

## Original Article

### **A sport-psychological diagnostic examination of young EHF handball referees with a focus on mental skills**

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#### **Abstract**

The continuous improvement of handball referees' performance, pushing physical limits, and the aspiration for ever-better results are some of the most important objectives of them. 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 referees 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 young handball referees of EHF (European Handball Federation) 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 referees, the aspect of visual orientation performance involved in tracking simple visual elements in a relatively complex environment, furthermore their reactive stress tolerance, as well as their attention and concentration skills. This enables us to identify those referees who are capable of adequately managing stress and who can recognize opportunities and properly make use of them even under pressure. The aims of our research is to examine the specific sports-related skills of handball referees, to explore the relationship between competencies, to learn their cognitive abilities, and to focus on decision-making, situational-awareness and concentration. The aim of the study is also to open up a new way of objectively measuring cognitive abilities by analysing the performance of referees individually and then according to the position of peers.

**Keywords:** Sport psychology, Young National Referees, Handball, Cognitive Skills, Vienna Test System

#### **Introduction**

Referees, as in all sports, are highly important part of competitions in handball as well. Not only because they have a significant impact on match output and players' behaviour, but also because they ensure that matches are safe and refers to fair-play. The referees' task is rather complex, as they need to make quick and effective, appropriate decisions at the same time and deal with problematic and ambiguous situations with players, coaches, the public or even the media. According to Cuskelly et al. (2008) refereeing is one of the most challenging and difficult tasks in high-performance sport. Referees have reported on psychological factors that are important to their successful refereeing, including concentration, self-confidence and emotional stability (Weinberg and Richardson, 1990). However, the ability of referees to respond to environmental stimuli and demands, and to manage the consequences of successes and failures is mostly determined by their cognitive abilities. In sport, cognitive abilities are essential to reach peak performance, meaning innate and developing sensory abilities which can influence the evaluation, response and overall the quality of referee behaviour (Tenenbaum, Basevitz& Gutierrez, 2015). The purpose of the recent study is to explore the characteristics of young international referees'key cognitive abilities by conducting individual and group-level analyses of their decision-making, attention and concentration skills, as well as their ability to focus and recognition.

#### **Description of the most important factors determining referee performance**

Referees play a key role in the outcome of the professional-level matches (Cruz, 1997; Dohmen&Sauermaann, 2015). During the match two teams struggle to win, when referees often have to make the right, appropriate and fair decision under great psychical and time pressure. The decisions made at these moments affect the next actions, ultimately the outcome of the game (Philippe et al., 2009). The qualities of an excellent referee require a combination of several factors. In addition to good physical condition, perfect knowledge of rules and excellent positioning they must have high level of mental qualities required to their

profession. Such psychological as the ability to control emotions and having an optimal motivational basis (Weinberg & Richardson, 1990; Mascarenhas et al., 2005; Simmons, 2011). Moreover, cognitive abilities such as decision-making, situational and perceptual abilities, and areas of attention and concentration should be mentioned. Individual differences in these characteristics are significantly influenced by gender, age and work experience (Weston et al., 2012).

Handball is a complex, dynamic sport where players interact continuously during attacks and defences although referees always have to make the best decisions in their judgements (Dubez, 2009). Other influencing factors besides players meanwhile refereeing are coaching expressions and audience noise that all referees must control (Gimeno et al., 1998; Debanne, 2014). Insufficient preparation of referees increases their level of anxiety and stress, which leads to attention and concentration problems, making them more likely to make bad decisions in these situations ((Estrada & Pérez, 2008; Debanne, 2014).

Judging requires objectivity, impartiality and consistent behaviour on the part of players, coaches and the public as well. This assumes consistent behaviour on the part of referees, which reflected in the fact that they must make the same decisions in all situations determined by similar environmental factors. According to Garnarczyk (1994), the differences in refereeing are caused by the fact that there are at least six different ideas in each situations during refereeing, each decision is driven by individual heuristics, and the intensity of the match and the actual scores influence judgement. Decision heuristics help to simplify decisions in and overloaded environment, which may work well, but although lead to wrong decisions as well (Tversky&Kahneman, 1974). These heuristics can be activated by even the colour of the players' jerseys, the aggressive manifestations of the athletes, which might activate certain behaviours constructed by the referees.

Trudel, Dionne, and Bernard (2000) conducted a research on hockey referees which confirms that after a situation is videotapes, players more likely to be penalized than before, during live play. This perception of the referees was explained by attacking rules used during the match (advantage rule for the attacking team) and the influence of the coaches and supporters. According to Nevill, Balmer and William (2002), the noise of the audience supports the home team in judgement making, and Jones, Paul and Erskine (2002) has shown that judgements against the team was assumed to be more aggressive by referees was more frequent. In addition, there are maybe discrepancies in the judgements of the female or male teams, mainly in terms of psychical characteristics, personality traits, expected behaviours related to gender roles and emotional dispositions (Deaux&Lafrance, 1998). Research has shown that referees are more likely to use gender stereotype heuristics when executing punishment when female players perform aggressive actions not typically associated with feminine behaviour (Eagly, 2007; Eagly&Karau, 2002).

