ORIGINAL ARTICLE

TRENDS in
Sport Sciences
2021; 28(**2**): 117-125
ISSN 2299-9590
DOI: 10.23829/TSS.2021.28.2-5

# Association between team sports and anxiety with reaction time of individuals with visual impairment versus individuals with normal vision

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**Abstract**

**Reaction time plays a major role in the functioning of every human being. The purpose of this study was to investigate the correlation between sports and anxiety in visually impaired individuals compared with people with normal vision. In this study 79 subjects who participated were divided into four groups. Two instruments were used. The first was a self-report questionnaire, the Symptom Rating Scale for Depression and Anxiety, which aimed to investigate anxiety. The Optojump Next was the other instrument which measured reaction time in real conditions. The results showed that sports influence reaction time positively, whereas a visual impairment influences reaction time negatively. Finally, it was shown that there was a correlation between anxiety and reaction time. Research findings show that sports improve reaction time. Improving reaction time is useful for people with special needs, including visually impaired people, as it can enhance their autonomy and functionality.**

**KEYWORDS: goalball, soccer, visually impaired athletes, non-blind athletes, auditory stimuli.**

Received: 3 July 2020
Accepted: 18 March 2021

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## Introduction

People receive a multitude of stimuli from their environment and are expected to react to them [34]. Reaction time is the time between the appearance of a stimulus and a person's onset of action [27]. Cognitive, perceptual and kinetic functions need to be involved in reaction time [27]. More specifically, a person has to process the stimulus, decide what the appropriate action is, and respond appropriately [27, 31]. There are three types of reaction time: simple reaction time, choice reaction time and recognition reaction time [19, 27, 32]. Simple reaction time is a response to a stimulus [27, 32]. Choice reaction time is a reaction corresponding to a given stimulus [27, 32], whereas in recognition reaction the person has to react to some stimuli and not to others [19]. The stimuli, to which a person reacts, can be visual, auditory or haptic [15, 24]. Visual stimuli incur a reaction to light, auditory stimuli to sound and haptic stimuli to touch. Reaction time to visual stimuli is about 180-200 ms, whereas to auditory stimuli it is about 140-160 ms [21]. Reaction to an auditory stimulus is faster than reaction to a visual stimulus, as the auditory stimulus needs half the time to reach the brain [19]. Reaction time plays an important role also in sports. People that do not practice sports have a worse reaction time than people who do [17, 31]. Exercise may influence and improve reaction time, which can be reduced by 0.12 seconds when the person changes their technique [17]. There are many factors that influence reaction time. Specifically, age is one of these factors [33]. At the age of 9 and 10 there is the greatest development of reaction

time [17], whereas after 65 years of age there is a large increase in reaction time [19].

Anxiety is also related to reaction time. General anxiety affects body reactions. When a teenager has symptoms of generalized anxiety he/she may develop generalized anxiety also as an adult [22]. An intense activation in the brain is often correlated with anxiety [13, 14]. People with high anxiety levels may show better performance in an easy activity [7]. When a person suffers from anxiety their reaction time in the case of a normal stimulus may be slower than to a negative stimulus [5]. Before a game the level of anxiety is often smaller than after the game [7]. The reaction time of an athlete is often faster due to brain activation [7]. The more anxiety a person feels, the slower the reaction time is; there is a statistically important negative correlation between the two. The experience of anxiety may cause a lessening of brain activation and there is a correlation between anxiety and loss of control [26]. Athletes who may show less anxiety and better reaction time before the game, might also show higher performance in agility [7].

Audition plays an important role for people generally, and especially for people with visual impairments, influencing their integration in the society [3]. Touch and audition may create internal representations of a part of what one could see [20]. Due to the lack of vision, a blind person learns to make better use of the other two basic senses: touch and audition, which may partially replace vision [12, 20]. Touch and audition in blind people may activate the visual cortex [35]. Blind people participate in various sports, such as football, goalball and running. The motor skills of blind people depend on the other two senses: audition and touch. For example, instructions from their coaches are mainly auditory [2]. When the stimulus cannot be understood by an athlete due to blindness, it must be replaced by another stimulus that can be understood [38]. Regarding blindness and reaction time, some researchers mention that there are no statistically significant differences between people who have lost their vision at birth and people with typical vision in simple reaction time to auditory stimuli [8, 9]. However, the small differences that exist showed that blind people who lost their vision at birth are faster [8, 9]. Reaction time in the case of auditory and haptic stimuli may be faster in blind people who have lost their vision at birth, especially in orienting exercises in space [9]. It is worth mentioning that blind people who have lost their vision at birth often show better performance in exercises that demand audio recognition when compared to people with typical vision [9, 12]. Blind people often show better performance at perceptual processes, such as reaction time to auditory stimuli, from people with normal vision [30]. When an auditory-tactical stimulus occurs near the person with visual impairment, the person often reacts faster [10]. There are no studies in literature that show the influence of physical exercise in blind people [2]. It is also mentioned that simple reaction time to auditory stimuli in subjects with partial blindness is often slower than in subjects with normal vision [16]. In turn, reaction time for totally blind people is often faster than for people who are partially blind [16].

