Neurocognitive abilities in soccer athletes are different from healthy non-athletes subjects

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Objectives This study was conducted to compare the reaction time & anticipation skills of football players with non-athletes.
Methods Participants of the study were 10 male soccer players and 10 male non-athletes. Auditory choice reaction time, auditory complex choice reaction time, visual choice reaction time, visual complex choice reaction time, ball anticipation skills with high & low speed individuals were assessed by using Speed Anticipation and Reaction Time (SART) Tester software.
Results Results showed significant differences ($P = 0.000$) between healthy athletes and healthy non-athletes males in the tests of auditory choice reaction time, auditory complex choice reaction, visual choice reaction time, visual complex choice reaction time as well as anticipation skills. Athlete males had higher cognitive abilities as compared to the non-athlete healthy individuals.
Conclusion Soccer players gain extensive knowledge regarding specific neurocognitive model of soccer during their vast exercise sessions and show better cognitive abilities in comparison with non-athletes in similar sport circumstances (like SART).
Keywords reaction time, anticipation skills, football players, speed anticipation & reaction time

Introduction

Cognitive abilities (reaction time & anticipation skills) are important for the successful performance of most activities in daily life. For example, drivers with higher cognitive abilities can survive dangerous situations while driving and can better realize the circumstances than the other individuals.[1] Such qualities are more important in hard conditions during games, especially in high-speed game to get ready for an appropriate motor response against the response of opponent. A successful soccer player should be able to imagine the tricky move of opposite players and show befitting response.[2] In recent years, researchers have paid special attention to the cognitive abilities (reaction time & anticipation skills).[3] Reaction time is the time interval between the appearance of a stimulus and the initiation of the unpredictable response to that stimulus.[4] Measurement of reaction time is common in many training and exercise programs. Data processing is widely used in laboratories to measure speed. This widely used data in many studies were very susceptible and a reflection of cognitive and motor performance.[5,6] Prediction of less reaction time or even less processing is naturally used to respond an unpredicted response. Individuals with higher cognitive abilities have following qualities; use the visual system effectively and efficiently,[8] have skilled motor behavior,[9] select an appropriate response to certain experiences[10] identify the best movement pattern based on recognition process and memory.[11] Most commonly used methods to measure reaction time and cognitive abilities are electromyography (EMG) and speed anticipation and reaction time tests. EMG can measure the reaction time of a specific muscle and cannot be used for the assessment of cognitive and decision-making abilities of the individual but computer-based methods can easily measure the overall reaction time of the individual. Therefore, by using these tests, new insight regarding brain mechanism could be attained. Sports men in the form of team like soccer remain in dynamic situation for specific period to give best performance against opponents in that time. These repeated practice sports sessions may cause variation in the cognitive abilities of the players. This phenomenon explains that increase in the sports skills of players is highly dependent on the increase in their cognitive abilities. No study has been conducted yet, to compare the visual and auditory reaction time, and the cognitive ability of male football players with male non-athletes. So, the aim of this study was to compare the reaction time and anticipation skills of soccer players with non-athletes.

Methodology

After the approval from ethical research committee of Tehran University of Medical Sciences (TUMS), a total of 10 male football players who used to play thrice a week for at least 2 h in each game and 10 healthy non-athletes males who were not regular in exercise were selected. Participants from 20 to 30 years were selected voluntarily by non-random sampling method. All the participants were right handed, had same education level and no visual and auditory disability.

Participants with a history of chronic diseases (neurological, cardiac, metabolic), user of drugs effecting motor and cognitive performance, user of stimulating drinks (coffee, alcohol, carbonated) before the test and individuals unwilling to continue the test procedure were excluded from the study. Every individual filled the consent form and was assessed for height and weight after filling the questionnaire of personal information.

