Reduce Depth Perception Error by Viewing 3D Images Compared to 2D Images

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Keywords	Abstract
	Background: Depth perception is a visual component that allows individuals to judge accurately the distance of objects and it is involved in many of the motor skills involved in locating, hitting and grasping to objects. Therefore, evaluating interventions to improve depth perception can be effective in increasing motor skills efficiency. **Objective:** The purpose of this study was to investigate the effect of viewing 2D and 3D images on the depth perception of female athletes' students. **Methods:** The participants were 30 female students of the Faculty of Physical Education of the University of Tehran (with an average age of 21±2 years) who participated in the research in an accessible way. The instrument used was the B122 Depth Electrical Testing Device. First, all participants were given a pre-test of depth perception (5 trials). Then the participants were randomly divided into 3 groups of 10 persons (control group, two-dimensional image group, and three-dimensional image group). After intervention, post-test of depth perception was performed. **Results:** Results showed that the difference between the post-test scores of depth perception at the error level of 0.05 was significant (P = 0.012). Also, the three-dimensional image group showed less error in the depth perception test than the two-dimensional image group (P = 0.003). **Conclusions:** Based on the findings of this study, 3D displays can be used as a tool to facilitate the educational process of sports disciplines that require high depth perception.

Introduction

One of the most important and widely used senses in humans is vision, so that sometimes the information of other senses is challenged and questioned. Sight plays an important role in regulating many human behaviors, including movement in the environment. Depth perception is one of the most important components of the visual system that affects motor function (Hambooshi, ArabAmeri, Shahbazi & Zeidabadi, 2018). In other words, depth perception is a visual component for receiving a three-dimensional world that allows the viewer to accurately judge the distance between objects and to understand and estimate the distance

between objects and their body (Zareiyan, Razdan & Tahmasebi, 2016). and try Improving it plays an important role in improving the functioning of the visual system (Eskandarnejad, Rezaei & Jahedi, 2018).

Visual recognition and perception of objects have different dimensions and can be considered from different perspectives. The first classification for the purpose of visual recognition and understanding of objects is two-dimensional and three-dimensional. Two-dimensional images have two dimensions of length and width, while in three-dimensional images, depth is also present as a third dimension (Ahmadi, Pourahmadi & Rastegari,

2016). In fact, 3D images are more complex than 2D images. (Nejati, 2015) Understanding the third dimension (depth) in images as well as sports situations, especially in sports that require accurate spatial positioning and in general in many movement skills that deals with locating, hitting and grasping moving objects plays an important role in the athlete's success. According to research, several factors such as color, fear, physical health, fatigue, etc. affect the perception of depth. (PourHosseini & Tahmasebi, 2018). Some previous research has shown that 3D viewing is more effective than 2D images in spatial memory performance (Tavanti, 2001) beneficial effect of advanced 3D graphics for interacting with a wide range of information structures (Franck & Ware, 1996). In a study entitled "Three-dimensional information in face recognition: an eye-tracking study", the findings showed that three-dimensional conditions facilitate face recognition for participants (Chelnokova & Laeng, 2011). In another study, comparing two-dimensional and three-dimensional images in learning neuroscience, it was concluded that three-dimensional images lead to better learning (Nejati, 2015). Indicocoburnomensky (2004) also concluded that 3D computer displays were more effective than 2D computer displays for spatial memory (Cockburn & McKenzie, 2004).

While in some other studies, different results have been obtained. In a study by Kokborn (2004), the findings showed that the presentation of three-dimensional images had little effect on the performance of spatial memory compared to two-dimensional images in static monochromatic

representations; Instead, the significance and distinctiveness of the content of the images has had a great impact on spatial memory and performance (Cockburn, 2004). Another study also reported that using a two-dimensional map of the earth for more accurate positioning was better and more effective than using a three-dimensional view (John, Harvey, Smallman, Oonk & Cowen, 2000). In a study to investigate the effect of training on three-dimensional laparoscopic systems versus two-dimensional systems to acquire laparoscopic skills, they did not observe a significant difference between the three-dimensional and two-dimensional groups (Noureldin, Stoica, Kaneva & Andonian, 2016). In another study in the field of psychology, although no significant difference has been reported between 2D and 3D video games, its positive effect on students' creativity and problem-solving styles has been confirmed (Khorrambakht, Hosseini & Pakizeh, 2016).