Lack of vision may also lead to the development of anxiety. Everyday life of people with lack of vision, and especially of older people, often causes more anxiety than that of people with normal vision [4, 18, 25, 36]. An appropriate treatment, for example some activities, can prevent anxiety [37]. The changes that take place in the bodies of teenagers with normal vision due to their adolescence can cause anxiety that does not occur in visually impaired teenagers [4].

**Aim of Study**

Taking into consideration the information that has already been mentioned an interesting question would be how sports and anxiety correlate with reaction time of people with visual impairment in comparison with people with typical vision. The present research aims to answer the above main question. The research is designed to investigate also the correlation between age and drills, differences between the dominant and non-dominant hand, differences in reaction time among the four groups, and finally differences between the above-mentioned sports.

**Methods**

*Participants*

This study was conducted with the participation of people visually impaired and people with normal vision. We used a convenience sample in our research, as we visited places where people with severe visual impairment or totally blind live. More specifically, the total population sample for this study was 79 people who were divided into four groups. The people were aged from 18 to 59 years old. There were 65 males and 14 females in total. In the first group there were 20 visually impaired people (mean 30 years old) who were also athletes (8 athletes practicing goalball, 12 athletes playing soccer, 18 right handed, 2 left handed) (AVI). In the second group there were 19 non-athletes totally blind (NATB) (18 right handed, 2 left handed, mean

27 years old). The third group comprised 20 people with normal vision (mean 28 years old) who were also athletes (9 athletes playing soccer, 11 athletes playing handball, 17 right handed, 3 left handed) (ANV). Each group consisted of both men and women. Handball was selected as it has many similarities with goalball. For example, in both sports athletes shoot the ball with their hands in order to score a goal. The fourth group included 20 non-athletes with normal vision (NANV) (17 right handed, 2 left handed, mean 30 years old). Goalball and soccer were selected as these sports are the most popular in Greece for blind people. The level of the athletes was the same and all of them played in a regional team. The level of the visual impairment of the people was already rated and each person gave us the final assessment. The group of athletes had severe visual impairment, whereas the group of non-athletes were totally blind. All the data were collected by the researcher.

*Instruments*

Two instruments were used for the research. The first was a self-report questionnaire. The questionnaire was the Symptom Rating Scale for Depression and Anxiety, which was translated and validated in Greek [11], ($\alpha = 0.816$) This questionnaire concerns depression, anxiety, melancholy, asthenia and mania; however, for this research we used only the sections related to depression and anxiety. The other instrument was the Optojump Next (Optojump Next, Microgate, Bolzano, Italy) which measures reaction time in real conditions ($\alpha = 0.715$). This instrument has photocells which measure reaction time, from the moment when the audio stimulus is heard until the time the subject raises their leg from the ground. For reaction time in real conditions two exercises were included: shoot of the ball and contact with the ball. We selected these two skills in order to measure the body reaction time. In the exercise when the subject has to shoot the ball, the instrument measures the time between the appearance of an audio stimulus until the time the leg is raised from the ground to shoot the ball. The ball was 20 cm away from the subject. The exercise must be performed when the subject hears the audio stimulus. Two skills were involved with both right and left feet. There were 5 trials, but prior to the test there were some preliminary trials in order to familiarize the subject with the instrument.

*Procedure*

We sent an informed consent form to the Center for Education and Rehabilitation for the Blind (CERB) in Thessaloniki in order to contact visually impaired individuals and ask them if they wanted to participate in the research. The study was conducted in a quiet room so the people who were visually impaired could hear the audio stimuli. The questions were read out loud by the researcher and the participant had to answer orally. After they had answered the questionnaire, the same day we met at their training court and the researcher measured the participant's reaction time in real conditions. Reaction time in real conditions is the simple reaction time, the response to one stimulus [29]. The reaction time in real conditions was measured at the places that the athletes practiced their sports (soccer arena, goalball court). For the people who were non-athletes the reaction time was measured in a sport complex. Reaction time in real conditions was the interval between the appearance of the audio stimulus and the moment when the leg was risen from the ground to shoot and meet the ball. Finally, the researcher collected some demographic traits for every subject such as sex, age.

