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ASSESSMENT AND COMPARISON OF VISUAL SKILLS AMONG ATHLETES

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ABSTRACT

Vision is a warning that directs muscles of the body to respond and gives information about where and when to move. Visual reaction time amongst athletes is mainly concerned with how fast an athlete reacts to a visual stimulus. However, little information is available on reaction time (RT), hand-eye coordination among athletes from different sport branches. In many sports branches; RT and hand-eye coordination is regarded as a prerequisite for success. For this reason, the aim of the current study was to investigate RT differences for eye-hand coordination of athletes from different sports and sedentary people. Study involved 48 athletes, aged 18-25 from different branches [basketball (n=6), arm wrestling (n=4), boxing (n=6), football (n=13), handball (n=4), rugby (n=8), volleyball (n=7)] and 9 sedentary people. Hand-eye coordination tests were conducted by using reaction development and training system FitLight Trainer™ (Fitlight Sports Corp., Canada). Test protocol consisted of 10 series of simple motor reaction task to visual stimuli; each of the 10 series included 22 reactions. Variables not fitting normal distribution were compared by Kruskal Wallis H test. Mean reaction time (MRT) was found to be different among branches (p=0.009). RT for 10 different trials were found to be different for 3rd(p=0.038), 4th(p=0.047), 5th(p=0.022), 6th(p=0.044), 7th(p=0.041), 8th(p=0.011), 9th(p=0.019), 10th(p=0.023) trials. According to results, it can be said that visual reaction times of field players are very specific and insufficient to distinguish. During trainings, it may be advisable to have reaction time development exercises with specific technical/tactical skills related to branches and positions.

Keywords: Fitlight, Motor performance, Visual reaction time

SPORCULARDA GÖRSEL BECERİLERİN DEĞERLENDİRİLMESİ VE KARŞILAŞTIRILMASI

ÖZET

Görüş; vücudun kaslarını yanıtlamaya yönlendiren, nereye ve ne zaman hareket edileceğine dair bilgi veren bir uyarıdır. Sporcular arasındaki görsel reaksiyon süresi, bir sporcunun görsel uyarana ne kadar hızlı tepki verdiği ile ilgilidir. Ancak, farklı branştan sporcuların reaksiyon zamanı (RT) ve el-göz koordinasyonu ile ilgili bilgiler sınırlıdır. Birçok spor branşında RT ve el-göz koordinasyonu başarı için ön koşul olarak kabul edilmektedir. Bu sebeple çalışmanın amacı, farklı branştan sporcular ve sedanterler arasındaki RT farklılıklarının araştırılması olarak belirlenmiştir. Çalışmaya farklı branşlardan [basketbol (n=6), bilek güreşi (n=4), boks (n=6), futbol (n=13), hentbol (n=4), rugbi (n=8), voleybol (n=7)] 18-25 yaş arası 48 sporcu ve 9 sedanter katılmıştır. El-göz koordinasyon testleri reaksiyon geliştirme ve antrenman sistemi FitLight Trainer™ (Fitlight Sports Corp., Kanada) ile ölçülmüştür. Test protokolü görsel uyarana karşı motor reaksiyon görevi içeren 10 seriden oluşmuş ve her seri 22 reaksiyon içermiştir. Normal dağılıma uygunluk göstermeyen veriler Kruskal Wallis H testi ile karşılaştırılmıştır. Ortalama reaksiyon zamanı (MRT) branşlar arasında farklı bulunmuştur (p=0,009). 10 deneme için RT üçüncü (p=0,038), dördüncü (p=0,047), beşinci (p=0,022), altıncı (p=0,044), yedinci (p=0,041), sekizinci (p=0.011), dokuzuncu (p=0.019), onuncu (p=0,023) denemelerde branşlar arasında farklılık göstermiştir. Sonuçlara göre, sporcuların görsel reaksiyon zamanlarının oldukça spesifik olduğu ve ayırt edici olarak yetersiz kaldığı söylenebilir. Antrenmanlarda branşa ve pozisyona özgü teknik/taktik becerilerle birlikte reaksiyon zamanını geliştirici egzersizler yapılması önerilebilir.

