Original Article

Effects of Sports Visual Training on Eye-hand Coordination and Perception of Depth among Adults Afflicted with Impaired Vision Acuity

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Abstract

Background: the effect of sports visual training on perceptional and kinetic performance has been long studied by scholars among subjects with vision impairment, with main variables considered as the degree of impairment and individual's age. Most of recent studies have directed the acute impairments as well as children groups. Considering the large population of those adults suffering from vision acuity impairment, this study attempts to investigate the same group of subjects. **Purpose:** the main purpose of this study has been to investigate the effects of sports visual training on eye-hand coordination and perception of depth among adults with impaired vision acuity. **Materials and Method:** the method used to conduct this study was quasi-experimental through the use of pre-test and post-test. The sample has been selected through availability sampling method from the population of 21-27 years students in University of Tehran with average age pf 24.6+2.8 who had impaired vision (nearsighted). A total of nine subjects have been selected. At first, eye-hand coordination test and perception of depth has been conducted. Then, the subjects took part in 18-20 sports training sessions and at the end of the sessions, depth perception test has been conducted. **Results:** the results of correlated T-test between pre and posttest showed that the visual training protocol significantly impacted the eye-hand coordination, in terms of the number of error factors as well as maintaining the error status (p=0.002, p=0.012); however, there wasn't any significant difference in terms of timing (p=0.130). Besides, the implementation of sports visual training protocol significantly impacted depth perception as well (p=0.001). **Conclusion:** the results of present study can be used to improve eye-hand coordination among adult subjects with impaired visual acuity to improve their perception of depth and eye-hand coordination.

Keywords: sports visual training, eye-hand coordination, depth perception, impaired vision, adults

Introduction

Vision is considered as the main source of sensory information in controlling human's coordinated and voluntary movements. The normal vision range according to Snelen chart is 10/10 for each eye. However, the vision acuity impairment till a range of 10/7 is considered as low visual acuity impairment and an acuity lower than 10/7 is considered as strong vision acuity impairment [1, 2]. Previous studied showed that poor vision will impact balance, reaction time, perception of depth, hands-eye coordination, and doing micro movements [3]. Accordingly, perception of depth is the ability to see things as 3D artefacts and being able to determine the distance between one's self to the thing or the distance between things. This is defined in the light of integrating the incurred difference in any of the eyes while observing the same phenomenon [4]. Factors such as age, impairment in hemispheric functioning disease such as amblyopia, astigmatism, and poor vision acuity result in the disturbance of depth perception potential [5, 6]. In addition, hand-eye coordination is considered as one of the most significant sensory-kinetic mechanism which controls eyes and hands in a united performance unit [7]. Poor eye-hand coordination may happen as a result of low cognitive potentials as well [8]. The literature illustrate that visual training can improve vision acuity impairment in nearsighted subjects to a great extent. though the efficacy of such kind of training protocol has been long debated for improving vision acuity impairment for longer distances and improvement of their fine motor skills, the evidence suggest that depth-learning related parameters are considered as an effective intervention in improvement of vision impairment disorders [9]. Generally, subjects with vision impairment disorders who are investigated by scholars

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most of the time are children, and those subjects with severe vision acuity impairment such as amblyopia (strabismus). According to the literature, the best golden age for treatment of visual disorders is ages 3-5 years and 5-7 years and treatment of visual disorders ay become harder for the individual patient from 18 year old onward due to loss of flexibility in visual system [10]. Therefor scholars consider the medical interventions for adults with vision acuity impairment and amblyopia as something unreal [11]. Among the medical interventions recommended for this group of patients, one can refer to insertion of pads, surgery, the use of medical lenses and glasses and sports visual training protocols which has been noticed more in recent years. [2, 6, 12]. Though medical glasses are capable of compensating for vision acuity impairments; however, the sensorimotor weaknesses seem to be persistent while they're not in place. The literature suggests that visual system can be improved just like any other physical systems through particular visual taraining [13]. Visual system responds well to the overload itself just like muscular-skeletal system. Even the perceptional components of the visual system can be improved through doing sports visual training [14]. Meanwhile, it seems that sports training protocols will strengthen sensory and performance aspects based on sports-medical interventions and through implementation of visual training protocols [3]. Subjects with impaired vision acuity face obstacles which may constrain permanent cooperation in sports activities in addition, physical education teachers consider those with vision impairments as one of the most challenging groups to learn physical education skills [15]. Poor visual acuity may negatively affect human's life quality, especially in childhood and teenage year and significant performance-related and mental consequences are observed for those with visual impairments a compared with healthy population considering the rise of weak visual impairments as well as the fact that the number of individuals afflicted with poor visual impairments is the times the individuals with acute impairments and blindness, therefore, it's required to implement rehabilitation services such as visual training, perception-related training, sports visual training protocols, and biofeedback training protocols in order to heighten performance-related potentials and improvement of patients' mental health and life quality [16]. Accordingly, this study seeks to investigate the effects of sports visual training protocols among adults with poor vision acuity impairments in order to heighten hands-eye coordination and perception of depth.