Finally, it is important to emphasize that performance in team sports and thus in handball can be defined as the sum of individual performance (Wagner, Finkenzeller, Würth& von Duvillard, 2014). According to this statement, the performance of the referees managing the matches is equal to the interaction of individual abilities and skills, making well-coordinated decisions, while highly important the same quality of the two referees and their synchronicity.

### **The importance of referees' cognitive abilities**

By cognitive factors can be meant those innate and developing sensomotoric abilities that can influence the evaluation, the response of a given situation and mainly the output of the entire referee work. Cognitive abilities are generally measured by the speed of information processing, so the amount and quality of information processed per unit of time. These cognitive characteristics make a sharp distinction among referees and place them in a completely different assessment grade with the appropriate physical and technical knowledge (Tenenbaum, Basevitz& Gutierrez, 2015). In practice, it is reflected in the referees' anticipation of actions, their follow-up, and the speed of their decision-making.

The ideal referees can be explained by the following characteristics (Valdevit, 2005):

- notice everything in the match, but rarely show themselves,
- quick-witted, decisive and lacking in pride,
- tactic, prudent, kind and not too strict,
- effectively control the match,
- providing players mental and physical comfort,
- excellent physics for the sake of getting every actions in time,
- perfect knowledge of the rules of the game.

In addition, it is important to emphasize the referees' communication skills, which clarifies and facilitates controlling matches where parties (player, referee, coach) communicate to each other (Rudzitis, Gravitis&Larins, 2004). Properly chosen communication tools (eg. language, nonverbal signs) increase the referees' effectiveness. In addition, the number of years of refereeing is positively correlated with excellent referee performance, as the more experienced, routine the referee is, the greater ability to have to respond to ambiguous and uncertain situations (Arehart, 2006).

**Decision-making ability**

Decision-making ability is a basic requirement in a significant proportion of sports, especially in fast-paced team games such as handball. Decision-making is a cognitive operation in which we consider the option that is best suited to the situation, thinking over the possible alternatives in the given environment. The speed of decision-making varies. It can slowly occur when there is no environmental decision-making pressure or need, but under pressure and stress, it can accelerate (Tenenbaum and Gershgoren, 2015). Much of the environmental information needed to make decisions is captured by the visual system. Though the visual system makes it possible to absorb environmental stimuli, detect visual patterns in the field of vision, but then transmit information to long-term memory, which forms the basis for future decisions. Many factors exist that can influence decision making, including refereeing expertise, past experience, time or other type of pressures, but also environmental stimuli or the athlete's current mental state (Tenenbaum, 2003). However, becoming an expert is not easy, and according to Ericson's (2003) definition we can consider expert referees who have spent about ten years in their professional work, investing more than the thousand hours in technical and tactical training. This expertise enables the cognitive system to function effectively by making more timely choices, reducing the likelihood or error that would adversely affect performance (Tenenbaum, 2003). Thus, when referees' tasks are simple, pre-practiced, they do not need to operate decision-making mechanisms that require a great deal of intellectual effort. Since they control the output of the action in a mental plane according to the pre-practiced scheme. However, if the tasks are complex or to be performed in a changing environment, the mental and motoric activities already acquired do not fit the new situation, and a new course of has to be found to make a right decision. Therefore, the decision-making processes that focus on solving the situation become active, thus the emphasis is on thinking, memory and imagination (Füleki, 2012). The effectiveness of the solution depends to a great extent on the difficulty of the task as well as on individual abilities (Cendrowski & Swebosci, 1976).

The ability to make decisions depends primarily on visual and spatial attention strategies, flexible attention shifting, attention selection, shape recognition, anticipation and the ability of athletes to assign appropriate probabilities to successive events (Tenenbaum, 2004). These decision heuristics are regularly used by referees during matches. Referees are often taken under pressure, either at stake or in the presence of the audience, the opponent or coach, which interferes with mental representations, in the thinking process, perception and cognition.

This is especially true when the environment is emotionally stressful. Thus, the perceptual cognitive system is not functioning properly, referees are more likely to make incorrect decisions. Developing effective coping strategies for stress appears to be a key factor in the effective outcome of athlete decisions (Tenenbaum & Gershgoren, 2015). Earlier research has focused on referees' decision-making ability through natural observation and polar coordinate analysis, providing informative and reliable data on referee achievement (Araujo, 2013; Pinderet al., 2011).