Anahtar Kelimeler: Görsel reaksiyon zamanı, Fitlight, Motor performans

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INTRODUCTION

All actions have three qualities that make up the themes of this element: (1) The individuals must first be able to perceive what needs to be done and represent it within neural, perceptual, and/or cognitive structures; (2) they must be able to select the best course of action from the many options that may be present efficiently and, (3) they must be able to implement a cognitively planned course of action so that an intended outcome occurs [1]. Vision is thought to be a dominant sense and the eyes provide both spatial and temporal information to the brain, which must be processed and acted on. Moreover, vision is a warning that directs the muscles to respond and gives information about where and when to move [2,3]. For this processing system to work optimally, its input must be optimal. In sports, especially in fastball sports, information must be gathered, processed and, acted on quickly for athletes to perform their best [3]. The environmental changes over space and time are used to support the goal-directed actions of athletes [4]. Successful performance in sport requires not only the efficient execution of motor behavior but also a high level of perceptual ability. Competitive high-level sports are characterized by several spatial and temporal constraints imposed on the performer by regulations and the opponents. Under such constraints, a player’s ability to quickly and accurately perceive relevant information will facilitate decision making and allow more time for preparation and organization of motor behavior [5]. To support performance, elite athletes require a combination of general visual skills (e.g. visual acuity, contrast sensitivity, depth-perception) and performance-relevant perceptual-cognitive skills (e.g. anticipation, decision-making) [3,6]. While these skills are typically developed as a consequence of regular field practice, training techniques are available that can enhance those skills in conjunction with regular training [6]. The higher order perceptual abilities commonly known to have a significant impact on athletes are the visual reaction time and visual anticipation time. Visual reaction time amongst athletes is mainly concerned with how fast an athlete reacts to a visual stimulus and visual reaction time test measures how quickly an individual respond to a sudden visual stimulus [7]. Two neuromotor variables have been commonly used for evaluation of the reactive ability of athletes of different sports modalities: (1) reaction time (RT) and (2) movement time (MT). RT is defined as elapsed time between onset of one stimulus and initiation of motor response and 3 different kinds of reaction time have received attention by researchers: (1) simple reaction time, (2) recognition reaction time and (3) choice reaction time. On the other hand, MT is defined as the interval between the beginning and the end of the motor action [8] and it is accepted as an indicator of successful performance in many sports and can be improved by training [8,9]. Visual reaction time amongst athletes is mainly concerned with how fast an athlete reacts to a visual stimulus. RT and MT are considered to be the classic measurements of the efficiency and effectiveness of an individual’s capacity to process information and perform sport skills [10]. Reaction tests can be applied for different purposes. Simple reaction time test can be applied for processing speed task. Choice reaction time test can be applied for attention task [11]. Recently, with the development of technology, systems that send visual stimuli to athletes, notify answers with feedback at the moment of the stimulus have started to be used. Kuan et al. (2018) investigated visual reaction time and visual anticipation time between athletes and non-athletes. The findings of the study indicated that visual reaction time of athletes was faster than non-athletes and visual anticipation time of athletes was better with less error and higher consistency parameters than non-athletes [12]. However, there was no interaction between gender and sport participation for these visual perception skills in this research. In another study where the role of gender, age and ethnicities on visual reaction time and visual anticipation time of junior athletes was investigated [7], authors reported that gender, age and, ethnicities may influence visual reaction time and visual anticipation time responses. However, little information is available on reaction time, hand-eye coordination among athletes from different sport branches. In many sports branches such as badminton, basketball, arm-wrestling, boxing, football, handball, rugby, volleyball, reaction time, hand-eye coordination is regarded as a prerequisite for success. Although, the expert-novice paradigm has been used extensively to investigate how vision and visual perception affect sport performance, additional research is necessary in order to understand better the key performance indicators that discriminate between expert and novice sport performers [10]. For this reason, the aim of the current study was to investigate RT differences for eye-hand coordination of athletes from different sports and sedentary people to see whether athletes from different branches present higher indices of neuromuscular performance during execution of a task when compared to sedentary people.

