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The effect of neurofeedback training on the anxiety of elite female swimmers

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ABSTRACT

The purpose of the present research was to study the effect of neurofeedback training on the anxiety of elite female swimmers. To that aim, 20 professional swimmers were selected through purposive sampling and were randomly divided into an experimental and a control group. The procedure of the research involved 12 sessions (45 min per session) of neurofeedback training with two protocols: (1) increased SMR activity and decreased high beta and theta activity, (2) increased beta activity and decreased high beta activity. Before the training, the pretest was administered using SCAT and then the posttest was administered. Two-factor analysis of variance (2×2) was applied for data analysis and the results were: the main effect of test and the interaction between test and group were significant, but the main effect of group was not significant. Given the significance of the interaction between test and group, correlated t-test was applied to compare the pretest and posttest scores of each group. The results indicated that there is a significant difference between the pretest and posttest scores of the experimental group in anxiety. Yet this difference was not significant in the control group. Correlated t-test was also applied to compare the two groups in the pretest and the posttest. The results revealed that in the pretest there was no significant difference between the groups in terms of anxiety, but this difference was significant in the posttest. It can thus be concluded that neurofeedback training reduces anxiety in elite female swimmers.

Keywords: Neurofeedback, Anxiety, Elite Female Swimmers.

INTRODUCTION

During the past few decades, psychologists, exploring various mental conditions, have studied the mental states of people in stressful situations and have tried to discover ways of improving and treating such conditions; the world of sports has not been an exception [1]. Anxiety has also

benefitted from such therapeutic methods as pharmacological and non-pharmacological treatment [2].

Research has shown that people are better able to control their body functions when they have more information about these functions. Feedback maintains that humans are able to voluntarily control their body [3]. One of the interesting non-pharmacological methods that have received increasing attention from scientists and psychologists is biofeedback. Biofeedback is the process of recording and sending biological data back to a trainee [4]. In this method, information about the biological functions of the body is provided to the person using the instruments attached to the body [5]. Biofeedback training conducted with athletes has demonstrated a variety of results including the enhancement of self-control, the prevention and treatment of overtraining and athletic injuries, the reduction of competition anxiety, and the encouragement of perceived control [8]. Neuro feedback is a modality of biofeedback in which people receive feedback of input signals that are related to their subconscious neural activities as the basis of that learning. All mental states are controlled by the brain. The nature of a neural message in a cell is as electric current. The electrical activity of neurons at the scalp leads to the formation of electrical activities in the brain called brainwaves (delta, theta, alpha, sensorimotor response wave, beta, and gamma). There is no doubt about the effect of brain on physical activity. Sport psychologists have frequently observed that most athletes tend to reduce anxiety during stressful activities and the conditions of the game. For an experienced athlete, improving attention in the most stressful situations and achieving peak performance means title. At higher levels of competition, mere training and simple exercises are not enough for achieving peak performance and it is imperative to provide the athlete with new situations for achieving such a level. These days there is not much physical difference between sport champions, but what matters is their mental readiness and psychological state [1].

Many athletes are not aware of their pattern of brainwaves (for it is these waves that mental states) or of the fact that like any other complex system the brain needs to overcome its shortcomings; thus, they cannot monitor them and control their mental states and as a result this problem can affect their performance in critical situations, especially during competition, and can lead to defeat [7]. Since neuro feedback regulates brain function, it will promote mental and cognitive abilities and skills such as decreasing anxiety, optimizing decision making, increasing creativity, helping with memory, and increasing attention and brain-body coordination, in particular in athletes. Seeing their brainwaves in computer screen, athletes can control these waves and change them based on their needs. This leads to learning in the athlete and they can unconsciously control their brainwaves in stressful conditions of the game and consequently have better performance [8].

Since the goal of all the investments in sport organizations and institutions is promoting the athletes to the level of championship in the shortest time and with the least capital possible, an option that can stabilize this process to championship (though the neurofeedback method itself requires expenditure), it will certainly prevent greater costs and waste of time and investment.

Since there has been little domestic research on the effect of neuro feedback training on anxiety, and those few have studied the national chess team [9], and the foreign research has mostly highlighted the motor aspects of swimming and in youth and adults [10], the present research

aims to study the mental aspects of this sport in 13-14 year old adolescents. This gives us important information regarding the effectiveness of neuro-feedback training on anxiety at this age group.