*Statistical analysis*

Quantitative data analysis was performed. For the analysis of the results, descriptive statistics was used first for the demographic characteristics, in order to calculate means and standard deviations. In order to investigate any correlations between the variables Pearson's correlation test was used. To explore differences among the means for various sports, the Independent t-test was applied, whereas to investigate differences between the four groups regarding their reaction time and psychopathology characteristics, variance analysis with an intersubjective factor was used, while for paired comparison testing the Bonferroni test was applied. These methods were selected, as the objective of the study was to identify differences between the groups and correlations between age and the variables. SPSS was used in order to analyze our data.

## Results

*The correlation of age compared to the reaction time of athletes and non-athletes with visual impairment and normal vision*

A statistically positive correlation was found between the age of individuals with reaction time in the drill of making contact with the ball with the right foot after a bilateral test was performed, with $r = 0.35$, $p = 0.03$. There was no statistical significance between the other variables and age.

*Comparison of the two sports regarding reaction time within the group of athletes with visual impairment*

In order to explore differences between the sports in the reaction time of individuals with visual impairment, the Independent t-test was used. A statistically significant difference was found between the two sports in the reaction time of shooting with the right foot in the first group (AVI) after a bilateral test was performed t(18) = = 3.65, p = 0.00. More specifically, a longer reaction time in shooting with the right foot was demonstrated by soccer athletes (M = 0.53, SD = 0.12) in comparison with goalball athletes (M = 0.40, SD = 0.03). A statistically significant difference was found between the two sports in the reaction time of making contact with the ball with the right foot in the two sports after a bilateral test was performed t(18) = 2.62, p = 0.02. Soccer athletes (M = 0.52, SD = 0.12) demonstrated also in this case a longer reaction time than goalball athletes (M = 0.42, SD = 0.05). A statistically significant difference was found between the two sports in the reaction time of making contact with the ball with the left foot, after a bilateral test was performed t(18) = 2.81, p = 0.01. The soccer athletes with visual impairment (M = 0.54, SD = 0.12) demonstrated again a longer reaction time compared to the goalball athletes (M = 0.43, SD = 0.06) (Table 1).

**Table 1.** Differences in reaction time among athletes with a visual impairment depending on the type of sport

| | Type of sport | Mean | Std. Dev. | t | p |
|---|---|---|---|---|---|
| Shot with right foot | soccer | 0.52 | 0.12 | 3.65 | 0.00 |
| | goalball | 0.40 | 0.03 | | |
| Shot with left foot | soccer | 0.50 | 0.14 | 2.09 | 0.05 |
| | goalball | 0.41 | 0.04 | | |
| Reception with right foot | soccer | 0.52 | 0.12 | 2.62 | 0.02 |
| | goalball | 0.42 | 0.05 | | |
| Reception with left foot | soccer | 0.54 | 0.12 | 2.81 | 0.01 |
| | goalball | 0.43 | 0.06 | | |

*Comparison of the two sports regarding the reaction time within the group of athletes with normal vision*

To investigate the differences between the sports in the reaction time of athletes with normal vision, the Independent t-test was used. Regarding the third group (ANV), statistically significant differences were found again between soccer and handball in the reaction time of shooting with the right foot, after a bilateral test had been performed t(18) = 2.74, p = 0.01. The reaction time in soccer (M = 0.40, SD = 0.04) was longer than the reaction time in handball (M = 0.35, SD = 0.03). Statistically significant differences were found between soccer and handball in the reaction time of shooting with the left foot, after a bilateral test was performed t(18) = 2.46, p = 0.02. The reaction time in soccer (M = 0.40, SD = 0.04) was longer than the reaction time in handball (M = 0.35, SD = 0.04). No statistically significant differences were found between soccer and handball in the reaction time of making contact with the ball with the right and the left foot, respectively (Table 2).

