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EXAMINATION OF THE FINGER TAPPING TEST AND MENTAL ROTATION ACHIEVEMENT LEVEL OF THE ORIENTEERING ATHLETES

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Abstract:
The purpose of this study is to assess the cognitive skills and the audio visual perceptions of orienteering athletes and to research the relationship between these two. 17 male athletes, who have been playing orienteering sport for at least 2 years, whose average age is 16.3 ± 1.6 years, participated voluntarily in our study. Reaction time test, mental rotation tests were implemented to the participants on successive days, during the same time zone, and in a quiet environment favorable for testing. The "Finger Tapping Test" (FTT), in which the speed of consecutive motor movements was evaluated was implemented via a computer program and the athletes were asked to press the specified key consecutively for 20 seconds. The obtained data was recorded. In conclusion, it was determined that the random-interval audio visual reaction times are longer than the Fix-interval audio visual reaction times. It was concluded that each question was answered in 8.7 seconds on average during the mental rotation test implemented in the study; whereas it was discovered that the correct answer average was 9.8 in the MR test, which consists of 16 questions. When the answers given by the athletes to the test questions were examined, it was determined that 4 athletes, who answered each question approximately in 3 seconds and completed the test in under 1 minute, are not successful in terms of accuracy and duration. These results indicate that the mental rotation performances of the orienteering athletes are not at a good level.

Keywords: cognitive skill, audio visual perception, orienteering, reaction time

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1. Introduction

Orienteering is a sport that requires matching of map reading skills with actual location and reaching the specified targets as soon as possible. This concept, which is used as Orienteering in English and Orienteering in Sweden, is the name of a sport that aims to find checkpoints, marked on a special topographic map, using a map and a compass, and requires mental attention, effort and motivation. The athlete is supposed to complete the map, which he/she starts reading at the beginning of the competition, making the right decisions despite his/her exhaustion and without getting distracted until the end. In order to follow the route on the map properly, he/she must react quickly to the visual stimuli. In this context, the situation of the orienteering athlete is constant action-reaction to visual stimuli and he/she needs to keep the visual reaction level at its best. Therefore, the orienteering athlete is expected to have a good reaction time (Akcan, 2016). Because the reaction is the ability to react quickly, instantly and consciously to various situations that cannot be predicted. The "reaction time" defined as the time elapsed between the beginning of the stimulus and the beginning of the reaction is one of the determinants of athletic performance and is closely related to the quick decision ability of the athlete, who is under the pressure of field, time and competitor (Achtman, 2008; Jansen, 2013).

Besides this skill required from the orienteering athlete, it is thought that the visio-spatial ability should also be at a good level. Visio-spatial ability is defined as cognitive representation, which has recently been examined in sport science and at the same time, it is one of the dimensions of cognitive representation, which combines the static and the dynamic properties of a previously observed object simultaneously. Besides, reaction time is most important factor in exercise performance and daily life quality (Pancar et al., 2016; Özaslan et al., 2017). Because it includes the the abilities of envisioning the 3-dimensional space coordinates, relocations and the dynamic properties of inter-objects relations of the symbolic knowledge. Thus, it is an ability that enables the individual to visualize the 3 dimensional motion of an object in detail, which was previously observed. This skill, which has a developable character, is important in terms of spatial positioning, cognitive reasoning, which requires goal-directed activity, and problem solving. It is possible to quantitatively evaluate this ability with various tests, known as visuospatial tests. The mental rotation (MR) test is the best known and the best defined test among these tests. This parameter, which is the concrete expression of the cognitive ability to manage, guide and process the visual information on the individual's memory, is widely used in the evaluation of the visuospatial skills. MR skill is also assessed as a skill that increases the speed of success and reaching a solution, in terms of spatial positioning and cognitive navigation, which requires spatial reasoning. The orienteering athlete starts the race with the visual signs on the map and follows the route until the end, reconciling these signs with the objects on the route, which he/she envisions as 3-dimensional. Karaca (2008), Ateş (2007) and Tamer (2000) defined orienteering as a method of learning through experience, with

which one learns analytical thinking, 3-dimensional perception, creating a solution to the problems and pushing their own limits.