The most widespread method in neuro-feedback is using a videogame in which the individual must use their brain rather than their hands for finishing the game and the game is directed in such a way as to activate the desired and normal pattern of brainwaves. In fact, when the activity of an inappropriate band is changed, the game is either amplified or inhibited. Gradually the brain and subsequently the individual learns to respond to certain signals and the new brainwave pattern replaces the older one [1]. By repeating this form of feedback, the brain will identify a relationship between what is observed in the screen and their mental state; in other words, the brain starts identifying its mental state and this happens when learning happens [5]. Various research studies on feedback training with pretest-posttest designs have reported positive changes in the activity of brainwaves which as a result led to regulation and improvement in brain function [7]. At present the researchers in this context are interested in studying brainwaves at different brain regions and their relationship with the level of performance of athletes.

Research has shown that bio/neurofeedback training considerably improves the anxiety of athletes. These studies have been carried out on swimmers, tennis players, skiers, and Olympic athletes. Research has reported improved performance through bio/neurofeedback in three main areas: athletic performance, cognitive performance, and artistic performance. The purpose of these studies has been to reduce anxiety in two major ways: (1) reducing the level of muscle tension using electromyographic biofeedback, and (2) conditioning the activity of brainwaves through neurofeedback. Finally, the results showed that bio/neurofeedback is applicable in the following conditions: (1) helping the athlete in learning how to control motor level, and (2) helping them in controlling their emotions and mood swings [10; 11; 12].

Tanis (2008) carried out a research on the effect of bio/neurofeedback training on anxiety. In this research, 18 handball athletes completed the Minnesota Multiphasic Personality Inventory (MMPI) and State-Trait Anxiety Inventory (STAI). Out of the 18 athletes, 10 participants with normal anxiety profiles were chosen to participate. Five participants were assigned to either a treatment or control group. Seven sessions of biofeedback using a handheld audio stress reducer and a home-use device were implemented with the treatment group. The STAI was read ministered at the completion of the study. The compiled treatment scores demonstrated lower anxiety in the treatment group compared to the control. Performance measures were not included [6].

Mahini (2010) did a research on the effectiveness of neurofeedback training on anxiety of chess players. 24 members of the national chess team volunteered for the study. All the subjects were within 15-35 years old and had at least 5 years of participation in national leagues. State-Trait Anxiety Inventory (STAI) was used for evaluating anxiety. The assessment was conducted in the form of pretest-posttest before and after neurofeedback training. The results of multivariate analysis of covariance showed that changes in the anxiety of the experimental group were significant in compassion with the control group [9].

In all sports the interaction between the brain and the performance of athlete is inevitable, but some sports require greater interaction. One of these sports is swimming. In this sport, not only does the individual require high physical strength, they must have a high level of proficiency in performance of movements. Further, this sport requires low anxiety for identification of movements, best performance, maintaining optimal position in water, and setting the best record. It is thus important the athlete controls their anxiety, for anxiety is one of the limitations that affect cognitive-motor activities that in turn affect athlete's information processing [13].

Thus, the present research aims to evaluate the effect of neurofeedback training on anxiety of swimmers (like other studies) and to examine whether this type of training can bring about changes in the anxiety of athletes.

MATERIALS AND METHODS

Participants

The participants of the present research are 20 female swimmers with 5-6 years of experience at the national level. The participants were selected using purposive sampling and they averred their consent for participating in the research. They were randomly divided into two groups of 10 subjects – an experimental and a control group.

Materials

(1) Three electrodes specific for head and ears for one-way transmission of data from the brain to the computer at electrode locations C3 and C4 on the scalp and an ear reference electrode.
(2) The computer and all the relevant hardware, including the monitor, mouse, speakers, and software related to neurofeedback training and video games.
(3) The special biofeedback and neurofeedback system specific to these types of training and can have several data channels related to the sensors and electrodes attached to the individual and these channels transfer data from the system and from the system to the computer. The data are transferred from the system to the computer using a Bluetooth that receives waves up to 10 meters away and transfers it to the computer.
(4) Sport Competition Anxiety Test (SCAT): Anxiety is measured using SCAT. This inventory was developed by Martens in 1997 after 5 years of investigation into 4000 people in the US. It has 15 simple items that can be used in different cultures and in less than five minutes.

Scoring Method

The inventory contains 15 items based on a 3-point Likert scale – rarely, sometimes, and often. 10 items are scored (2, 3, 5, 6, 8, 9, 11, 12, 14, and 15) and 5 other items are not scored (1, 4, 7, 10, and 13). Items 2, 3, 5, 8, 9, 12, 14, and 15 are scored as: 1 for rarely, 2 for sometimes, and 3 for often. Items 6 and 11 are scored as: 1 for often, 2 for sometimes, and 3 for rarely. The scores in SCAT test range from 10 (low trait-competition anxiety) to 30 (high trait-competition anxiety). Unlike most other tests, the items are implicit and in none of them is there an explicit reference to anxiety which can add to the validity of the test. It must be noted that SCAT is a relatively valid predictor of the trait-competition anxiety of the samples with a reliability coefficient of 0.64.