**Table 2.** Differences in reaction time among athletes without visual impairment depending on the type of sport

| | Type of sport | Mean | Std. Dev. | t | p |
|---|---|---|---|---|---|
| Shot with right foot | soccer | 0.40 | 0.04 | 2.74 | 0.01 |
| | handball | 0.35 | 0.03 | | |
| Shot with left foot | soccer | 0.40 | 0.04 | 2.46 | 0.02 |
| | handball | 0.35 | 0.04 | | |
| Reception with right foot | soccer | 0.41 | 0.03 | 1.8 | 0.9 |
| | handball | 0.38 | 0.05 | | |
| Reception with left foot | soccer | 0.42 | 0.04 | 1.31 | 0.21 |
| | handball | 0.40 | 0.05 | | |

*Anxiety in correlation to the reaction times in the 4 groups of individuals*

In terms of the correlation of anxiety with field reaction time, Pearson's correlations were used. A statistically positive correlation was demonstrated between the reaction time of shooting with the left foot and anxiety, after a bilateral test was performed with r = 0.22, p = 0.05. The bilateral test showed a statistically positive correlation between the reaction time of making contact with the ball with the right foot and anxiety, with r = 0.22, p = 0.05. No statistically significant difference was found between the reaction time of making contact with the ball with the left foot and anxiety. There was no statistically significant difference between each group and anxiety.

*The relationship of anxiety with reaction time for the group of athletes with visual impairment*

Regarding the investigation of anxiety in relation to the field time, Pearson's correlations were used. No statistically significant correlation was found between the reaction time of making contact with the ball with the right and the left foot and anxiety.

*Correlation of anxiety with reaction time for the groups of athletes with normal vision*

The correlation of anxiety with field reaction time for athletes with normal vision was investigated using Pearson's correlations. A weak statistically significant correlation was found between the reaction time of shooting with the right foot and anxiety, with r = 0.42, p = 0.06. A bilateral test showed a statistically positive correlation between the reaction time of shooting with the left foot and anxiety, with r = 0.47, p = 0.05. There was a weak positive correlation between the reaction time of making contact with the ball with the right foot and anxiety, as shown by the bilateral test with r = 0.43, p = 0.06. A weak statistically positive correlation was found between the reaction time of making contact with the ball with the left foot in relation to anxiety after a bilateral test was performed with r = 0.44, p = 0.05.

*Comparison of the reaction time in each group*

In order to investigate the differences between the groups in the reaction time and the personality traits and psychopathology characteristics, variance analysis was performed with an intersubjective factor, the population, at four levels, i.e. the four groups of the sample population. The analysis was carried out separately for each group of the population.

*Field reaction time in shooting with the right foot – group comparison*

It should be reported that there are statistically significant differences between the four groups of the sample in the reaction time of shooting with the right foot, with F(3.75) = 6.96 and p = 0.00. The Bonferroni paired comparison testing showed that the first group of the sample (AVI) in the field drill with the right foot did not demonstrate any statistically significant differences compared to the second group (NATB). Nevertheless, statistically significant differences were found (p = 0.03) between AVI (M = 0.44) compared to ANV (M = 0.37). There was no statistically significant difference between the first group (AVI) compared to NANV. Statistically significant differences were demonstrated between the second group (NATB) (M = 0.49) compared to the third group (ANV) (M = 0.37) (p = 0.00).

*Field reaction time in shooting with the left foot – group comparison*

It should be reported that statistically significant differences were found between the groups in the reaction time of shooting with the left foot, with F(3.75) = 9.86 and p = 0.00. The Bonferroni paired comparison testing showed that the first group of the sample (AVI) in the field drill with the left foot did not demonstrate any statistically significant differences compared to the second group (NATB). Statistically significant differences were demonstrated between the group of AVI (M = 0.44) compared to ANV (M = 0.37) (p = 0.02). There were no statistically significant differences between the first group (AVI) compared to NANV. Statistically significant differences are demonstrated again between the second group (NATB) (M = 0.51) compared to the third group (ANV) (M = = 0.37) at p = 0.00. There were statistically significant differences between the second group (NATB) (M = = 0.51) compared to the fourth group (NANV) (M = = 0.42) at p = 0.00. The comparison between ANV in relation to NANV showed no statistically significant differences (Figure 1).

