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Effect of Mental Training on Psychophysiological Response, Selected Physical Fitness and Psychological Skills in Football Players*

Futbolcularda Zihinsel Antrenmanın Psikofizyolojik Tepki, Seçilmiş Fiziksel Uygunluk ve Psikolojik Beceriler Üzerine Etkisi

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ABSTRACT: This study investigates the effects of mental training on football players' heart rate (HR), heart rate variability (HRV), flexibility, agility, reaction time, and psychological skills. The originality of the research lies in its holistic approach, combining psychophysiological, physical, and psychological measurements. The study assumes that integrating mental training with physical exercises enhances athletic performance and ensures its stability. Using a convenience sampling method, 30 football players were divided equally into experimental and control groups. The experimental group participated in a 40-minute mental training program twice a week for 12 weeks alongside their regular physical training, while the control group continued only with physical training. Statistical analyses revealed no significant differences between the groups in HR and flexibility. However, the experimental group showed significant improvements in HRV, heart-mind coherence (including its maximum value), agility, reaction time, and scores on the Athletic Psychological Skills Inventory (APSI) ($p<.01$). Within the control group, pre-posttest comparisons showed limited improvements in flexibility and two APSI sub-dimensions—being open to learning and performing under pressure ($p<.05$)—but no changes in other measures. In conclusion, the mental training program positively influenced HRV, heart-mind coherence, agility, reaction time, and key psychological skills, although it had no effect on HR or flexibility. These findings suggest that mental training can significantly contribute to enhancing athletic performance.

Keywords: mental training, psychophysiology, biofeedback, physical fitness, psychological skill.

ÖZ: Bu çalışma, futbolcuların kalp atım hızı (HR), kalp atım hızı değişkenliği (HRV), esneklik, çeviklik, reaksiyon süresi ve psikolojik beceriler üzerinde zihinsel antrenmanın etkisini incelemektedir. Araştırmanın özgünlüğü, psikofizyolojik, fiziksel ve psikolojik ölçümleri birlikte değerlendirmesinde yatmaktadır. Çalışma, fiziksel antrenmanla birlikte uygulanan zihinsel antrenmanın sporcu performansını artıracağı ve bunun sürdürülebilir olacağı varsayımıyla planlanmıştır. Kolayda örnekleme yöntemiyle seçilen 30 futbolcu, eşit olarak deney ve kontrol gruplarına ayrılmıştır. Deney grubuna 12 hafta boyunca haftada iki kez 40 dakikalık zihinsel antrenman programı uygulanmış; bu süreçte fiziksel antrenmanları da devam etmiştir. Kontrol grubuna ise yalnızca fiziksel antrenman uygulanmıştır. İstatistiksel analizler sonucunda, HR ve esneklik açısından gruplar arasında anlamlı bir fark bulunmamıştır. Ancak, deney grubunda HRV, kalp-zihin uyumu (ve maksimum düzeyi), çeviklik, reaksiyon süresi ve Atletik Psikolojik Beceriler Envanteri (APSI) puanlarında anlamlı artışlar gözlenmiştir ($p<.01$). Kontrol grubunda ise sadece esneklik ile "öğrenmeye açık olma" ve "baskı altında iyi performans gösterme" alt boyutlarında anlamlı farklılık saptanmıştır ($p<.05$), diğer ölçümlerde bir değişiklik gözlenmemiştir. Sonuç olarak, zihinsel antrenman programı HRV, kalp-zihin uyumu, çeviklik, reaksiyon süresi ve bazı psikolojik beceriler üzerinde olumlu etki yaratmış; HR ve esneklik üzerinde ise etkili olmamıştır. Bu bulgular, zihinsel antrenmanın sporcu performansını artırmada önemli bir katkı sağladığını göstermektedir.

Anahtar Kelimeler: zihinsel antrenman, psikofizyoloji, biyolojik geri bildirim, fiziksel uygunluk unsurları, psikolojik beceri.