Procedure

The period of the research was four weeks and three sessions per week. The athletes were introduced to the procedures one week before the beginning of the period. During training sessions 2 sensors were attached to the scalp and one to the pinna of the subjects. These sensors recorded the scalp data of the participants and displayed them to the tester and the participant in two separate monitors and in the form of brainwaves.

First, an EEG and a baseline were recorded using the electrodes and neurofeedback software in order to determine the level of brainwaves and then the subject underwent the first training session. In the most prevalent method for neurofeedback, the individual plays a video game in the computer screen; indeed unlike other games they should not use their hands, but play with their brainwaves. During this period, the athlete observes the brainwaves and the analysis performed on them in the monitor and directs the game in such a way as to activate the desired and normal pattern of brainwaves. The subject is asked to direct the game only with their brain and by focusing on the game without making use of their hands. The game is set by the experimenter in a way that increase or decrease of activity in a wave needed for the protocol, amplification is provided. When the activity increases or decreases in an improper band, the game or the amplifications are stopped. Each session (40 minutes) was divided into two 20-minute parts and the first 20 minutes involved the following games: boat sailing and directing the boat to the finish line faster than other boats (8 minutes); making animation figures (6 minutes); jigsaw puzzle (6 minutes). The second 20 minutes involved the following games: playing an animation in a moving screen and the participant has to enlarge the screen in order to keep the animation in the same position (10 minutes), moving a train (10 minutes).

In these training protocols, the athlete, through learning, increase the production of beta (15-18 Hz) and SMR (12-15 Hz) in electrode location C3 and C4 during the two 20-minute exercises, thus increasing their motivation, improving their emotional states, increasing sensorimotor coordination, and developing their mental abilities, while at the same time these protocols suppress high beta activity (22-37 Hz) and theta (4-8 Hz) in order to increase their composure, reduce their tension, and regulate their vital processes such as sleeping. Moreover, continuity and symmetry of the two hemispheres are included in these protocols.

Statistical Methods

The collected data were analyzed using descriptive and inferential statistics and the results are presented in the form of tables and figures. Data analysis was done in SPSS. First, the normal distribution of the data was examined using Kolmogorov-Smirnov test and then two-factor analysis of variance (2×2) was applied. It must be noted that the significance level for all the calculations has been considered to be $P < 0.05$.

RESULTS

The main effect of test was significant ($F(1,18) = 9.868; P = 0.006$). In other words, mean anxiety score in the pretest (18.300 ± 0.514) was significantly lower than that of the posttest (20.100 ± 0.774). The main effect of group was not significant ($F(1,18) = 1.608; P = 0.221$), but the interaction between test and group ($F(1,18) = 6.853; P = 0.017$) was significant. Given the significance of test-group interaction, the results of post hoc correlated t-test with Bonferroni

correction ($P < 0.025$) showed that there is a significant difference between the pretest and posttest anxiety of the experimental group ($P = 0.008$; $t = 3.414$), but this difference was not significant in the control group ($P = 0.638$; $t = 0.487$). The results of post hoc correlated t-test with Bonferroni correction ($P < 0.025$) showed that the difference between the studied groups in the posttest is significant ($P = 0.009$; $t = -2.917$).

The results of the analysis of variance in the pretest and posttest revealed the following results.

Group/Statistic Variable	Experimental		Control	
	Mean	Standard Deviation	Mean	Standard Deviation
Anxiety (Pretest)	20.100	3.478	20.100	3.446
Anxiety (Posttest)	16.800	1.751	18.800	2.740