**Attention and concentration**

Referees are confronted with selection problems with important information at any given moment. How do they select certain information for further processing while other information is ignored? Attention help to choose relevant information from the environment that is consistent with the inner feelings (Moran, 2015). Attention is part of the human cognitive process, which helps to reflect reality in different ways. Attention is not a separate cognitive process and does not exist as an independent psychic phenomenon, but it is an essential part of the cognitive process as it is related to all sensory and mental functions and thus has a significant impact on the development of perception and emotions (Dilworth, 2008).

**Situation awareness**

Also in dynamically changing, open-mobility sports such as handball, a referee needs to have an excellent level of insight to respond to situations with the best reaction speed, which in most cases is the perfect decision. The performance of handball referees is very difficult to evaluate objectively, but could be attributed with fewer errors and misjudgements. However, it can be assumed that the ability of position recognition, which helps in situational awareness by recalling key features in the configurations present in a given situation, and enabling the filtering of relevant information in a multi-stimulus environment (Gorman, 2015).

**Aims of the recent research**

The aims of our research is to examine the specific sports-related skills of handball referees, to explore the relationship between competencies, to learn their cognitive abilities, and to focus on decision-making, situational-awareness and concentration. We applied Vienna Test System for examining referees, providing a possibility for an objective evaluation of athletes' competences and a novel exploration of psychological factors. The aim of the study is also to open up a new way of objectively measuring cognitive abilities by analysing the performance of referees individually and then according to the position of peers. The above mentioned Vienna Test System was previously used by Fózser-Selmeci et al. (2016) in examining the psychological skills required for football academics. Csáki et al. (2013, 2016) also applied it to football players and Patócs et al. (2016) investigated reactive stress tolerance of fencers and Kiss et al. (2018) explored the cognitive abilities of handball

players with it. However, these measurements have not been applied on referees so far, so our research can enrich the exploration of factors influencing the holistic approach to handball.

## Method

### The sample

The sample consisted of 28 young referees nominated by EHF, representing 20 male and 8 female participants. The average age was 22.8, with 18 being the youngest, 31 years the oldest referee, with 2.8 standard deviation. All of them belong to the top referees of their nation, they regularly attend on professional trainings and scientific forums. The sample included Hungarian, Norwegian, Polish, Romanian and Serbian referees.

### Data collection

The three subtests selected within the Vienna Test System (VTS) were completed by handball referees in the laboratory in the Institute of Psychology at University of Debrecen. The research was conducted in a quiet and confined room where the referees were able to concentrate on their tasks. The capacity of the room can accommodate 5 subjects at a time, where referees spent approximately half an hour. Thus, the test was taken in stages, grouped throughout the day.

Before testing, the study leader gave a verbal instruction of the course of testing, and instrumental measurement began by signing the appropriate ethical permits. The tests of Vienna Test System were completed in Hungarian. In the first part of the measurement the referees were given brief instructions, followed by the practice phase of the tests, and then the real measurement began, thus ensuring the standard conditions were guaranteed. Selected tests were supported by input tools, such as response bench and pedal, which helped the measurement of decision-making, attention and concentration, and to explore areas of recognition. The test leader was present throughout the tests, and if any subject had problems helping clarify the instruction or restart the test, or put an extra required break.

### Applied tests

The Vienna Test System (VTS) is an objective test instrument consisting of computer-controlled interactive tests that can analyse constructs that are important to athletes from various aspects of sport psychology. VTS as an Austrian developed test system and has the great advantage of being able to reveal athletes' characteristics, traits, cognitive and psycho-motor functions as valid, reliable test procedure (Schuhfried, 2013). The tests for handball referees were based on pilot studies where the coaches, players and referees were asked about the key factors of the successful refereeing activity. The above mentioned interviews were summarized and by using content analysis method, we selected those three tests that could be the most relevant for measuring these competencies. In addition, the time limit for the survey and the measurement of the psychological areas determined by the Referee Subcommittee of the Hungarian Handball Association were also taken into consideration during the selection of the tests. The interview questions focused on the following expectations: key psychological factors for success, differences between successful and unsuccessful referees and the factors playing role in the outcome of a winning match. Based on 6 interviews we conducted, the following measurable criteria were formulated: attention at the last minute of the match, choosing the right decisions under high pressure and excellent positioning. Therefore, from the VTS package the following tests were selected: DT (Determination Test), COG (Concentration and Attention Test), LVT (Position Recognition Test). The study was computer-assisted, with the test completion time of 30 minutes, while the subjects could request a break at any time.