Given the importance of depth perception in various sports, it can be important to examine the factors affecting it. Another important issue that can be considered in training and achieving athletic performance is to be able to consider strategies to improve depth perception. Therefore, considering that there have been discrepancies in previous research and so far no research has examined the effects of observing two-dimensional and three-dimensional images of depth perception, so it seems necessary to conduct research in this field. Therefore, the primary challenge is the effectiveness of two-dimensional and three-dimensional images on depth perception. The

second challenge is to compare observations with two different dimensions.

Method

The research design was pre-test-post-test with the control group and the present study was a semi-experimental study and in terms of purpose was practical.

Society and Statistical Sample

The statistical population of the study included female students (18-22 years old) of the Faculty of Physical Education, University of Tehran in the second semester of the bachelor's degree in the second semester of 2009-2010, 30 of whom participated in the present study voluntarily. Inclusion criteria included no visual abnormalities. The sample size was calculated according to scientific estimates (using G-Power software with a reliability of 0.8 and an effect size of 0.25 for the statistical method of analysis of covariance), 30 people who were randomly divided into three groups of 10 people (two-dimensional, three-dimensional and control) were divided.

Tools

1 - Electric depth tester tester model B122

The B122 (Takaie Japan) electric depth perception tester has three vertical bars, the middle of which is moved back and forth by the button. The speed at which the center bar can be moved is 25 and 50 mm / s, which in the present study used a speed of 50 mm / s to better differentiate the functions. The device has a chassis that the subject, while standing at a distance of two and a half meters from the bars,

when he realizes that the middle bar is parallel to the two side bars, must push it. The data obtained from this tool were used in centimeters and based on the calculation of the mean error.

2 - Flash cards with two-dimensional and three-dimensional images

Flash cards with two-dimensional and three-dimensional images were other equipments that were used in this research. A total of twenty flash cards were prepared, of which ten flash cards were used for the 3D group including 3D images and ten flash cards for the 2D group including 2D images. The images in the 3D and 2D group flashcards were similar and the only difference was in the dimensions of the images.

The process of conducting research

After obtaining informed consent from the participants to participate in the study, the input criterion was considered in the form of a questionnaire for the participants in order to ensure non-interference of visual abnormalities and problems as a result of the research. Participants were then explained how to take the test, and then the depth perception pre-test (5 attempts) was taken from all participants for three minutes (Menant, George & Lord, 2010). The groups then underwent their own intervention. Thus, the control group did not see any images between the pre-test and the post-test, and only in terms of time with the other groups, the distance between their two tests was observed. In the two-dimensional images group, participants viewed ten two-dimensional images in the form of flash cards, and in the three-