Participant used to sit on an adjustable chair with feet on the ground and a high resolution, 24 inch; liquid crystal display (LCD) of Samsung (68-02555A) was placed in front of him. SART software was used to find the reaction time and cognitive ability. The software was installed on the laptop which was connected to the LCD by (HDMI) wire and could be seen on both screens (Fig. 1). A selection of menu and start

of the test were controlled by the examiner who was sitting on the laptop. Laptop screen was invisible to the participant and test drivers used to be selected randomly by the examiner. Type of the test to measure time i.e. discriminative reaction tester to aim speed anticipation or cognitive ability was visible on the laptop screen and used to be selected by the examiner. Next, menu had all the anthropometric data of participant. Reaction time window appeared as the examiner selected the first menu and showed four bulbs with red, yellow, green and blue colors to stimulate the visual sense while the auditory response corresponding to the colors was provided with the help of 500, 1000, 3000 and 7000 HZs frequencies (Fig. 2). After selecting the intended test, the examiner used to press the related button on the laptop (bulb for visible & frequency for auditory) and the participant used to respond the auditory or visual stimuli by pressing the response button. This part of the test was helpful to explain the choice visual and auditory reaction time. The reaction time software also had a non-compatible mode in which the reaction buttons used to act non-correspondingly with the stimuli and in this way provided the possibility to assess visual & auditory complex choice reaction time. At the beginning, the participants had self-training for *s* specific time to get familiar with the procedure and after that three sets of the test were performed 10 times in each (30 times). Detection and response time to the stimuli in each test were measured and electronically registered by the system with 1 millisecond accuracy.

For the estimation of anticipation skills, the participants adopted the previous position and the examiner initiated the software. On the screen, a ball used to move horizontally from the right to the left with a constant speed and used to disappear on striking the embedded screen (Fig. 3). At this stage, the chronometer started and the participant had to estimate the speed and route of the ball and used to press the joystick button at the time ball struck the screen. A bulb located on the extreme left corner of the screen used to turn on and the chronometer stopped at the end of the test. In this test, the predicted time was calculated from the moment the ball disappeared till it reached the goal. Software used for this purpose had the provision to calculate low and high speed. At the end, after averaging, the anticipation skills of the participants were calculated and electronically registered by the system in millimeters. Accuracy of chronometer in this test was 1 millisecond. All the reaction time and anticipation tests for these two groups were performed at a specific daytime in a comfortable room. In reaction time test, parameters like average response time of the participant and number of tests with errors were calculated while in the anticipation skills test, the average of the total predicted time and difference between real average times from the predicted times of the participant were reported. SPSS version 19 was utilized for statistics analysis of data. The one-sample Kolmogorove-Smirnov test was done in both groups for assessing the normal distribution of all independent variables. The analysis of the independent *t* test was used to determine any significant differences between two groups. The significance of tests accepted at an alpha level of 0.05.

Fig. 1 **Schematic view of the SART setup.**

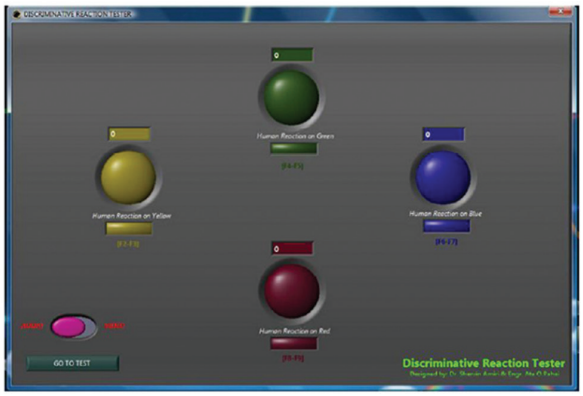

Fig. 2 **The SART menu for auditory and visual reaction time tests.**

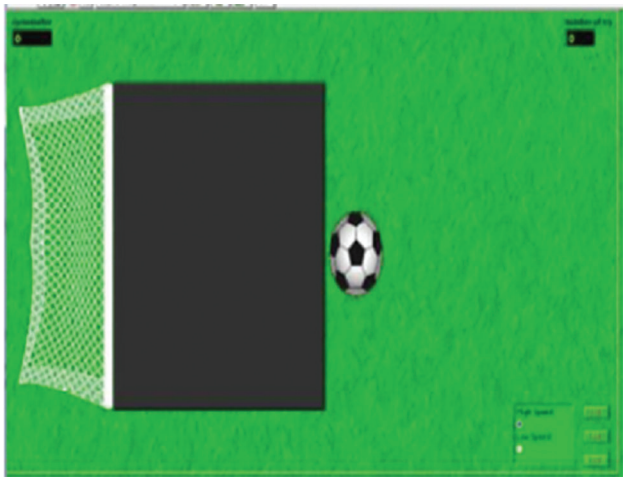

Fig. 3 **The SART screen for the estimation of anticipation skills.**

Results

Anthropometric characteristics of both groups are shown in Table 1. KS test confirmed that both groups had a normal distribution of the variable and there was no significant difference between the groups ($P < 0.05$). Results showed significant difference ($P = 0.000$) between healthy athletes and healthy non-athletes males in the tests of auditory choice reaction time, auditory complex choice reaction, visual choice reaction time, visual complex choice reaction time as well as anticipation skills. Male athletes had higher cognitive abilities and less reaction time as compared to the healthy non-athletes individuals. In comparison of the high- and