#### *DT (Determination Test)*

The test examines attentional ability, reactive stress tolerance, and responsiveness between constantly and rapidly changing acoustic and visual stimuli. The subjects had to respond to incoming stimuli with 5 coloured buttons on the response pad, 2 high and low volume sensitive buttons and 2 pedals. The task of the subject was to respond to incoming stimuli as fast as possible by selecting the appropriate buttons and pedal. The test task itself seems simple, the difficulty of the task is due to the variety of incoming stimuli and their speed. Thus, the subjects' cognitive abilities needed to distinguish between colours and sounds, to recognize the characteristics of stimuli, to memorize them, and to select the appropriate response. The stimuli received during the test are unpredictable and must be responded randomly (Schuhfried, 2013). We examined four key variables: mean value of response rate (DT4, sec), number of correct answers (DT1, raw score), which refers to the ability of the subject how accurately and quickly select the correct answer under pressure. In addition, we examined the number of incorrect answers (DT2, raw score), to determine how the subject is prone to confusion under stress and high pressure, and finally the number of missed answers (DT3, raw score) highlights the inability of the subjects maintain their attention during stress and tend to give up situations (Neuwirth&Benesch, 2012). Finally, two other variables were used to test impulsivity reflexivity: the amount of processing of incoming stimuli (DT5) and the number of responses to them (DT6). The internal consistency value (Cronbach alpha) is between 0.98 and 0.99. test reliability was also convergent, supported by previous studies in psychology of transport (Karner&Neuwirth, 2000), but the studies of Ong (2015) conducting on athletes and non-athletes has shown that the test can be considered as a reliable and valid measurement tool.

*COG (Cognitore test)*

The test is based on Reulecke's (1991) theoretical model. In his view, the ability to concentrate can be interpreted through three variables: the energy required to perform a task, the function associated with controlling the varying concentration according to the task, and the precision associated with the success of the output. The variables we examined were the number of correct answers (COG3, raw score), the number of incorrect answers (COG4), and the response time (sec).

The subjects completed the S8 test form, which involves comparing a geometric figure with another four within a fixed working time to see if it matches the reference shape. The test reliability (Cronbach alpha) is 0.98. The test filling time is 7 minutes (Schuhfried, 2013).

*LVT (Visual Pursuit Test)*

The test examines subjects' visual orientation performance in a complex environment by detecting simple elements. Subjects should focus attention on filtering out disturbing stimuli and selecting the appropriate one within time limits. The test is also suitable for selective visual attention. In the test, we examined a main variable: Essential Vision (LVT1) which is a raw score based on observation time and the number of correct answers. The subjects filled in the S1 form, where the task was to find the end of the line correctly in the shortest possible time. The reliability of the test (Cronbach alpha) is 0.96. The test filling time is 18 minutes (Schuhfried, 2013).

**Method**

The presentation of the results is divided into three parts. In the first part, we use the descriptive statistics method to reveal the minimum, maximum, average, age distribution and standard deviation. and the descriptive statistics of the 11 measured variables. In the second part, we present a histogram of each referee's score on the 11 test variables in peer rankings, where we also highlight a possible cumulative ranking in the test results. Finally, in the third part, a cluster analysis is used to classify the measured variables.

**Results***1. Description of the sample and the measured variables*

The international referees had an average age of 22.8 with a standard deviation of 2.8, the youngest subject was 18 years old, and the oldest was 31 years old. The sample included 20 men and 8 women.