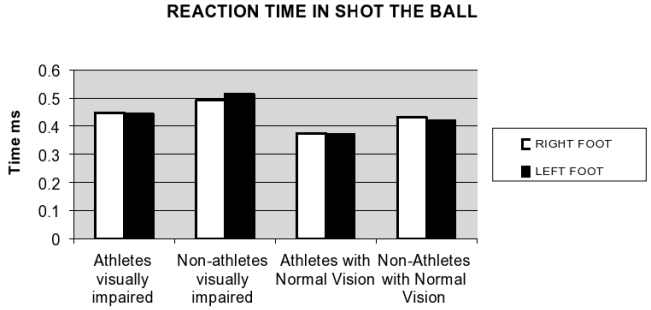


**Figure 1.** Differences in reaction time among the four groups in shot the ball with right and left foot

*Field reaction time in making contact with the ball with the right foot – group comparison*

It should be reported that statistically significant differences were found between the groups in the reaction time of making contact with the ball with the right foot, with F(3.75) = 11.43 and p = 0.00 (Figure 2). The Bonferroni paired comparison testing showed that the group (NATB) (M = 0.56) compared to (AVI) (M = = 0.46) demonstrated statistically significant differences (p = 0.00). The comparison between the group of AVI with the group of ANV did not show any statistically significant differences. Furthermore, no statistically significant differences were found between the first group (AVI) with the group of NANV. Statistically significant differences were demonstrated between the second group (NATB) (M = 0.56) compared to the third group (ANV) (M = 0.39) (p = 0.00). Statistically significant differences were demonstrated between the second group (NATB) (M = 0.56), compared to the fourth group (NANV) (M= 0.46) (p = 0.00).

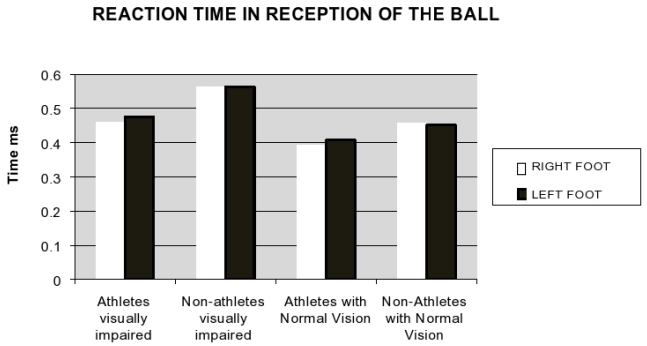


**Figure 2.** Differences in reaction time among the four groups in reception of the ball with right and left foot

*Field reaction time in making contact with the ball with the left foot – group comparison*

It should be reported that statistically significant differences were found between the groups in the reaction time of making contact with the ball with the left foot ($F(3.75) = 10.94$; $p = 0.00$). The Bonferroni paired comparison testing showed that between the group of NATB ($M = 0.56$) and the group of AVI ($M = 0.47$) statistically significant differences were demonstrated ($p = 0.00$). In contrast, no statistically significant differences were found between the group of AVI compared to the group of ANV or the group of NANV. Statistically significant differences were shown between the second group (NATB) ($M = 0.56$) and the third group (ANV) ($M = 0.41$) ($p = 0.00$). There were statistically significant differences between the second group (NATB) ($M = 0.56$) and the fourth group (NANV) ($M = 0.45$), ($p = 0.00$). The comparison between the group of ANV in relation to NANV did not show any statistically significant differences.

## Discussion

It is reported in the relevant literature that age plays a major role in the reaction time of adults; more specifically, as a person grows older his/her reaction time increases, whereas the younger a person, the shorter his/her reaction time [17, 19]. The fact that age shows a correlation with the reaction time of an individual in real-life conditions was only confirmed in the case of field reaction time in the drill of making contact with the ball with the right foot in the population sample with normal vision. In the other drills of reaction time there was no correlation with the age of the individuals. This may be due to the fact that, since the drill of making contact with the ball was more demanding, and when combined with the change from the drill of shooting the work of the participants became more difficult and thus, at this point, correlations were demonstrated with the age of the participants. Another possibility is that the size of the population sample of individuals participating in the study has an impact. In the study two sports were used in each group that consisted of athletes. Differences were identified between the two sports; while it may have been expected that soccer players are faster, since the drills were taken from this specific sport and they were more familiar with them, the opposite was observed. The relevant literature referring to differences in the reaction time between sports is rather scarce. In more detail, individuals with visual impairment who played goalball showed a faster reaction time than soccer athletes in the drill of shooting with the right foot, in the drill of making contact with the ball with the right and the left foot, respectively. Handball players with normal vision showed a faster reaction time than soccer athletes with normal vision. More specifically, the group with normal vision showed a faster reaction time in handball, in the drill of shooting with the right and the left foot. This was possibly due to the fact that in the first group (AVI) the mean age of the soccer players was relatively higher than the mean age of athletes who played goalball. Nonetheless, in the population with normal vision the group of handball players was of an older age, and also had a faster reaction time in relation to the group of soccer athletes. This is possibly due to the sport, which is different from soccer; therefore further research is required in order to investigate the reaction time in soccer compared to handball and other sports.