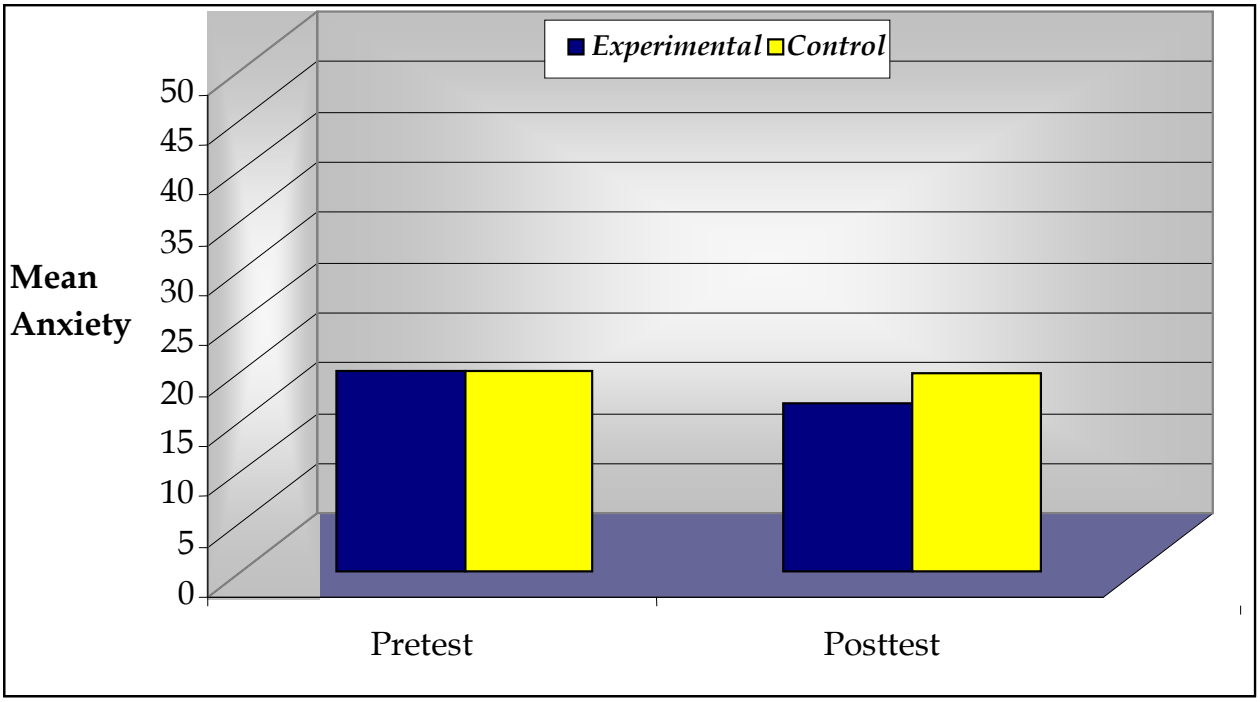

Figure 1 – The mean pretest and posttest anxiety score of the studied groups

Based on the findings it can be deduced that neurofeedback training reduces anxiety of elite swimmers.

DISCUSSION

Based on between-group comparison in the posttest, the results indicated that neurofeedback training has had a significant effect on the anxiety of elite female swimmers and a significant difference was observed in the pretest and posttest of the experimental group. These results are

consistent with the results of Blumenstein et al. (2002), Galloway et al. (2005), Tanis (2008), Vernon et al. (2005), and Mahini (2010) [10; 11; 6; 12; 9].

Considering the positive effect of neurofeedback training on anxiety as suggested by the results, using bio/neurofeedback can be effective in the treatment of anxiety disorders [14]. Further, one of the effects of bio/neurofeedback in sports is creating self-regulation in the athlete. If the athlete is self-aware and has good physiological skills, they will overcome competition anxiety in the face of stress [10].

Neurofeedback training focuses on developing awareness of one's arousal state for improving control over the central nervous system and it also improves the ability of entering the parasympathetic state before sympathetic control over the body. Thus, it will counteract anxiety responses and in fact biofeedback training improves the balance between the activities of sympathetic and parasympathetic nervous system and this often leads to balance in the autonomic nervous system. One of the consequences of balanced activity of the nervous system is optimal level of arousal and anxiety. Two of the basic elements in mental functioning are arousal and anxiety and the intensity of anxiety affects the quality of a certain function; this intensity should always be at an optimal level. It appears that neurofeedback reduces anxiety by regulating the central nervous system and optimizing the level of arousal which can increase blood flow to the brain. In this state training the brain for creating optimal waves has advantageous effects on the balance of the autonomic nervous system and its physiological responses such as heart rate and anxiety. With the help of neurofeedback we can teach the brain not to behave based on habits and achieve a stable state without resistance and without negative thoughts [2]. Sport, physical exercise, and relaxation can reduce anxiety and increase energy; yet, there is no conscious, systematic control. Neurofeedback is the systematic, conscious focus of the psychological energy and an effective method against anxiety. This method reduces or removes any tendency to resist and block energy which has turned into a habit. While other methods try to create new behavioral patterns, neurofeedback training focuses on improper patterns and behaviors that lead to anxiety symptoms. This method raises the consciousness of the individual and makes them aware of themselves, their body, and their environment. Moreover, it teaches the individual to remain calm under stressful situations [15].