The purpose of this study is to assess the cognitive skills and the audiovisual perceptions of orienteering athletes and to research the relationship between these two.

2. Material and method

2.1 Participants

17 male athletes, who have been playing orienteering sport for at least 2 years, whose average age is 16.3 ± 1.6 years, participated voluntarily in our study.

2.2 Method

Reaction time test, mental rotation tests were implemented to the participants on successive days, during the same time zone, and in a quiet environment favorable for testing. Before the test, brief information was given about the implementation of the test to each participant, and then a short trial was made. The study was carried out based solely on voluntariness and no incentive or prize was given to the participants.

The "Finger Tapping Test" (FTT), in which the speed of consecutive motor movements was evaluated, was implemented via a computer program and the athletes were asked to press the specified key consecutively for 20 seconds. The obtained data was recorded.

Visual and auditory, Fix (simple reaction time) and Random-Interval (selective reaction time) reaction times were evaluated with the MP36 Biopac System (USA) and Computer Program. Participants were seated in a position where they could not see the computer monitor. The test vehicle's calibration was tested and made ready for implementation. Participants were asked to respond to 10 stimuli sent at equal intervals (fix interval) by the computer and then to the same number of stimuli with different intervals (random), as soon as possible, pressing the button in their hands. All the replies participants gave by pressing the button or not pressing the button were recorded by the computer in terms of milliseconds. Participants were asked to respond to the auditory and the visual stimuli sent by the computer using their dominant hands.

In the computer-based MR test, the image files of the library "Mental Rotation Stimulus Library ©" were used with the written permission of the author. These images, with validity and reliability, were created by adding 10 pieces of cube tip to tip. The pictures consist of 2-dimensional images of cubes, rotated at certain angles in a 3-dimensional space. In the computer environment, 5-minute period was defined for the completion of the test, and participants were asked to complete the test as soon as they can. Each question contains 4 images selected from the library (Figure 1). The first image is the "reference" image. Only one of the other 3 images is the same as the object in the "reference" image, with the only difference of being rotated in 3-dimensional space. In the half of the questions, "x-axis" was chosen as an axis of rotation in space,

and in the other half "z-axis" was chosen. For both groups of axes, the "angle of rotation" was selected as a 30° increase between 0-180°.

The participant was asked to find out which of the three images other than the reference image was the same as the "reference" image as soon as possible. The "response time" of the questions was determined in millisecond (ms) resolution with the "true", "false" and "error" record and stored on the computer for later analysis (Moreau, et al., 2011).

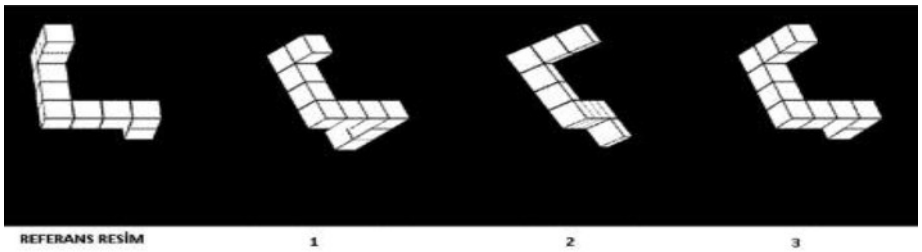

Figure 1: A set of questions prepared with images selected from the library "Mental Rotation Stimuli Library ©" prepared by Peters and Battista. Participants are asked to find out which of the three images on the right with the numbers 1, 2 and 3 is the same as the object shown in the reference image on the left

Statistical evaluations were performed in the SPSS "20.00" package program. Results are given as average ± standard deviation and minimum-maximum values. Comparisons of intra-group dependent variables, were made with paired t test for those which show normal distribution, and with Wilcoxon rank sum tests for those which does not show normal distribution. The Spearman test was implemented for the connections between the tests. $p<0.05$ was accepted as the significance level.