MATERIALS AND METHODS

Participants

The study involved 48 athletes, aged 18-25 from different sport branches [basketball (n=6), arm wrestling (n=4), boxing (n=6), football (n=13), handball (n=4), rugby (n=8), volleyball (n=7)] participating in competitions of the University League, representing the University of Eskisehir Technical University and 9 sedentary people. 35 athletes and 6 sedentary people were right-handed and 13 were left-handed. Clinical signs of color vision, stereopsis, strabismic and ocular disease were defined as exclusion criteria. Test procedure was explained to participants before the measurement. Written consent was obtained prior to the start of the work. The local Ethical Committee approved the study (No: 43180). The study was conducted in accordance with the principles of Helsinki Declaration.

Data Collection

Hand-eye coordination tests were conducted by using reaction development and training system FitLight Trainer™ (Fitlight Sports Corp., Canada) (Figure 1). The test protocol was configured by the PDA controller and consisted of 10 series of simple motor reaction task to visual stimuli appearing on 8 wireless light discs.

Figure 1. FitLight Trainer™ System

Hand-Eye Coordination Test

Light discs were placed on a plate with dimensions of 110 × 80 cm at intervals of 20 cm apart and 45 cm from the designated starting point as shown in Figure 2. Participants were asked to stand and hold their dominant hands on the designated start point. After each deactivation of light, the hand was supposed to return to the original position on the table. Each of the 10 series included 22 reactions, occurring at intervals of 0.1 to 3.0 seconds. The participants were given 5 seconds of rest between each series. In total, each participant completed 220 tasks. In this test, the aim was to perform the fastest hand movement in order to touch the disc surface and deactivate the lights [13].

Before the testing session started, participants were allowed to perform a pre-test, which consisted of making 5 responses to light stimuli. Participants were instructed to deactivate the lights as fast as possible by placing one hand in close proximity to the activated light. Analysis concerned the mean reaction time of 22 reactions and the average response time to stimuli during each of the 10 series.

Figure 2. Hand-eye motor task

Statistical Analysis of Data

Statistical analysis of the study was conducted using the trial version of the SPSS 22.0 (SPSS Inc., Chicago, IL). Conformity of the data to normal distribution was assessed with the Kolmogorov-Smirnov test. Since none of the quantitative variables fit to the normal distribution, groups were compared by Kruskal Wallis H test. Median (25^{th} – 75^{th} percentiles) or frequency (n) was used as descriptive statistics. A value of $p<0.05$ was accepted as statistically significant.

RESULTS

Mean reaction time (MRT) was found to be different among branches (p=0.009). There were significant differences in MRT between arm wrestling, handball, football, boxing, volleyball, rugby, and sedentary people. MRT for arm wrestling was found to be statistically shorter than handball (p=0.003), football (p=0.010), boxing (p=0.010) and sedentary people (p=0.008). Handball had longer MRT than volleyball (p=0.010) and rugby (p=0.017). MRT for volleyball was significantly shorter than sedentary people (p=0.026), football players (p=0.032) and boxers (p=0.033). Rugby players were found to have significantly shorter MRT than sedentary people (p=0.045). Arm wrestling and volleyball players were found to have shorter MRT than others. Handball players had the longest MRT (Table 1).

Table 1. Descriptive Statistics and Comparison Results for the Mean Reaction Time According to the Branches

VARIABLE	GROUP				p
	Sedentary (n=9)	**Football (n=13)**	**Boxing (n=6)**	**Rugby (n=8)**	
MRT	0.47 (0.42-0.50)	0.47 (0.42-0.49)	0.46 (0.45-0.51)	0.42 (0.37-0.43)***	**0.009**
	Volleyball (n=7)	**Basketball (n=6)**	**Handball (n=4)**	**Arm Wrestling (n=4)**	
	0.39 (0.37-0.46)**	0.46 (0.37-0.50)	0.49 (0.47-0.52)	0.38 (0.36-0.39)*	

*: Arm wrestling is significantly different from; handball, sedentary, football, boxing (p=0.003, 0.008, 0.010, 0.010; respectively).