Blumenstein et al. (2002) contended that the goal of bio/neurofeedback training programs in sports is to improve the level of self-regulation and optimize the competitive behavior of athletes. Through bio/neurofeedback training athletes are equipped with skills for regulating the level of physiological arousal at will and regulating response to anxiety. Most coaches and athletes agree with the fact that mental control and self-regulation can be learned through bio/neurofeedback training which is imperative for successful performance. Physiological and psycho-emotional regulatory strategies are taught using bio/neurofeedback interventions which are considered as an important method for increasing self-regulation and, consequently, improving performance [10].

Performance was not studied in the present research, but the interaction between emotions and optimal functioning can be explained according to the theory of Individual Zone of Optimal Functioning (IZOF). This theory examines the difference between the levels of arousal and emotions and their effect on ideal performance. Some athletes become extremely anxious when

trying to achieve an optimal level of functioning, while the high levels of anxiety may lead to decline in functioning [16]. Examining the effects of emotions will help athletes in identifying their zone of optimal functioning. This occurs during neurofeedback process and when people observe their brainwaves in response to emotions and when they use self-regulation techniques for controlling the effect of negative emotions. Moreover, using different methods for reducing physical and mental tension, achieving an optimal level of arousal, regulating physiological responses, self-regulation, and reinforcing such psychological skills as managing anxiety, increasing self-confidence, and regulating emotions concurrently and individualization of these trainings for each athlete can be effective for improving functioning [3]. Dupee (2008) reported that after neurofeedback training, all the subjects were closer to the optimal levels of attention, calmness, and emotional regulation. Yet their functioning did not change by the end of the half-season and these reports were consistent with the results of the present research [17]. Moreover, Tanis (2008) carried out a research on 10 handball players and showed that by reducing their anxiety during bio/neurofeedback training, athletes can improve their physical and mental functioning [6]. The present research also shows that the psychological symptoms of anxiety that are experienced by the athlete can be regulated through neurofeedback training.

CONCLUSION

As was mentioned, one of the effects of neurofeedback in sports is creating self-regulation in athletes. If the athlete is self-aware and has good physiological skills, they will overcome competition anxiety in the face of stress [10]. Considering the literature on the effect of this type of training on various sports, including swimming, in the youths and adults [10], the results of the present research which was carried out among adolescents (that does not exist in the literature) also confirmed previous findings and demonstrated that these exercises can be used as a complement along with physical exercises and can replace such traditional methods as taking medication for treating anxiety. Considering the fact that this is an emerging method in Iran and that this is the first research in the area of swimming and the third research regarding the effect of neurofeedback on anxiety along with two studies carried out in the area of shooting (Allahkarami, 2010) and chess (Mahini, 2010), it is recommended that the effect of this training method on anxiety be examined in other sports and in other age groups [9].

REFERENCES

[1] Eskandarzadeh, M., **2009**. Doctorate Dissertation, Shahid Beheshti University.
[2] Bruce, K., **2000**. University of North Texas.
[3] Dehghani-Ara, F., **2007**. MSc Thesis, University of Tehran.
[4] Creswell, J. W., **2001**. Qualitative inquiry and research design. Thousand Oaks, CA.
[5] Nosratabadi, M., **2007**. MSc Dissertation, Allameh Tabatabaee University.
[6] Tanis, C., **2008**.Thesis. Capella University.
[7] Rostami, R., **2008**. *Atieh Journal of Psychiatry*. No. 43.
[8] Hammond, D. C., **2007**. *The Journal of the American Board of Sport Psychology*, 1-2007.
[9] Mahini, M., **2010**. MSc Thesis, University of Tehran.
[10] Blumenstein, B. Bar-Eli, M. Tenenbaum, G. (Eds.), **2002**. Chichester: Wiley.
[11] Galloway, S., & Lane, A., **2005**. *The Journal of Sport Sciences*, 23 (11-12), 1247.
[12] Vernon, D. J., **2005**. *Applied Psychophysiology and Biofeedback*. 30, (4), 347-364.

[13] Schmidt, R.E., **1991**. First edition. Human Kinetics Pub. P: 186-189.
[14] Schwartz, M. S., & Andrasik, F. (Eds.). **2003**. 3rd ed. New York: Guilford Press.
[15] Denzin, N. K. Lincoln, Y. S., **2005**. 3rd ed. Thousand Oaks, CA: Sage Publishing.
[16] Zaichkowsky, L. D. Baltzell, A., **2001**. New York: Wiley. 2nd ed. pp. 319-339.
[17] Dupee, M., **2008**. University of Ottawa (Canada), **2008**, 109 pages; AAT MR48451.