Table 1 Descriptive statistics of the measured variables

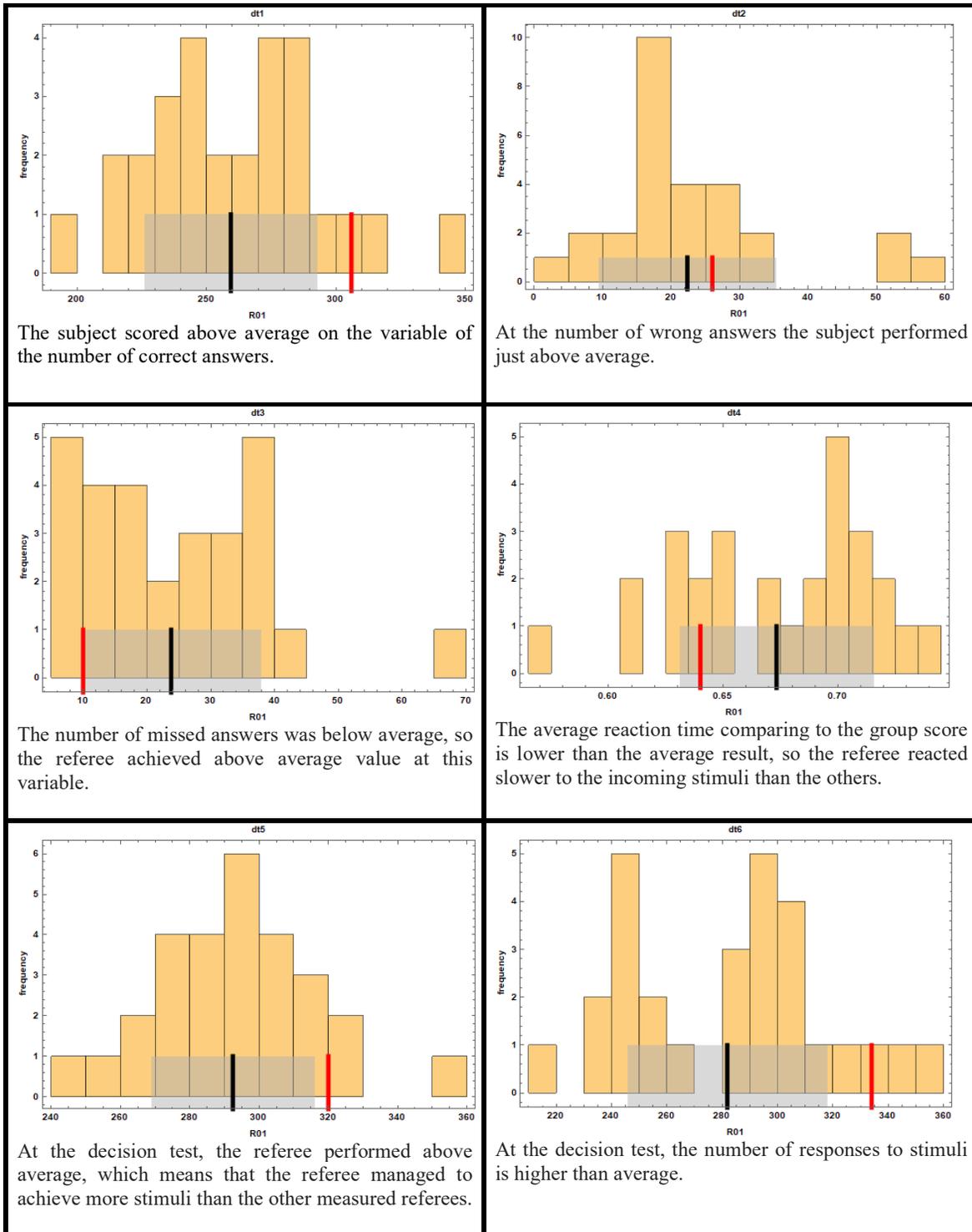
	N	Minimum	Maximum	Mean	Std. Deviation	Population percentile
DT1	28	191.00	343.00	259.3929	33.42691	68,3
DT2	28	3.00	56.00	22.3571	12.95638	23,7
DT3	28	6.00	65.00	23.7857	14.12997	25,4
DT4	28	.57	.74	.6732	.04234	-
DT5	28	245.00	352.00	292.4286	23.55990	-
DT6	28	213.00	350.00	281.8214	36.08945	-
COG1	28	358.00	771.00	524.3214	92.15127	81,5
COG2	28	.18	8.81	3.1864	2.03414	38,4
COG3	28	351.00	738.00	507.1786	86.95212	78,3
COG4	28	1.00	57.00	17.1429	12.45649	34,1
LVT	28	17.00	40.00	36.9286	4.42994	75,2

Table 1 shows the cumulative average score of the referees for each measured variable, with standard deviation, minimum and maximum values. The last column shows the average percentile value of population of the 8 variables, and the value that they achieved comparing to the population.

As a result, the DT1 variable, which shows the number of correct answers in the decision test, is better than 68.3 percent of the international referees. The table also shows that the referees sample underperformed the population on average, suggesting that under high pressure their performance is deteriorating and that they make mistakes several times. based on the high score on the COG1 variable, it can be concluded that the measured referees have excellent concentration ability and accuracy.

The lower value of the attention, concentration test along the GOG2 variable also indicates that a strain-stressed situation can degree referee performance. last, but not least, the referees' score above the visual perception and essence test indicates that they are able to see through complex situations and to choose adequate reactions to the situation.

Figure 1 Profile of a selected referee (R01) using histograms



The subject scored above average on the variable of the number of correct answers.

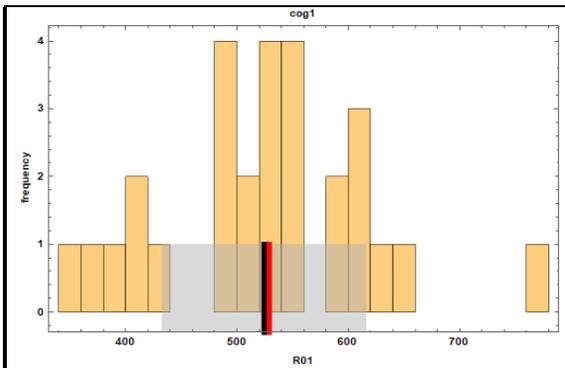
At the number of wrong answers the subject performed just above average.