**: Volleyball is significantly different from; handball, sedentary, football, boxing (p=0.010, 0.026, 0.032, 0.033; respectively).

***: Rugby is significantly different from; handball, sedentary (p=0.017, 0.045; respectively).

Reaction times for 10 different trials were compared among branches. According to results of this comparison, first and second trials did not show any significant difference among sedentary people and branches. Moreover, there wasn't any statistically significant difference among branches, either (p>0.05). All other trials except these two were found to be significantly different among branches and sedentary people (p<0.05) (Table 2).

Table 2. Descriptive Statistics of Trials among Branches and Comparison Results

TRIALS	BRANCHES								p
	Sedentary (n=9)	**Football (n=13)**	**Boxing (n=6)**	**Rugby (n=8)**	**Volleyball (n=7)**	**Basketball (n=6)**	**Handball (n=4)**	**Arm Wrestling (n=4)**	
I	0.50 (0.46-0.52)	0.49 (0.44-0.52)	0.48 (0.45-0.51)	0.44 (0.40-0.50)	0.43 (0.39-0.49)	0.50 (0.38-0.53)	0.50 (0.50-0.58)	0.41 (0.37-0.50)	0.252
II	0.50 (0.43-0.51)	0.49 (0.46-0.52)	0.47 (0.44-0.52)	0.43 (0.38-0.47)	0.41 (0.41-0.49)	0.49 (0.38-0.54)	0.49 (0.48-0.56)	0.41 (0.38-0.49)	0.167
III	0.46 (0.44-0.51)	0.49 (0.45-0.52)	0.48 (0.45-0.52)	0.42 (0.39-0.45)**	0.41 (0.39-0.48)***	0.46 (0.38-0.51)	0.49 (0.48-0.57)	0.40 (0.37-0.49)π	**0.038***
IV	0.47 (0.41-0.50)	0.46 (0.42-0.50)	0.49 (0.47-0.55)	0.43 (0.38-0.46)β	0.39 (0.38-0.47)ππ	0.46 (0.37-0.50)	0.49 (0.48-0.53)	0.41 (0.36-0.48)πππ	**0.047***
V	0.47 (0.43-0.50)	0.48 (0.43-0.50)	0.49 (0.46-0.52)	0.41 (0.39-0.44)β	0.39 (0.37-0.48)ββ	0.46 (0.36-0.50)	0.50 (0.48-0.51)	0.39 (0.37-0.47)πππ	**0.022***
VI	0.46 (0.42-0.50)	0.47 (0.44-0.49)	0.46 (0.44-0.49)	0.40 (0.38-0.42)Ω	0.38 (0.36-0.47)βββ	0.45 (0.36-0.50)	0.49 (0.47-0.49)	0.39 (0.36-0.46)π	**0.044***
VII	0.49 (0.43-0.51)	0.46 (0.40-0.48)	0.46 (0.43-0.50)	0.39 (0.36-0.43)ΩΩΩ	0.38 (0.35-0.46)ΩΩ	0.46 (0.36-0.51)	0.48 (0.47-0.49)	0.37 (0.36-0.45)¥	**0.041***
VIII	0.49 (0.41-0.50)	0.47 (0.41-0.49)	0.46 (0.45-0.51)	0.40 (0.36-0.42)¥¥	0.36 (0.34-0.44)ββ	0.44 (0.36-0.49)	0.47 (0.45-0.48)	0.38 (0.35-0.45)¥¥¥	**0.011***
IX	0.45 (0.41-0.49)	0.43 (0.40-0.47)	0.44 (0.43-0.50)	0.39 (0.36-0.42)ɱ	0.36 (0.34-0.43)ββ	0.44 (0.37-0.49)	0.48 (0.45-0.48)	0.37 (0.35-0.44)π	**0.019***
X	0.45 (0.41-0.50)	0.42 (0.39-0.47)	0.44 (0.40-0.50)	0.37 (0.35-0.41)ΩΩΩ	0.35 (0.33-0.42)ββ	0.43 (0.36-0.48)	0.46 (0.45-0.49)	0.37 (0.34-0.44)	**0.023***