dimensional images group, three-dimensional images were viewed in the form of ten cards. At the end of the intervention, a depth perception post-test (5 attempts) was performed for three minutes (Menant, George & Lord, 2010).
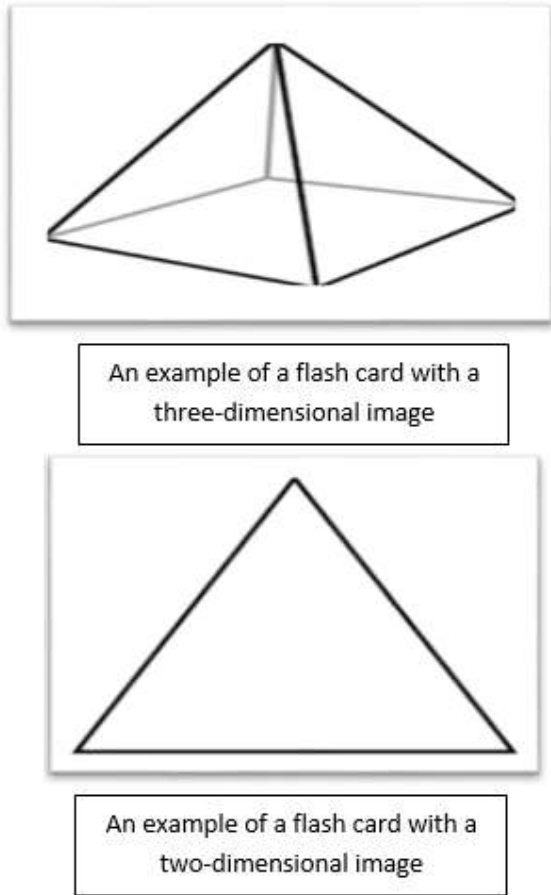

An example of a flash card with a three-dimensional image

An example of a flash card with a two-dimensional image

Figure 1: Example of a flash card with a two or three-dimensional image.

Statistical Method

For statistical analysis using descriptive statistics (mean and standard deviation), the subjects' scores in the pre-test and post-test for each of the three groups were calculated. Then, using the Shapiro-Wilk test, the normality of the data distribution was tested. Due to the normal distribution of the data, the univariate analysis of covariance was used to test the effect of two-dimensional and three-dimensional images on the depth perception of female students; In this way, post-test scores were considered as a dependent variable and group membership was considered as an independent variable and pre-test scores of individuals were considered as a covariate variable. The analyzes were performed in Spss software version 20 and the significance level was considered 0.05. Excel version 2016 was also used to draw the chart.

Results

Table 1 shows the mean and standard deviation of the subjects' depth perception scores by test turn and group.

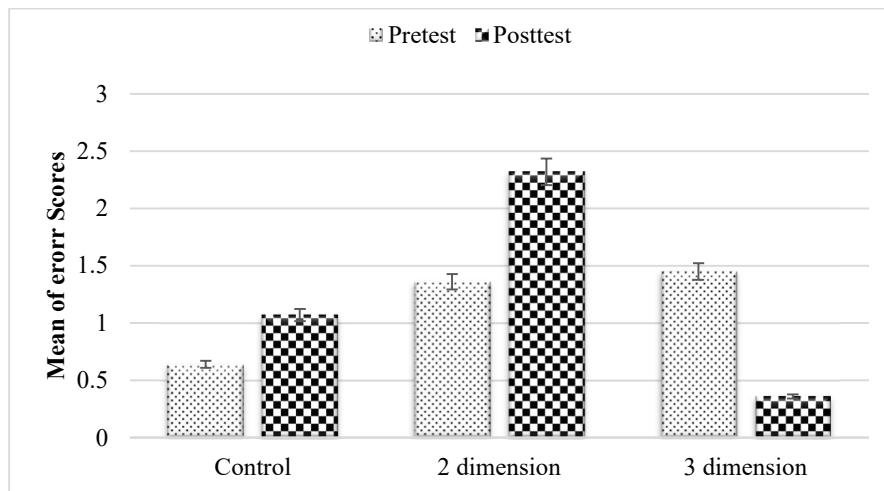**Table 1: Mean and standard deviation of the subjects.**

Group	Pretest		Post-test	
	Mean	Standard Deviation	Mean	Standard Deviation
Control	0.64	2.09	1.07	2.03
2D Images	1.36	1.75	2.32	1.91
3D Images	1.45	1.25	0.36	1.19

Then, before comparing the scores in different modes using Shapiro-Wilk test, the normality of data distribution was checked and confirmed (P /0 0.05). Equality of variance was also confirmed by Leven test (P /0 0.05).