3. Results

Findings obtained in the research are presented in tabular form.

Table 1: Auditory visual Fix Random Reaction Times of the participants and the arithmetic average values of Finger Tapping Test

Participants	Auditory Reaction Time (m / sec)		Visual Reaction Time (m / sec)		Finger Tapping Test (minutes / number of strokes)	
	Fix	Random	Fix	Random	Right	Left
1	0.204	0.235	226.8	274.3	116	93
2	0.200	0.214	211.5	261.6	139	132
3	0.192	0.224	261.3	267.8	118	115
4	0.160	0.217	241.8	253.7	135	129
5	0.172	0.210	255.7	311.1	121	123
6	0.170	0.247	259.2	297.8	103	92
7	0.163	0.239	224.5	273.1	124	110
8	0.188	0.270	210.7	270.0	113	99
9	0.139	0.183	192.1	231.3	159	145

10	0.196	0.214	266.4	266.9	161	146
11	0.141	0.188	200.3	252.9	127	110
12	0.161	0.202	229.3	273.4	157	124
13	0.165	0.180	207.9	247.1	123	118
14	0.160	0.205	240.4	270.4	127	110
15	0.135	0.200	222.0	244.9	154	135
16	0.178	0.207	258.4	272.6	119	103
17	0.204	0.259	197.2	278.2	121	111
Avg.	**0.172**	**0.217**	**229.7**	**267.5**	**130.4**	**117.4**
ss	**0.022**	**0.026**	**24.5**	**19.0**	**17.6**	**16.4**
Min	**0.135**	**0.180**	**192.1**	**231.3**	**103.0**	**92.0**
Max	**0.204**	**0.270**	**266.4**	**311.1**	**161.0**	**146.0**

Participants' dominant hand fix reaction time arithmetic average value was determined as 172 (m / sec), while the random reaction time as 217 (m / sec), the visual reaction time as 229.7 (m / sec), 267.5 (m / sec) respectively and finger tapping test result was determined as 130.4 for the right hand and 117.4 (minutes / strokes) for the left hand.

Table 2: Arithmetic average values of participants' Mental Rotation levels

Participants	True	False	Fault	T T	A T	T T	A T
1	7	9	0	53721.7	3357.6	53.7	3.4
2	11	4	1	148855.5	9303.5	148.9	9.3
3	6	10	0	55634.4	3477.1	55.6	3.5
4	12	4	0	153429.2	9589.3	153.4	9.6
5	9	7	0	139582.3	8723.9	139.6	8.7
6	12	4	0	204858.5	12803.7	204.9	12.8
7	14	2	0	183972.5	11498.3	184.0	11.5
8	9	6	1	97257.8	6078.6	97.3	6.1
9	14	1	0	252034.0	16802.3	252.0	16.8
10	6	10	0	97464.1	6091.5	97.5	6.1
11	9	7	0	207508.2	12969.3	207.5	13.0
12	7	9	0	141039.7	8815.0	141.0	8.8
13	11	5	0	58801.5	3675.1	58.8	3.7
14	6	10	0	59807.3	3738.0	59.8	3.7
15	11	5	0	219788.4	13736.8	219.8	13.7
16	9	7	0	207218.0	12951.1	207.2	13.0
17	13	3	0	77241.1	4827.6	77.2	4.8
Avg.	**9.8**	**6.1**				**138.7**	**8.7**
ss	**2.8**	**2.9**				**65.9**	**4.2**
Min	**6.0**	**1.0**				**53.7**	**3.4**
Max	**14.0**	**10.0**				**252.0**	**16.8**

In Table 2, when the MT arithmetic average value of the participants was examined, it was found that the average of the sum of the response time was 138.7 sec.; while the average response time of each question was 8.7 sec.; the average correct answer was 9.8 and the average false answer was 6.1in the MR test, which includes 16 questions.

