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Effect of Bio-Neural Feedback Exercises on the Performance of Female Rugby Players

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Abstract

Background/Objective: This study aimed to determine the effect of bio-neural feedback exercises on female rugby players' performance.
Methods: The design was quasi-experimental with experimental and control groups. Twenty-four female rugby players aged 16 to 25 in Alborz province were randomly divided into two equal groups of 12. Bio-neural feedback or neurofeedback exercises were performed for 15 sessions, three times a week, including the alpha protocol at point Pz and increasing the sensory-motor wave at point C3, each for 20 minutes. Data collected in pre-test and post-test were used to measure rugby performance, including pass accuracy and shot accuracy. The Mann–Whitney U test was used to analyze the data.
Results: The results showed that the left and right passes' accuracy increased significantly after bio-neural feedback exercises. However, no significant improvement in shooting accuracy was observed.
Conclusions: Therefore, bio-neural feedback training can be used as an effective way to improve athletes' optimal performance in sports such as rugby that require accurate passing.

Introduction

The quality of a person's performance is closely related to her mind and body. Achieving optimal performance results from a person's proper interaction with the environment and her mastery of motor tasks; the more correct this interaction is, the better the person will achieve in movement (1). In recent years, researchers have become particularly interested in studying brain waves in different areas of the brain and their relationship to athletes'letes' behavior and perfo Various studies have shown that when an athlete reaches a state of concentration and relaxation, she performs better (2). On the other hand, human beings cannot recognize and change their brain waves' patterns due to lack of knowledge, but by observing the display of these athletes'es, after a while, res the ability to change and influence them. This process is also called self-regulation. Finally, the person will understand the incorrect physiological answers in daily activities and replace them with more correct answers (3). Today, Neurofeedback is one of the new and growing ways to improve athletic performance. Neurofeedback is based on specific aspects of cortical activity that refer to a factor conditioning pattern and teach individuals to modify their wave patterns. Neurofeedback informs the desired mental state athlete and helps him achieve this state (3). Neurofeedback can retrain brainwave activity to increase optimal performance in athletes in various sports. According to studies, Neurofeedback leads to increased concentration, improved cognitive performance, emotional control following brain injuries, and increased balance in various movements and performances (4). Neurofeedback training affects the subjects' performance and reaction time by increasing the sensorimotor wave or SMR for short. Considering this method's positive effects on individuals' performance and reaction time, this study showed that Neurofeedback could be used as an effective method to achieve optimal performance (5). Neurofeedback training program using alpha protocol improved the intensity and duration of concentration and, while having a significant effect on different types of attention, helped improve performance (6). Vernon's (2005) studies showed that neurofeedback training is done to increase performance in three main areas: sports performance, cognitive performance, and artistic performance (7). Besides, in recent years, many studies have been conducted on the effect of neurofeedback training on athletes' performance, such as Sheng et al. (2015), who examined the difference between sensory-motor wave in the performance of two skilled and beginner groups during darts throwing. Their results showed that skilled people have a higher sensory-motor wave than beginners before throwing. Increasing the sensor-motor wave is probably effective in cognitive-motor processing processes (8). Ring et al. (2015) also examined the effectiveness of neurofeedback training to accelerate the acquisition of skills and excellence in sports under pressure in golfers. The aim was to increase the alpha at the F_z point. The results showed that the experimental group achieved a better record than the control group. Therefore, neurofeedback exercises improved their performance, especially in high-pressure conditions and increased learning speed (9). In another study, Strizhkova et al. (2014) investigated Neurofeedback's effect on increasing gymnasts' skills during menstruation. This method improved coordination and combination activities and functions and stabilized female athletes' vegetative parameters in the ovulation stage (10). Cook et al. (2014) studied psychological activities before a motor skill and the result of performance and stress in both groups of novice and skilled golfers. The results showed that skilled individuals had a lower heart rate, decreased theta wave, and increased alpha wave before pot golf. Also, it was found that high alpha as a key variable has led to successful results in skilled people (11). Besides, in his research, Kao (2013) examined the effect of Neurofeedback on central alpha in golfers' executive performance. Based on the reported results, the improvement was observed in the