low-speed anticipation skills time between healthy male athletes and healthy non-athletes, there was a significant difference ($P = 0.000$) in such a way that male athletes had better low and high speed anticipation skills in that particular time. Results regarding auditory and visual reaction time of both groups are shown in Table 2 while the results regarding anticipation skills in low- and high-speed of the ball.

Discussion

The present research was among the first few studies showing the difference in auditory choice reaction time, auditory complex choice reaction time, visual choice reaction time and visual complex choice reaction time. The results of the present study reported better reaction time and anticipation abilities among the male athletes. According to the results, in a dynamic sports environment like soccer, the players get trained during practice with the auditory stimuli. These players had more concentration on the auditory stimuli like whistle by referee during game. Therefore, these players required better understanding about the postural direction of the opposite player as well as the ball direction for better performance. This ability requires speedy reaction time to have better visual signs during game.[13] Kluka had mentioned three visual perceptual skills (visual search, choice concentration, prediction power) that were the base of the right decision by players.[14] According to the study by Wilkinson, the players during game need different kinds of eye movements to gather data quickly. For example, ability to concentrate on the opponent while he approaches towards or goes away from the player, following a moving object with quick eye movement. These eye movements while working with the peripheral visual system help the player to gather information in an unpredictable situation.[15] According to the results of cognitive skills tests, we can conclude that football players can better understand or analyze the expected environment as compared to the non-athletes. When the players participate in a game as a team, they have to face more unexpected movements; they need to have awareness about the weaknesses of their own team members as well as about the opponent team players, the position of their own team players and opposite team players as well as the position of the ball is very necessary for them. Therefore, their abilities for the competitive games improve to make better decisions. Although there had been no such study that compared the cognitive skills between soccer players and non-athlete individual, but different studies have investigated the effect of exercise training on decision making abilities of players while playing as a team.[16–18] The researchers have concluded that sports environment of competitive games cause the improvement in decision making and cognitive skills abilities. Present research has correlated the cognitive ability with the estimated time to reach ball at goal which is completely similar to the game environment for the football players and this also justified their better performance.

The results of the present study also confirmed the achievement of extensive knowledge by players regarding neuro-cognitive models during sports training and in similar situations like SART; players have shown better cognitive abilities because of the attainment of such knowledge.

In the present study, the players have shown better cognitive abilities in SART and anticipation skills tests, it is quite possible that we may implement these cognitive abilities obtained from these tests on similar sports conditions in a very effective way. These sports similar conditions could be effective for those who have sports injury and remain absent from the practice sessions. Further studies in this field are required to investigate better effects by implementing these obtained cognitive abilities tests on the sport environment.

Table 1. **Demographic data of participants ($N = 10$)**

	Soccer Mean (SD) Min Max	Non-Soccer Mean (SD) Min Max
Age (years old)	22.7 1.56 21 25	22.6 1.77 20 25
High (m)	1.84 0.03 1.78 1.89	1.71 0.05 1.65 1.82
Weight (Kg)	77.80 4.13 71 82	69.60 14.15 52 87
BMI (Kg/M^2)	22.68 1.03 19.88 23.35	23.57 4.71 18.33 29.4

Table 2. **Mean and standard deviation of neurocognitive parameters between two groups ($N = 10$)**

	Soccer Mean (SD)	Non-Soccer Mean (SD)	*P* value
Visual choice RT (ms)	398.60 (17.77)	371.35 (19.26)	0.000
Visual complex Choice RT (ms)	443.21 (23.33)	496.20 (35.14)	0.010
Auditory choice RT (ms)	623.10 (111.67)	713.95 (107.51)	0.000
Auditory complex choice RT (ms)	683.75 (104.32)	763.40 (99.85)	0.027
Anticipation with low speed (ms)	276.10 (144.45)	388.50 (213.94)	0.036
Anticipation with high speed (ms)	242.80 (160.40)	392.00 (56.02)	0.000

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Conflict of Interst

None.

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