Materials and Method

Considering the predicted findings and purposes, this study is considered to be quasi-experimental with pre and posttests. The sample for this study included 21-27 years old male students studying for a degree in Tehran University who were afflicted with vision acuity impairment (nearsightedness) in a range of 7/10-9/10. At first, 15 participants have been selected as the sample. Six of them have been dropped due to irregular presence in training sessions. Finally, the research sample included nine 21-27 years male students with an average sage of 24.6+2.8. After gaining written consent and determining their vision acuity, hands-eye coordination pretest has been undertaken using Vina instrument three sub-factors including total number of errors, maintaining the error status and movement time have been documented as the scores for hands-eye coordination. Then, depth perception pretest has been conducted in three attempts and their mean scores have been calculated as their depth perception scores after four weeks, five sessions each and each sessions lasting for 50-60 minutes doing sports visual training (a total of 18-20 sessions), with one day reminder interval, hands-eye coordination and depth perception posttest has been conducted. It's noteworthy that implementation of all study phases including pre and posttest, and sports visual training protocol has been undertaken with their own medical glasses.

Instruments

1) Vina device (manufactured by Lafight, USA) available in Physical Education Faculty's laboratory of Tehran University in order to measure hands-eye coordination in pre and posttest. In this test, the individuals use two levers; the right hand lever moves in up/down direction and the left hand leer moves in left and right directions. The subjects must take the ball displayed in the monitor from point A to point B without being strayed form the path. At the end of the posttest, individual's score will be documented based on total number of errors, maintaining the error status duration (when the ball is located in a point out of the curved line until the time it will be inserted in the path once again) and total movement time from A to B.
2) Depth perception instrument, B122 model (manufactured by Lafight, USA) has been used I order to assess subject's perception of depth.
3) A video projector to display video training protocols and a tennis ball in order o implement visual-sports training protocols.
4) Two ping pong tables and rockets to practice ping pong.

Sports visual training protocols

Each subject is required to participate in four points including throwing the ball to 1 checkered-like board and moving Seibel, ping pong exercise, and tracking the suspended ball. It's noteworthy that all the training protocols have been researcher-made.

a) Throwing ball to checkered board's stimulants

In this phase of the study, a checkerboard with a high number of sections is displayed through a video projector. The English alphabet appear randomly in white parts of this checkerboard and they disappear within a short time. The subjects would through the tennis ball to the goal using both their dominant and non-dominant hands (five minutes each). From fifth session on, variations have been made in training protocols regarding the emphasis on precise hitting of the moving objects, emphasis on throwing speed, hit cycle and receiving ball with both dominant and non-dominant hand

and subjects' distance from the wall. The main purpose behind doing so was to prepare the subjects further.

b) Throwing ball t moving Seibel

In second phase of the study, an animation from a moving shooting Seibel is displayed on the wall for the subjects through the use of a video projector. This shooting table is divided into three equal sections, which has been stable in two lateral sides and the central part was moving, such that the central part of the Seibel was moving back and forth as compared with lateral sides. Meanwhile, three parts of the Seibel would approach each other in a particular moment. The subject is required to throw and receive the tennis ball to eh center of the Seibel (five minute for each hand). Just like the previous training protocol, variations has been made in the training protocol from fifth session onward.

c) Table tennis training protocols

In third phase of the study, each of the participants have been confronted with the experimenter and they started forehand and backhand movements in table tennis after 10 minutes of warm-up. After 10-20 minutes, they must de forehand and backhand hits in a cyclical manner. After 10-20 minutes practice with dominant hand, they were asked to do it once again with their non-dominant hand (they were required to practice repeatedly and consecutively while working with their dominant hand and while working with non-dominant hand, the tester sent the ball using hand). Just as the previous training protocols, variations has been made in training protocols from fifth session onward. For instance, the table has been divided into some parts using a tape strip and the participants were required to send the ball to those parts the tester would ask them. For instance, the table has been divided into behind the net, center of the table and end of the table. The participants were to throw the ball repeatedly to these sections. This training protocol has been implemented using both dominant and non-dominant hand. It's noteworthy that forehand and backhand hits have been included from 8th session onward. In addition, in the last three sessions of training each participant has been given two rockets to practice the movements using both dominant and non-dominant hand. It's also noteworthy that the training time has been extended just because the participants didn't have enough past experience in playing table tennis.

d) Suspended ball training protocol

e) In fourth point, each of the participants have been standing in a 70-80 cm distance from a tennis ball connected to the rope which has been located in 170 cm distance from ground level. The participants were required to hit the suspended ball slowly. Then, ball started moving in different directions. The participants were asked to follow the ball path with their eyes and with their head and neck kept in a constant position. This training protocol lasted for 3-5 minutes.