executive performance, but there was a discrepancy in alpha power changes. This performance improvement continued even after the cessation of exercise (12). Unlike other studies, Dupee (2008) showed that neurofeedback training did not change skiers' scores. In his research, he used the alpha protocol at point P_z and the sensory-motor wave protocol at point C_z on six male athletes with six years of experience in the Olympics to improve concentration and level of arousal, reduce anxiety, and increase self-regulation of physiological and psychological states to improve their performance. The results showed that there was no change in their record despite the improvement of physiological and psychological conditions (13). Raymond et al. (2005) used three groups of dancers in their research. The first group received alpha/theta neurofeedback training sessions for 8 sessions, the second group received heart rate variability biofeedback, and the other group received no feedback. The results showed that rhythmic movements' performance improved in the two feedback training groups, but no change was observed in the control group. The alpha/theta group improved in execution time, while the heart rate variability group improved in technique (14, 15). Galloway and Lane (2005) also used biofeedback (electromyography, electrical skin reaction) and neurofeedback exercises for 12 weeks in their study of 5 tennis players (13-14 years old) and their results showed that the service of all players improved (16). In a similar study, Bar-Eli et al. (2004) examined the relationship between mental training and biofeedback and swimmers' performance. In this study, 40 athletes (16-18 years old) were divided into control and experimental groups. The results showed a significant improvement in the performance of the subjects (17). Cheng et al. (2001) investigated the effect of brain waves on tennis players' performance. Their results showed that the training program effectively improved the intensity and duration of concentration, which led to a significant effect on the types of attention and helped improve tennis performance (6). Mohammadi et al. (2016) investigated the effect of a course of neurofeedback training on error detection and performance in skilled shooters. They found that neurofeedback training effectively improved performance by improving and increasing scores but did not affect error detection (18). Also, Nabavi Al-Agha et al. (2013), by examining the effect of neurofeedback exercises on performance and reaction time of people with sensitive occupations, found that Neurofeedback affects executive performance and reaction time of subjects by increasing the sensorimotor wave. Considering this method's positive effects on individuals' performance and reaction time, this study showed that Neurofeedback could be used as an effective method to achieve optimal performance (6). In another study, Salehi et al. (2011) studied the effect of neurofeedback training, mental imagery, and physical training on learning darts. Their results showed that the application of the independent variable increased performance in the experimental groups. Still, the control group did not show progress in the test stages, and there was no significant difference between the experimental groups based on exercise (19). In the study of Eskandernejad et al. (2011), the effect of neurofeedback training on the performance and characteristics of electroencephalogram (EEG) was investigated in archery. The results showed that neurofeedback training could change EEG characteristics and performance record (20). Also, Rostami et al. (2012), by studying the functional changes of a group of elite shooters under the influence of Neurofeedback and comparing them with the normal group, concluded that Neurofeedback has been effective in improving the performance of shooters by improving the record (21). According to previous studies, neurofeedback exercises have been used to improve individual athletes' performance with a level of arousal and mental demands, such as equal attention and concentration. However, so far, no research has been done either in Iran or in foreign countries on rugby, which is a high-pressure team sport with different levels of arousal, especially on women. Therefore, the contradictory results of the existing research encouraged the researcher to conduct this research to investigate the effect of neurofeedback exercises on female rugby players' performance. The present study can help increase the necessary information in this field and sports psychologists; in addition, coaches can use the results of this research to obtain better information to improve their athletes' performance.

Method

The present study is a quasi-experimental, cross-sectional, and applied research conducted with a pre-test and post-test design. The statistical population of the study was 24 female rugby players from Alborz province. Due to the existence of only this number of players in Alborz province, the statistical sample was equal to the population and included all female players aged 16-25 years who were members of the team for at least two years and had participated in national and league championships previously. The research samples were randomly divided into experimental and control groups of 12 people. All players took the rugby skills performance tests, which included a shot and pass accuracy test, and then the experimental group began neurofeedback training and finally did the tests again.