The number of missed answers was below average, so the referee achieved above average value at this variable.

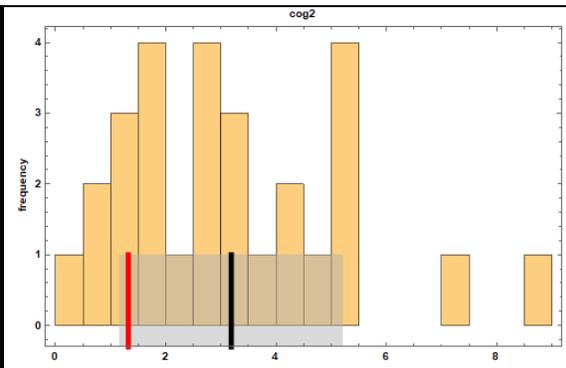
The average reaction time comparing to the group score is lower than the average result, so the referee reacted slower to the incoming stimuli than the others.

At the decision test, the referee performed above average, which means that the referee managed to achieve more stimuli than the other measured referees.

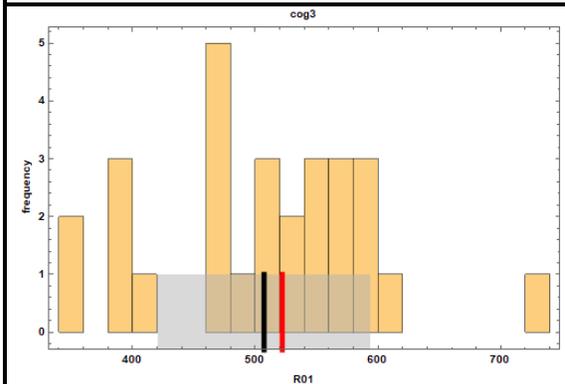
At the decision test, the number of responses to stimuli is higher than average.



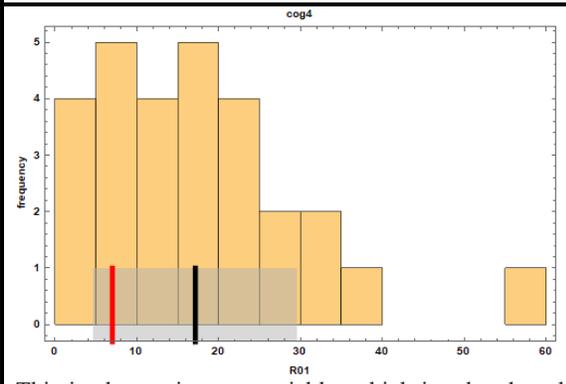
At the attention and concentration test, the referee achieved average performance at the sum of correct and incorrect responses.



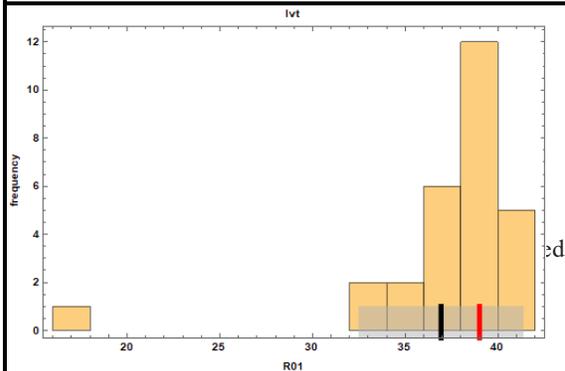
The percentage of incorrect answers was lower than the average for the referee, which result is an inverse score, so means above average performance.



On the attention and concentration test, the number of correct answers was slightly better than average, so the referee showed more correct responses than the others.



This is also an inverse variable, which is related to the number of incorrect answers at the attention and concentration test, so the subject scores lower than others, which means better performance.