*p<0.05

**: Rugby is significantly different from; boxing, football, handball (p=0.043, 0,012, 0,012; respectively).
***: Volleyball is significantly different from; football, handball (p=0.026, 0.021; respectively).
π: Arm wrestling is significantly different from handball (for trial III p=0.034, for trial VI p=0.032; for trial IX p=0.044).

ππ : Volleyball is significantly different from; boxing and handball (p=0.008, 0.011; respectively).
π π π : Arm wrestling is significantly different from; boxing and handball (for trial IV p=0.030, 0.031; respectively and for trial V p=0.028, 0.027; respectively).
β : Rugby is significantly different from; boxing and handball (for trial IV p=0.018, 0.023; respectively and for trial V p=0.019, 0.022; respectively).
β β : Volleyball is significantly different from; sedentary, football, boxing, handball (for trial V p=0.042, 0.024, 0.007, 0.009; respectively and for trial VIII p=0.010, 0.008, 0.004 and 0.023; respectively; for trial IX p=0.007, 0.029, 0.006, 0.006; respectively; for trial X p=0.005, 0.031, 0.019, 0.008; respectively.).
β β β : Volleyball is significantly different from; sedentary, football, handball (p=0.031, 0.020, 0.013; respectively).
Ω : Rugby is significantly different from; football, handball (p=0.039, 0,023; respectively).
Ω Ω : Volleyball is significantly different from; boxing, sedentary, handball (p=0.039, 0.011, 0.019; respectively).
Ω Ω Ω : Rugby is significantly different from; sedentary, handball (for trial VII p=0.024, 0,035; respectively; for trial X p=0.018, 0.023; respectively).
¥ : Arm wrestling is significantly different from; sedentary, handball (p=0.031, 0.038).
¥¥ : Rugby is significantly different from; football, sedentary, boxing (p=0.031, 0.035, 0.015, ; respectively).
¥¥¥ : Arm wrestling is significantly different from boxing (p=0.023).
ɱ : Rugby is significantly different from; sedentary, boxing and handball (p=0.040, 0.028, 0.027; respectively).

DISCUSSION

This study was designed to assess mean reaction time differences among athletes from different branches and determine the reaction times of 10 different trials to understand the hand-eye coordination structures of athletes.

Perceptual skills are important for the complex cognitive processes as well as the ability to predict and react to a stimulus for an effective response [12]. It is stated that the visual system assists in acquiring information from the environment and acts as the basis for the execution of appropriate motor tasks and athletes have to gather a great amount of information, mainly visual, swiftly from the environment in order to execute appropriate motor tasks [14,15].

It is stated that the visual system of athletes, especially with respect to motor reaction time, ocular motilities, depth perception, and dynamic visual acuity was superior than non-athletes [14]. According to results of the current study, as an expected outcome, athletes from different sports had shorter and more effective MRT than sedentary people. One of the reasons for finding athlete and sedentary people differences in MRT may be that athletes are more competitive and motivated than the sedentary group. This may have been the reason for the slightly slower MRT of the sedentary group once they had been extracted from the normal sample of individuals. Moreover, these results, as stated in the literature from a neurophysiological viewpoint, provide evidence that athletes may develop peculiar mechanisms of occipital neural synchronization during visuospatial demands, showing better visuomotor performance compared to sedentary people [15]. Also, an occipito-parietal-premotor dorsal stream is involved in the visuo-spatial analysis of environmental stimuli and in the visuo-motor transformations aimed at selecting proper reaching, interception, grasping, and handling actions better for athletes than sedentary people [16].