4. Discussion and Conclusion

Audio and visual reaction time test was implemented to measure how fast orienteering athletes perceive the information coming from the environment; mental rotation test was implemented to measure cognitive functions; finger tapping test was implemented to measure the motor output. Orienteering athlete is expected to achieve high level ability to envision 3-dimensional space coordinates, relocations and the inter-objects relations of the symbolic information. Hence, the implemented mental rotation test requires the athlete concentrate, to be careful and to be able to give fast and correct decisions. It was concluded that each question was answered in 8.7 seconds on average during the mental rotation test implemented in the study; whereas it was discovered that the correct answer average was 9.8' in the MR test, which consists of 16 questions. When the answers given by the athletes to the test questions were examined, it was determined that 4 athletes, who answered each question approximately in 3 seconds and completed the test in under 1 minute, are not successful in terms of accuracy and duration. These results indicate that the mental rotation performances of the orienteering athletes are not at a good level.

Schmidt et al., (2016) showed in their research that gymnasts and orienteers displayed better mental rotation performance than non-athletes, people actively doing sports out performed non-athletes; orienteers and gymnasts out performed non-athletes; on contrary to expectations, gymnasts did not differ from orienteers. The mental rotation performances of both group athletes were determined to be higher when compared with the orienteers in our study. Moreau et al., (2011) stated that to-date only two cross- sectional studies have compared two sports groups with different mental rotation demands with each other and revealed that elite combat athletes display better mental rotation performance than elite runners or Jansen and Lehmann (2013) showed in their study that soccer players did not differ from gymnasts.

The results of the study by Kızıltan et al., (2015) on the relation between visual-spatial skills and academic achievement show that the average values were higher than the orienteering athletes in terms of mental rotation response time and accuracy rates obtained. It is stated that the students with high mental rotation performance, also have high test success and the abilities of thinking and processing in three dimensions is also positively affected. In this context, the fact that the athletes gave the maximum number of wrong answers supports the view that they performed the tests without concentrating.

In addition to this, it has been stated that the athletes who practice regularly in terms of the audio visual reaction times, experience a positive change, regarding the eye-hand coordination development (Griffith et al, 1983); increase in the processing time of the environment (Green and Bavelier, 2006), development of mental rotation abilities (Sims and Mayer, 2002); attention ability, divided in stronger ratios (Subrahmanyam and Greenfield, 1994); faster reaction time (Castel, 2005) and cognitive and motoric characteristics (Achtman, Green and Bavelier (2008). In the study, though,

it was determined that the random-interval audio visual reaction times are longer than the Fix-interval audio visual reaction times. In a similar way, visual reaction time is longer than the auditory reaction time. Participants, who have faster fix- interval auditory reaction times, complete the MR test in a longer time.

It has been observed that the participants, whose audio visual random-interval reaction times are fast, also have higher number of consecutive motor movements. The study reveals that those who have fast fix interval audio visual reaction time, completed the mental rotation test in the longest duration and achieve higher number of correct answers. These athletes are thought to be able to concentrate better on both tests with regular and effective exercise.

The finger tapping test is a different motoric test that gives information about upper extremity motor skills and is implemented for 20 seconds. In this test, the level of fatigue also causes changes to the performance. The result that the participants who had fast visual/auditory random interval reaction time in the study, had pointedly more finger tapping counts, shows that the motoric component also contributes to time in the response to the unforeseen warning.

As a result, the relationship between audio visual perception and motor and mental functions, planned based on the perception is interesting. The answers given by the orienteering athletes to different tests were examined and the result is also interesting: The mental rotation skills of the orienteering athletes, are related to the auditory reaction time. It is suggested that orienteering athletes should do exercises that will develop the mental rotation values (time and correct action) which enable them to follow the route, correlating the signs with the objects on the route until the end of the race.

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