The results showed that there was a significant difference between the pre-test depth perception scores in the groups (P = .3822η, P = .0003, 16.04 = (1,26) F). The results of analysis of covariance showed that there was a significant difference

between the groups in the depth perception error test (P = .2872η, P = .012, 5.24 = (2,26) F). In order to find a significant position, it was shown (Figure 1) that the three-dimensional image observation group (1.19 36 .36) had less error than the two-dimensional group (2.32 ± 1.91; P = .003), but they

were not significantly different from the control group (1.07 ± 2.03; P = .068). Also, no significant difference was observed between the control group and viewing two-dimensional images (P = .221).

Figure 2: Results of LSD post hoc test the average difference is at the level of 0.01 Mean of error scores.

Discussion and Conclusion

The type of visual images is one of the important visual factors that in the present study, two-dimensional and three-dimensional flash cards were used to investigate its effect on depth perception. The results showed that viewing 3D images leads to better depth perception, while viewing 2D images does not have a significant effect on depth perception. 3D images seem to make more environmental information and signs available to people and increase the possibility of exploiting environmental signs; Therefore, people can do the task better by relying on more environmental signs related to the task.

The results of the present study are consistent with the results of Andy Cockburn and Mackenzie (2001). Cockburn and McKenzie argued that the

use of 3D representations leads to better performance in the field of mental evaluation (Cockburn & McKenzie, 2001). Franck & Ware also stated that the use of advanced 3D graphics to interact with a wide range of information structures. (Franck & Ware, 1996) Tavani and Lind, in their research, concluded that viewing three-dimensional images compared to two-dimensional images leads to better performance of individuals' spatial memory (Tavanti, 2001).

As can be seen, the presentation of the three-dimensional images resulted in a better perception of depth, which contradicts the findings of Andy Cockburn and Bruce Mackenzie. The reasons for the discrepancy include differences in gender (in the present study, only girls were used as subjects), differences in tools and the type of homework used.

Cockburn and McKenzie concluded that the three-dimensional physical and virtual environment leads to more disruption of people's spatial memory and has a devastating effect (Cockburn & McKenzie, 2002). It also contradicts the findings of research by John, Harvey et al. They stated that the use of a two-dimensional map of the earth for positioning is more accurate and better than three-dimensional visibility (John, Harvey, Smallman, Oonk & Cowen, 2000).

The findings of the present study can be justified by stating that 3D displays increase flexibility. Flexibility means the ability to change the direction of thought or the ability to generate diverse ideas, based on different perspectives. People with high flexibility do not think and act in a certain frame, and are able to think about the problem from different angles. (Sadat Hosseini & KhorramBakht, 2017) Viewing 3D images increases a person's ability to generate diverse ideas from different perspectives. In addition, the 3D display provides more effective information on the spatial position, shape, size and positioning of objects, leading to more search in the environment (Palmisano, 2002). Receiving more and more effective information from the environment in turn leads to a more comprehensive and complete understanding of the environment, which provides the basis for better performance of the individual. On the other hand, due to the fact that three-dimensional displays provide positive and stronger emotions than two-dimensional displays (Rajae-Joordens, 2008); Therefore, psychologically, they create a positive stimulus in the person and can lead to a better understanding of the environment.

Findings of Schild et al. (2012) show that spatial imagery and simulation occur more in three-dimensional representations (Schild et al., 2012) and therefore these representations can lead a person's perception to be more meaningful, and have a facilitating and understanding role.

According to the contents that show that the display of 3D images has a positive and significant effect on the perception of depth of people, the authors are suggested to use more 3D displays in the content of textbooks. Sports coaches can also use 3D displays to teach skills and concepts. Due to the limitations of this research in the field of collecting subjects, it is suggested that researchers who intend to conduct research in this field in the future, use professional athletes in disciplines such as basketball and table tennis as subjects, and evaluate the effect of observing two-dimensional and three-dimensional representations on their perception of depth. They can also use virtual reality glasses in their research instead of designed 3D images.

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