In the study that examined the sprint reaction time and anaerobic strength of young football players, volleyball players and wrestlers, it was reported that statistically significant difference was found between wrestlers and volleyball players. Also, authors detected statistically significant difference between football players and other branches ($p<0.05$) [17]. Reaction values of football players were detected to be better than volleyball players and handball players [17]. Moreover, in a study that investigated the sprint reaction and visual reaction times of athletes from different branches (volleyball, basketball, handball) authors reported that the best visual reaction time score belonged to handball players, while volleyball players had the worst score [18]. In our study, when branches were compared among each other according to MRT of 10 different trials, arm wrestlers and volleyball players were found to have the shortest MRT among others. In addition to that, handball players were found to have the longest MRT over all branches. These differences between our study and the ones in the literature may be due to the different number of participants from each branch and different visual-motor task that was given to the athletes. The reasons why there are so many contradictory findings in the literature are the different designs, testing procedures as well as testing devices that are used in RT research studies. Clearly, there are many factors affecting RT, with one of them being individual constraints such as motivation and competitive nature [10]. Also, the dramatic contrast to act on the basis of visual information does not lie in differences in the speed of operation of the perceptual system. It lies in the organization of the motor system that uses the output of the perceptual system. Moreover, the real and laboratory reaction times of athletes can be different due to the situations. This points to important differences between the laboratory settings of the present study and the conditions of real situations. In the present study, the athletes responded to a visual light stimulus, while in real situations they would make defensive actions (such as blocking, making defense etc.), which would be more natural for them to act against the opponent's attack and probably faster [5]. In addition, visual stimuli received by different parts of the eye may produce different reaction times. And it is stated that the fastest reaction time comes when a stimulus is seen by the cones (when the person is looking right at the stimulus). If the stimulus is picked up by rods (around the edge of the eye), the reaction is slower [19]. It is also stated that athletic training is often accompanied by high activation of the visuomotor system, especially in sports that require the processing of dynamic visual information [13].

Volleyball and handball players need to read all the stimulus coming from their opponents, team mates, surroundings. This prevents them to read the stimulus directly. To re-act to the stimulus; first, they have to process and integrate complex visual information. On the other hand, arm wrestlers keep attention for only their hands and opponent's hand therefore, it is not necessary for arm wrestlers to get information or any stimulus from their surroundings. According to this information, it can be reported the structures of the branches may be affecting the reaction times.

Zwierko et al. (2014) investigated the effect of prolonged visuomotor task performance on ability to maintain attention in athletes and non-athletes [13]. Moreover, it has been reported that reaction times in athletes depend on the type of sport activity. As seen in the results of the current study; even though there were differences among branches, all subjects had their best reaction time during 10^{th} trial which may be a proof that they had the motor learning completed during the last trial. According to this information, it may be suggested to have at least 10 trials to evaluate the best reaction times of athletes from different branches.

CONCLUSION and SUGGESTIONS

There are many factors that affect RT and several different ways in which researchers have measured MRT and RT. During trainings, it may be advisable to have reaction time development exercises with specific technical/tactical skills related to branches and positions. Interactive training lights are the perfect cognitive training system that can be adjusted and modified to meet the needs of each user, type of sport, and training practices. During these training routines, the reaction system may be designed to provide users and trainers with comprehensive data that will allow them to locate where specific areas of improvement are needed and, therefore, adjusting the cognitive training system accordingly. With ability to accurately monitor an athlete's development and performance, trainers can apply specific routines that will target the aspects of a training routine that their athlete needs–i.e., speed, agility, stamina, conditioning, coordination, etc.

Analysis of both visual reaction time and visual anticipation time measurements should be utilized in designing and executing a visual training program aimed at optimizing athletes' visual skills as a part of the strategy to enhance and optimize their sporting performance. Refinement of an athlete's visual function in relation to their sports performance is further explored. Many of the reaction tests are promoted as apparatus suitable for training sessions for athletes to improve eye-hand coordination, eye-body coordination, etc. There has been no research showing that an improvement in this RT as measured by a light panel based test results in improved eye-hand coordination in a sports setting. For this reason, it would make for interesting research in the future.

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