Implementation Method and Test Session

First, the accuracy of the shot was tested. To measure the shot's accuracy, a cube with dimensions of 1 meter, which was placed at a distance of 20 meters, was used. Subjects had to try to land the ball on the box with a shot. The ball had to land directly on the box, meaning that no points were awarded to the ball hitting the box after hitting the ground. Each subject had the opportunity to shoot five times. Scoring was as follows: 5 points for the box, 3 points sides of the box, 1 point in the environment of 2 meters around the box (the maximum possible point was 25), (22). Then, the accuracy-test was passed. The subjects, holding the ball while walking in a straight path, after running for 3 meters, passed the ball towards 40 cm diameter circles that had 1-meter height and had been installed 2 meters away from the players running line. This test was performed five times from the left and five times from the right. There was a 1-minute break between each pass. Each correct pass received 1 point, and each pass that only stroke the circle received 0.5 points (22). The experimental group performed neurofeedback exercises for 15 sessions and three days a week; each session lasting for 40 minutes.

Neurofeedback Exercises

The Procomp Model of neurofeedback device, made in Canada and its software called Biograph, was used in the exercises. Sensors called electrodes were placed on the subject's scalp. In the training session, after measuring the head's dimensions and determining the desired points based on the division system of 10-20 from each subject, the initial evaluation of brain waves was performed. In the training session, after measuring the head's dimensions and determining the desired points based on the division system of 10-20 from each subject, the initial evaluation of brain waves was performed. The subjects were placed in a sitting position, the earlobes and the desired points on the head were cleaned using alcohol, and Nuprep Gel and the electrodes were attached to the head and ears using the Ten20 conductive paste. The initial protocol was performed as a unipolar assembly on alpha waves at the P_z point. The eyes closed and listened to the sound emitted from the computer for 20 minutes. Whenever the person was in the correct position, auditory feedback was given in the form of a horn as a reward. The second protocol was performed as a unipolar assembly on sensory-motor wave waves at point C3 and with the eyes open for 20 minutes, which included playing a computer game and the subject should try without the intervention of hands and feet and only with brain waves to bring the boat to the finish line. If successful, she was given both visual and auditory feedback in the form of points.

Statistical Methods

In this study, descriptive statistics (mean and standard deviation) were used to describe the collected information. In the inferential statistics section, the Mann-Whitney U nonparametric test was used to test the hypotheses. All calculations were performed using SPSS 20 software at a significance level of 0.05.

Results

Table 1 shows the mean and standard deviation of the shot accuracy and left and right pass accuracy in the pre-test and post-test of the two control and experimental groups.

Table 1. Mean ± SD of Shot Accuracy and Pass Accuracy in Pre-test and Post-test of Groups.

	Experimental Group		Control Group	
Left Pass Accuracy	2.37±1.05	3.79±1.03	2.83±1.07	2.37±0.68
Right Pass Accuracy	2.75±0.94	3.75±0.72	3.04±1.16	2.17±0.83
Shot Accuracy	2.75±0.94	6.17±2.66	2.83±1.58	3.33±3.08

Table 2 shows the results of the Shapiro-Wilk test for pre-test and post-test values of left pass accuracy, right pass accuracy, and shot accuracy of the two experimental and control groups. Significant values showed that the data did not have a normal distribution (P <0.05). Therefore, the non-parametric Mann-Whitney U test was used to evaluate bio-neural training's effect on female rugby players' pass accuracy and shooting accuracy.

Table 3 summarizes the results of the Mann-Whitney U test to compare the rate of change in left pass accuracy of the two groups.

Table 2. Shapiro-Wilk Test Results for Pre-test and Post-test Accuracy of Pass and Shoot Accuracy of Groups.

		Left Pass Accuracy			Right Pass Accuracy			Shoot Accuracy		
Groups		**Statistics**	**DF**	**Sig**	**Statistics**	**DF**	**Sig**	**Statistics**	**DF**	**Sig**
Pre-test	**Experimental**	0.914	12	0.237	0.697	12	0.001	0.697	12	0.001
	Control	0.794	12	0.008	0.800	12	0.009	0.729	12	0.002
Post-test	**Experimental**	0.854	12	0.042	0.853	12	0.040	0.875	12	0.076
	Control	0.696	12	0.001	0.723	12	0.001	0.787	12	0.007

Table 3. Mean ± SD results of Mann-Whitney U Test to Compare the Left Pass Accuracy of Groups.