The results of the referee presented in Figure 1, show that the subject achieved at least an average value for the most measured variables compared to the others. In practice, this means being able to make the right decisions at the right time, event when the subject is in a stressful situation. The subject's excellent response time and information processing speed must be emphasised, which represents in a high number (320) of processed stimuli and in an outstanding response rate (334). The subject (marked R01) makes mistakes, maybe bad decision as well, but the number within the acceptable range. the results of the Attention and Concentration test are also better than the others', which is demonstrated by the ability to process large information, while being able to pay attention to detail, thus performing above average on the test. The subject's performance does not deteriorate with increasing pressure and the reaction time is outstanding as well. The position recognition test

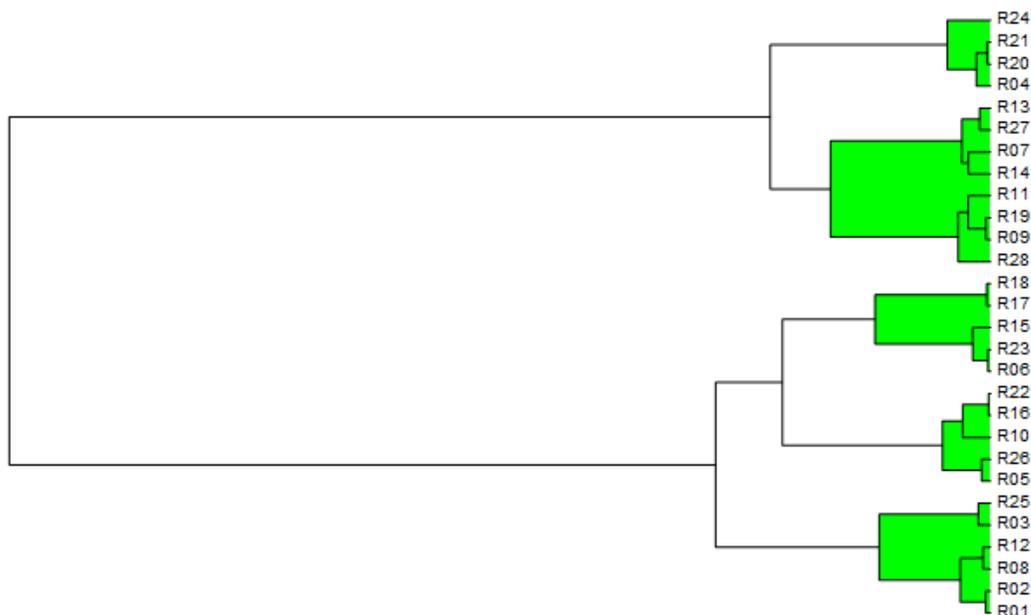
scores also show above-average scores, meaning that these are able to filter out of the multitude of information from the environment that are relevant to a given situation.

Table 2 Ranking by referees' total scores

Ranking	Codes of referees
1	R08
2	R12
3	R25
4	R01
5	R16
6	R03
7	R18
8	R06
9	R02
10	R05
11	R23
12	R26
13	R11
14	R22
15	R10
16	R20
17	R04
18	R09
19	R27
20	R15
21	R14
22	R21
23	R13
24	R17
25	R19
26	R28
27	R07
28	R24

Table 2 shows the cumulative ranking of the scores of the referees on each measured variables, which differentiates the subjects according to their abilities. The ranking is based on the relative number of raw scores. This means that the referee coded R08 has achieved an outstanding score in all variables, placing this referee first in the overall ranking.

Figure 2 Cluster Analysis of Referees



According to Table 2, the cluster analysis aims at a better understanding of referees' individual differences based on their performance. In clustering, we highlighted four key variables that formed the basis of evaluation:

- Number of correct answers on decision test (DT),
- Average reaction time on decision test (DT),
- Number of correct answers on attention and concentration test (COG),
- Total score on position recognition test (LVT).

The Figure 2 shows the relationship between the level of variables' scores of the referees according to their similarity or difference. Two types of subjects' groups can be distinguished, the class of the excellent and the referees with weaker abilities. Accordingly, the referees signed R24, R21, R20, R04, R13, R27, R07, R14, R11, R19, R09, R28 belong to the first, better-performing group, while R18, R17, R15, R23, R06, R22, R16, R10, R26, R10, R28, R05, R25, R03, R12, R08, R02, R01 are assigned to the second, poorer performing group. As highlighted in green in the Figure 2, it can be seen that further smaller groups can be distinguished, further narrowing their similarities. Thus, the following 5 groups were added to the new cluster:

1. R24, R21, R20, R04: They have lower levels of judgement and acceptable concentration ability, they are referees who have lower level of cognitive skills, usually cannot focus properly and often make bad decisions, especially in a stressful situation.
2. R13, R27, R07, R14, R11, R19, R09, R28: They are good at all competencies measured, but they are not always able to deliver this excellent performance, which may be due to lack of motivation, or also to other external environmental pressures. Referees in this group, with appropriate training and development, can perform perfectly during the games, but they must be motivated enough to develop the best their skills.
3. R18, R17, R15, R23, R06: Group of average performers with in measured variables. These average performance referees can always judge at least on a good level, but they do not perform on a peak-performance. This group characteristic can be also very positive, as far as they can provide a balanced and good performance. They typically belong to that category that is generally not affected by positive or negative opinions after the matches.
4. R22, R16, R10, R26, R10, R28, R05: They can be described as a group of impulsive people who have excellent reaction speeds but often are not efficient enough and the stress they exert can significantly affect their performance into negative.
5. R25, R03, R12, R08, R02, R01: They are the referees who excel at all the measured test variables, have excellent cognitive abilities, are able to understand the full range of stimulus situations and make the best decisions, even in stress-filled situations.