Next anxiety was investigated in relation to the reaction time of individuals. Anxiety shows a direct correlation with hypervigilance [26]. When a person is characterized by anxiety, the reaction time to a natural stimulus is longer than the reaction time to a negative stimulus [5]. Regarding anxiety before a match, the longer the anxiety, the longer the reaction time, showing a statistically significant correlation [7]. Athletes who showed less pre-match anxiety and faster reaction time were those who showed longer motor performance [7]. The argument that there is a positive correlation of anxiety with reaction time was partly confirmed by the research findings. More precisely, in the four groups overall a positive correlation was identified between anxiety and the reaction time of shooting with the left foot, making contact with the ball with the right foot, and the reaction time for the right and the left hand. In the group of athletes with normal vision a positive correlation was detected between anxiety and the reaction time of shooting with the right and the left foot. When it comes to the investigation of differences between the four groups of individuals, and whether blindness

affects the reaction time, the findings showed that there was a statistically significant difference between ANV and AVI in the field reaction time of shooting with the right and the left foot. The ANV group had a faster reaction time. To the best of my knowledge, no relevant literature has been found regarding the above finding, thus this specific result may not be fully substantiated. In literature it is reported that individuals who are born blind sometimes perform better in activities that require sound recognition than individuals with normal vision, as the former become familiar with the sounds more quickly [9, 12]. Individuals with blindness demonstrate better perceptual processes such as reaction time to auditory stimuli, when compared to individuals with normal vision [30]. When an audio-tactile stimulus is near a visually-impaired person, that person responds faster to such sounds [10]. It is also reported that the standard reaction time to auditory stimuli in partially blinded subjects is longer than in subjects with normal vision [16]. Nevertheless, there are several studies that do not identify any differences in terms of standard reaction time between visually impaired individuals and individuals with normal vision [8, 9]. The findings of this study contradict most literature sources. The above finding can possibly be justified first by the fact that the sample population with visual impairment that was used in this study did not consist exclusively of blind individuals, but also of individuals with severe visual impairment. Another argument to substantiate the finding that ANV demonstrated faster reaction time than AVI is the fact that the sample population used in the study was specific and limited. Statistically significant differences were identified between NATB and NANV. This finding was identified in the field drills of shooting with the left foot and making contact with the ball with the right and the left foot. In these cases NANV were faster. In terms of the effect of sports on the reaction time of individuals, the findings showed statistically significant differences between NAVI and AVI. The AVI participants were faster in the field drill of making contact with the ball with the right and the left foot. Statistically significant differences were also identified between NATB compared to NANV. In turn, ANV were faster in all the field drills than NATB, except for the comparison of AVI with NANV, where the visually impaired dominated, while the individuals with normal vision were faster.

According to literature, practice improves reaction time in athletes [19, 31]. Through athletic drills and thanks to sports reaction time can be improved by 0.12 seconds [17], which is the reason why athletes appear to be faster. The literature agrees with the findings, since it is reported that sports play an important role in the everyday life of any person, and the same applies to his/her mental functions. Individuals who are involved in sports demonstrate statistically faster reaction time compared to those who are not involved in sports [1, 17, 23, 31]. There is a statistically significant difference in the reaction time after auditory stimuli between athletes and non-athletes who play soccer [28]. There is a statistically significant difference in terms of auditory stimuli between professional athletes, amateur athletes and non-athletes regarding their physical reaction time [6].

This study had also some limitations. For instance, a convenience sample was used, as we visited a specific place where people with severe visual impairment or blind people live. We also measured their achievement in specific sports, such as goalball and soccer. Moreover, our study was a cross-sectional study. Future researchers can measure athletes' achievement in more cases in a year.

## Conclusions

In terms of the practical implication of research findings it should be noted that the level of blindness influences reaction time in sports, since it enhances the reaction time and can improve it. In the field of sports reaction time plays a prominent role, since it is one of the factors that affect the final performance of a person. Anxiety is also a trait that people cope with in their everyday life, including sports. It should be reported that individuals with no impairment as well as individuals with special needs (e.g. blind, deaf) can become more functional, independent and calm in their everyday life, provided that they have developed their reaction time.

## Conflict of Interests

The authors declare no conflict of interest.

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