	Descriptive Statistics				Mann-Whitney U Test		
Group	**Pre-test**	**Post-test**	**Change Amount**	**Median**	**U**	**Z**	**sig**
Experimental	2.37 ±1.05	3.79 ±1.03	1.42 ±1.39	1.250	18.500	-3.132	0.002
Control	2.83 ±1.07	2.37 ±0.68	-0.46 ±1.39	0.000			

The results show that the accuracy of left pass increased in the experimental group after neurofeedback training, but it decreased slightly in the control group. Their difference is also significant (P = 0.002), and this shows that neurofeedback training has a better effect on the left pass accuracy of female rugby players.

Table 4 presents the Mann-Whitney U test results to compare the rate of change in right-pass accuracy between the two groups.

Table 4. Mean ± SD results of Mann-Whitney U Test to Compare the Accuracy of Right Pass between Groups.

	Descriptive Statistics				Mann-Whitney U Test		
Group	**Pre-test**	**Post-test**	**Change Amount**	**Median**	**U**	**Z**	**sig**
Experimental	2.75 ±0.94	3.75 ±0.72	1.00 ±0.74	1.000	22.500	-2.897	0.004
Control	3.04 ±1.16	2.17 ±0.83	-0.87 ±1.57	-1.000			

The results of the Mann-Whitney U test show that the accuracy of the right pass increased in the experimental group after the neurofeedback training. Still, it decreased slightly in the control group. Their difference is also significant (P = 0.004), and this shows that neurofeedback training has a better effect on the right pass performance of female rugby players.

Table 5 presents the results of the Mann-Whitney U test to compare the rate of change in shot accuracy between the two groups.

Table 5. **Mean ± SD results of Mann-Whitney U Test to Compare the Accuracy of Shot between Groups.**

	Descriptive Statistics				Mann-Whitney U Test		
Group	Pre-test	Post-test	Change Amount	Median	U	Z	sig
Experimental	2.75 ±0.94	6.17 ±2.66	3.42 ±3.17	3.000	45.00	1.569	0.117
Control	2.83 ±1.58	3.33 ±3.08	0.50 ±4.50	0.000			

The results show that the shot's accuracy increased in the experimental and control groups, but it did increase slightly in the control group. Despite a further increase in shooting accuracy in the experimental group, the difference between the two groups is not significant (P = 0.117), and it can be said that the two types of training are not superior to each other in improving shooting accuracy.

Conclusion

This study aimed to determine the effect of bio-neural feedback training (Neurofeedback) on the performance of female rugby players. The results showed that bio-neural feedback training has a significant effect on the right and left passing accuracy of rugby players and can lead to players' better performance. Findings of the present study are consistent with those of Cheng et al. (2015), Ring et al. (2015), Cook et al. (2014), Kao (2013), Raymond et al. (2005), Galloway & Lane, (2005), Bar-Eli (2004), Chung et al. (2001), Mohammadi et al. (2015), Nabavi Al-Agha et al. (2013), Salehi et al. (2013), Eskandarnejad et al. (2011), and Rostami et al. (2012) (21, 20, 19, 5, 18, 6, 17, 16, 14, 12, 11, 9, 8). Probably, as Bailey et al. (2008) stated, this could suggest that different people have different needs g on differ athletes' performances of brain activity. According to these researchers, the nervous system needs different protocols in different areas to reach the peak of performance due to different factors and cognitive loads in different activities, and their goal in neurofeedback exercises is to increase performance and learn in different ways to achieve the pattern of efficiency (25). Considering the increase in the records of the subjects in both groups, which could be due to their familiarity with the pre-test, and considering the improvement of the records in the average of the experimental group, it can be concluded that the protocols used were not ineffective. And the occurrence of mismatch may be due to differences in motivation levels, different mental or physical states in the subjects, and the duration of inadequate neural biofeedback exercises.

Given that the present study showed the effect of neurofeedback training on performance, coaches and sports psychologists in rugby can benefit from bio-neuronal feedback and use its effects to improve performance. Due to the significant increase in the accuracy of left and right passes, coaches and sports psychologists, in particular, are recommended to use these protocols to improve players' passes. Researchers are also advised to examine the effect of other existing protocols on player accuracy. Finally, it is recommended to use psychological exercises such as relaxation, imaging, concentration, and neurofeedback exercises.

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