### Discussion and conclusion

The profile show non histogram is intended to illustrate a possible interpretation of recent study. The selected referee is in the average in most of the measured variables. The histogram illustrates the referees' cumulative performance in 11 variables and shows (black line) the mean as well as the individual (red line) results achieved. This gives the opportunity to analyse, evaluate and compare the differences within the referee group. It is important not to draw far-reaching conclusions about a young referee's performance in a certain variable, but to interpret them in context. Therefore, if a subject has received excellent scores on the attention concentration test, then it cannot be expected that the subject achieve outstanding scores in the other measured variables. However, it is also possible to disclose for example that a high number of reactions to decision-making can determine a person towards an impulsive behaviour.

The next part of the study will show you how and by what characteristics referees can be grouped. For this we used the cluster analysis method, which spectacularly divides the referees into 5 smaller groups based on the presented characteristics. Grouping is useful because it is well-described, characterized by general attributes, or possible predictable by the ability of some referees.

In the Table 1 ("Descriptive statistics of the measured variables") we present the minimum, maximum, average and standard deviation results for the measured variables, as well as the percentiles of the associated standards of the population except for DT4, DT5 and DT6. The percentile values of the referee group can be compared with the Austrian population sample according to the Vienna Test System. The results in the population are compared by age, gender and education. Based on the values associated with the measured variables, the referees achieved outstanding results in DT1 (decision-making, number of correct answers), COG1 (attention and concentration test, total number of correct and incorrect answers), COG3 (attention and concentration test, total number of correct answers), and in LVT1 (position recognition test, cumulative correct and incorrect answers) components.

These results show that the measured international referees have outstanding skills in decision making, attention, concentration and situational awareness as well as making adequate decisions in a baseline situation. Furthermore, they are aware of the right solution for complex situations. However, the number of incorrect answers in both the decision-making and the attention-concentration tests is quite high, indicating that when the

pressure increases, they tend to make mistakes and degrade their otherwise excellent abilities. This may be due to a loss of motivation or a loss of coordination resulting from the situation (Bakacsi et al., 1999). Losses in motivation can be manifested, for example, in reduced attention and concentration skills, in the amount of many mistakes and in correct decisions. Reducing motivational loss is a possible way to develop a performance benchmarking system that can test the added value of individual effort in team performance, whether it is with the referee or even with the larger organisational units that coordinate them. Coordination losses may result from unmatched actions by the referee, the operation of inadequate communication channels, which may be directed to each other but to the referee or the players. these losses can be reduced by increasing the frequency of alignment, common activities (team building), and more open, direct communication, all of which can be more routine through practice. bad habits can be eliminated through error corrections and positive reinforcements. It should be also being noted that large

It should also be noted that that huge differences in performance can be noticed within the measured referees' sample. This means that there is a big gap between referees with high and lower level of skills. On one hand a referees' group exist scoring all measured variables very high, so they can be considered outstanding in their measured psychological competencies. On the other hand, there is another referee's group performing rather low level on variables. The difference between the two referees' sample could be decreased by training referees in pairs, facilitating them by thinking together, consulting in professional teams, discussing critical and ambivalent situations on handball field and analysing their solutions. Finally, an interesting or even expected result should be presented, that the performance of the referees' pairs converges to each other, thus showing a very similar pattern when compared.

### Summary

The recent research was conducted in honour of a request made by the Hungarian Handball Association toward the University of Debrecen. According to the request, we measured the psychological qualities of the top referees. During the measurements, it was obvious that we included individual subtest of the Vienna test System, which provides objective, reliable results. The test selected focused on the key competencies, involving decision-making, attention and concentration, and situational awareness. In this study we first presented the exploration of the psychological competencies relevant to referees' performance in the literature review, with particular reference to international research. Next, we overviewed the theoretical background of cognitive abilities and the applied subtests of Vienna Test System. Based on the results of the research, it can be said the results of characterising the referees' psychological profile can be considered highly relevant. However, it should be mentioned that there were some referees with lower achievement which was may due to the stressed situation, but these abilities could be relatively well developed by using special sport-psychological methods and trainings. Though, some psychological competences revealed by the examination may require additional measurements, either by supplementing other research method (interview, protocol or video analysis) or by applying other tests of the Vienna Test System. Such areas could be the achievement motivation test for inferred levels of motivation, or even risk-taking or monotony tolerance of the referees.

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