Statistical analysis

Descriptive statistics have been used to record to scores of eye-hand coordination and depth perception pre-tests, post-tests. Then, Shiprowilk test has been used in order to test the normality of data distribution. Besides intra-group comparisons have been made using dependent T-test with a significance level of p=0.05. SPSS version 16 has been used to statistically analyze the data.

Results

In general, the results showed that sports training protocols improves hands-eye coordination among the subjects and therefore reduced the number of total errors and duration of maintaining error status. However, no significant difference has been observed with regard to genera factor of movement time. In addition, the results show that sports training protocols significantly reduced errors related to depth perception among the participants.

Table 1: descriptive statistics

Variable	Group	
	Pretest	Posttest
Hand-eye coordination	SD+mean	SD+mean
Total time	17.45+4.9	24.19+19
Duration of maintaining error status		
Total number of errors		
Variable		
Depth perception	18.14+2.06	9.25+1.29

The results of dependent T-test for comparison of hands-eye coordination pretest and posttest with regard to total number of errors (p=0.012 and t=3.237) and duration of maintaining error status (p=0.002, and t=4.643), illustrates a significant reduction in posttest; however, no significant difference has been observed in total duration of movement from pretest to posttest (p=0.130, and t=1.689) (Figures 1 and 2). Furthermore, the results of dependent T-test displayed a significant reduction from pretest to posttest in terms of depth perception error (p=0.001, and t=6.442) (Figure 3).

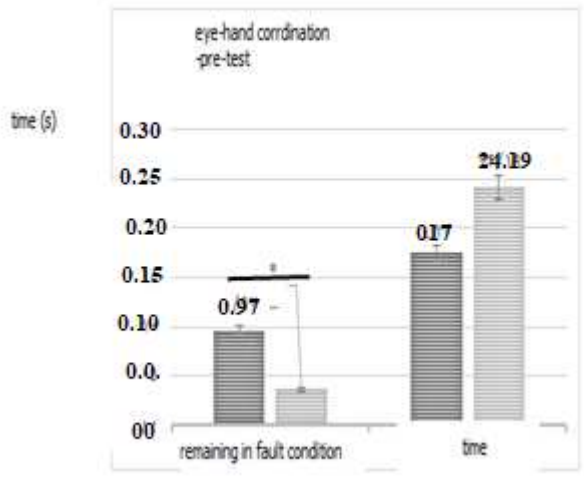

Figure 1: hand-eye coordination curve with regard to factors including total implementation time and maintaining the error status

