgoren, L. (2015): Decision Making. In C. R., Eklund, & R. Tenenbaum (Eds.), *Encyclopedia of Sport and Exercise Psychology* (pp. 189-191). Los Angeles, London, New Delhi, Singapur, Washington DC: Sage.
- Tenenbaum, G., Basevitch, I. & Gutierrez, O. (2015). Cognitive Capabilities. In C. R., Eklund, R. Tenenbaum (Eds.), *Encyclopedia of Sport and Exercise Psychology* (pp. 135-136). Los Angeles, London, New Delhi, Singapur, Washington DC: Sage.
- Tenenbaum, G., & Bar-Eli, M. (1993). Decision making in sport: A Cognitive Perspective. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of Research on Sport Psychology* (pp. 171-192). Macmillan Pub Co; First Edition.
- Tenenbaum, G. (2003). Expert Athletes: An Integrated Approach to Decision Making. In J. L. Starkes, & K. A. Ericsson (Eds.), *Expert Performance in Sports: Advances in Research on Sport Expertise* (pp. 192-218). Champaign, IL: Human Kinetics.
- Tenenbaum, G. (2004). Decision Making in Sport. In C. Spielberger (Eds.), *Encyclopedia of Applied Psychology* (pp. 575-584). San Diego, CA: Elsevier.
- Vaeyens, R., Lenoir, M., Williams, A.M., & Philippaerts, R. M. (2008). Talent Identification and Development Programmes in Sport. *Sports Med*, 38(9), 370-376.
- Wagner, M., & Dawo, O. (2012). Handball. : Handbuch sportpsychologischer Praxis: Mentales Training in den olympischen Sportarten. In D. Beckmann-Waldenmayer, & J. Beckmann Balingen (Eds.), *Handboobk of sport psychological practice: Mental training in olympic sports* (pp. 237-250). Balingen: Spitta Verlagen.
- Wagner, H., Finkenzeller, T., Würth, S., & von Duvillard, S. P. (2014). Individual and Team Performance in Team-Handball: A Review. *Journal of Sports Science and Medicine*, 13, 808-816.
- Ward, P., Williams, A. M., & Hancock, P. (2006). Simulation for Performance and Training. In K. A. Ericsson, P. Hoffman, N. Charness, & P. Feltovich (Eds.), *The Cambridge Handbook of Expertise and Expert performance* (pp. 243-262). Cambridge, UK: Cambridge University Press.
- Williams, A. M., & Franks, A. (1998). Talent Identification in Soccer. *Sport, Exercise and Injury*, 4(4), 159-165
- Wilczyńska, D. (2016). Correlations between Psychomotor Abilities and Selected Personality Variables in Rowers. *Baltic Journal of Health and Physical Activity*, 8(2), 42-54.
- Zwierko, T., Osinski, W., Lubinski, W., Czepita, D., & Florkiewicz, B. (2010). Speed of Visual Sensorimotor Processes and Conductivity of Visual Pathway in Volleyball Players. *Journal of Human Kinetics*, 23, 21-27.