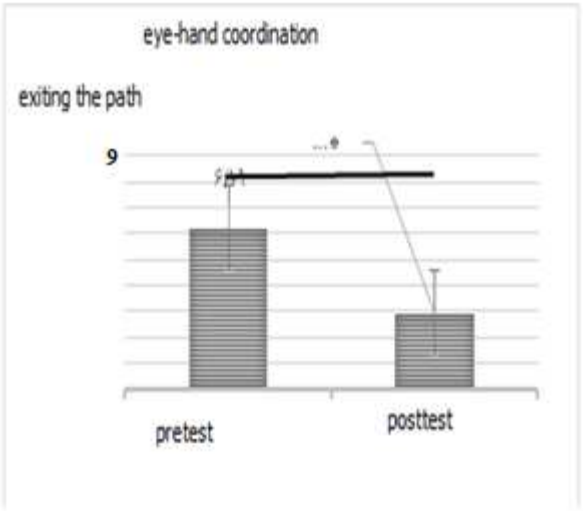

Figure 2: hands-eye coordination curve with regard to total number or errors

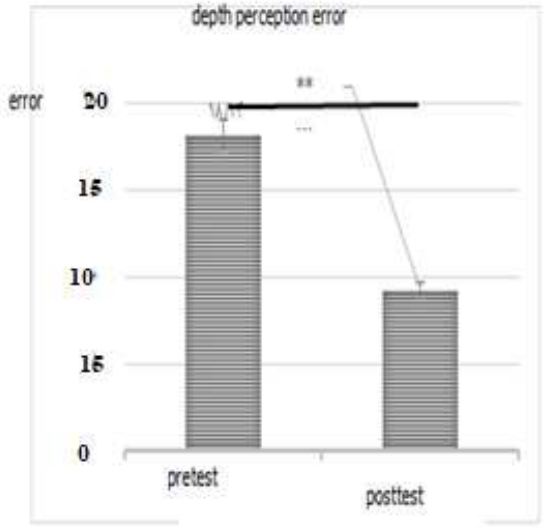

Figure 3: depth perception curve

Discussion

This study was an attempt to investigate the impact of using sports visual training protocol to improve hands-eye coordination and depth perception among adults with impaired vision acuity. The difference between present study, with previous ones is that most of the previous studies implemented sports visual training protocols for athletes or individuals with severe vision acuity impairment such as strabismus. Though individuals with minor vision acuity problems compensate their sight capability with medical glassed, but they have been ignored due to necessities to study more severe cases. On the other hand, children and kids are another group with deficient vision, with more hopes for their recovery. Meanwhile, this study sought to attempt the adult group. The general indication of this paper was that sports visual training protocols greatly impacted hands-eye coordination and depth perception among the subjects under study.

According to inferential statistics conducted here, researcher's hypothesis with regard to the impact of sports visual training on eye-hand coordination and depth perception has been proved with regard to the total number of errors and maintaining the error status; however, no significant difference has been observed with regard to total movement time in pretest and posttest. One of the possible explanations is that the subjects have reduced their speed in training implementation due to more emphasis put on precision and accuracy. Accordingly, Ellison et al. (2020) found that stroboscopic visual training had a positive impact on hands-eye coordination among male participants [17]. On the other hand, Tupper (2019) found that sports visual training protocol significantly impacted hands-eye coordination and sports skills among baseball players [18]. Azimzadeh et al. (2015) also pointed out to the positive impact of sports visual training on visual abilities including hands-eye coordination [19]. Shandiz et al. (2018) suggested that visual training has a positive significant impact on hands-eye coordination among students with impaired vision [20]; however, such training protocols didn't result in improvement in vision acuity. Meanwhile, Abernethy and Wood (1997) declared that sports visual training didn't have any significant impact on visual-motor capabilities [21].

Furthermore, the results of this study point out to the significant impact of sports visual training protocols on improvement of depth perception among the participants. In a similar study, Maman et al. (2013) investigated the impact of sports visual training protocols on 45 table tennis players in university level. After eight weeks, it has been argued that sports visual training group performed well with regard to factors such as reaction time, depth perception, compatibility prediction, and jumping movements [22]. Accordingly, Balasaheb et al. (2008) who conducted a study to investigate the impact of visual training on Cricket players' performance, found that the group who undertook visual training besides skill training sessions, performed better in all visual abilities including depth perception, coordination, reaction time, and eye's jumping movements [14]. Shahbi et al. (2018) also investigated the impact of visual and motor training on movement-dependent visual perception components among 5-8 years children with amblyopia [23]. Finally, the results suggested that visual components such as depth perception, dynamic vigilance, and visual following among experimental group participants was better that control group participants [23]. Birch et al. (2015) also conducted a study on pre-school children afflicted with amblyopia through two-eye treatment protocol [24]. They found that four weeks of visual training, eight hours a week, using iPad games (without eye closing method) may improve vision acuity impairments.

On the other hand, Shoja and Arabamiri (2012) found that visual and skill training sessions didn't make any significant difference in aging women's sensorimotor skills. This incongruity may be explained in the light of higher age of the

participants, physical readiness level and similarity of depth perception exercises with depth perception test in the present study. Besides, Ludeke (2003) conducted a study on Rugby's professional and non-professional players and found that hardware visual skills including sharpness, adjustment, and depth perceptions are more inherent and they didn't significantly change after training [25]. On the other hand, Abertheni and Wood (2001) doubted about the efficacy of sports visual training on the improvement of motor performance and visual skills [26]. They divided 40 participants equally in four visual training groups of Roin and Gipour, sensory visual training (video training), placebo group (watching table tennis skills), and control group (motor training only). After four weeks of training, no result regarding the improvement of visual-motor skills hasn't been observed. This can be explained in the light of not using proper training protocols and lower duration of these training sessions in the mentioned study. Basiri et al. (2011) studied the impact of four weeks of visual and skill training on the improvement of tennis players' sensory and motor skills and they found that these training protocols didn't have any impact on depth perception among the participants [27]. It's possible that this stable status may be due to short duration of training protocol.

Considering the information collected in this study, one can argue that the use of sports visual training in the form of a new approach is a good intervention to treat visually impaired patients. However, those patients with low vision acuity impairment have been less noticed by scholars due to the fact that their problems weren't as much severe. Further, according to general public, higher age would slow down the process of improving vision-related problems. Therefore, it's recommended that this group would be studied by scholars because they form the majority of the society it's recommended to include enough number of both sexes in future studies. On the other hand, the stability of such training protocols must be investigated in 36 months periods through reminding and transfer tests in order to investigate their efficacy.

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