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1. INTRODUCTION

Football, where physical fitness components related to health and skill are tried to be demonstrated at the highest level, and where many movements performed one after another within certain limits are performed with a solid condition, is a sport where it is important to be talented not only in terms of physical abilities but also in psychological skills for a good performance. It is a fact that the performance of athletes who cannot motivate themselves, are nervous, have low self-confidence, and have problems coping with stress will be negatively affected (*Ekstrand, Karlsson, & Hodson, 2003*). Nowadays, most athletes are almost equal in terms of physical capacity, and having physical activity appropriate to the branch is the basic need of the sport. The important thing here is to be able to create the mental readiness to perform skills specific to the sport branch (*Ekmekçi, 2022*). The mental training practices we encounter at this stage not only affect performance and results, but also ensure the establishment of a deep connection between mind and body, the enjoyment of the work performed by athletes, and the management of the psychological processes necessary for success (*Morris, Spittle, & Watt, 2005*).

Sports psychology, which aims to maximize the performance of athletes in both individual and team sports (*Azboy et al., 2012*), has gained even more importance, especially with the remarkable technical advances in recent years (*Blumenstein, Bar-Eli, & Tenenbaum, 2002*). Psychological skill applications applied in the form of mental training eliminate the mental obstacles to the athlete's success and enable them to reach their maximum performance. In fact, the main purpose of the training process is to increase the athlete's work capacity and skill abilities, as well as to enable the development of strong psychological qualities for successful performance (*Carrera & Bompa, 2007; Bompa & Haff, 2009*). Thus, psychological and psychophysiological measurements have become possible in addition to physical tests. Psychophysiological research is based on a number of techniques to understand mental processes. One of these is biofeedback techniques. This method, which emerged as a field of study in the 1960s, was implemented to measure the physiological responses of the individual and provide real-time feedback about them (*Kondo et al. 2019*). Biofeedback (BFB) appears to be an important method in sports when training athletes to achieve better self-control and relaxation. (*Blumenstein et al., 2002*). Additionally, as stated by Lehrer, Woolfolk, and Sime (*2007*), BFB is a widely used method to learn voluntary control of various psychological functions by providing instant feedback for changes in psychological activity. In their research using the BFB method, Field et al. (*2017*) stated that the training program they applied to participants using HeartMath technology was a feasible method to improve heart rate variability, coherence and positive thinking. Unlike researchers who use the HeartMath EMwAVE Pro Plus device in their studies, in this research we wanted to create an area where athletes can easily access and apply the HeartMath Inner Balance device and compare the results. And in this way, we wanted to bring a different perspective to the BFB field. In another study, Griffin et al. (*2020*) found significant changes in the stress and anxiety levels of university students in their study using the BFB Inner Balance device stated that it is important to use this technology in coping with non-clinical levels of stress and anxiety. Our research is a parallel study to this study and it is an applied study brought into the performance field. Psychophysiological data obtained through the BFB method are revealed from the human body as both data and graphics with appropriate wearable devices (*Mancevska et al., 2016*). Just as an individual voluntarily makes changes in his/her life or position and creates self-discipline, in biofeedback applications, the individual who obtains information about his physiological state through measurements can turn to healthy arrangements in line with this information. BFB measurements that create awareness provide the information that needs to be learned about the situation (*Paul et al., 2012*).

Psychophysiological data obtained through this method are revealed from the human body as both data and graphics with appropriate wearable devices (*Mancevska et al., 2016*). As the importance of sports psychology is recognized, it has become necessary to utalize knowledge and skills for the well-being and good performance of athletes. In sports activities, athletes should be trained from a holistic perspective in terms of sporting performance and health (*McHenry et al., 2022*). However, elite athletes are more focused on using mental training techniques in competition as part of their physical training program than in their daily training (*Raalte & Petitpas, 2009*). Athletes benefit from this training for their personal development in order to sustain this success along with their performance success (*Vealey, 2007*). In fact, the main purpose of the training process is to increase the athlete's work capacity and skill abilities, as well as to allow the development of strong psychological qualities for successful performance (*Bompa & Haff,*

2009; Carrera & Bompa, 2007). Since the athlete is not a mechanical being, any change in their emotions, thoughts and behaviors will be reflected in their performance. With mental training practices, mental obstacles to the success of the athlete are eliminated and the athlete is ensured to reach their maximum performance. In this regard, the techniques used in mental training include physical relaxation, arousal regulation, imagery, goal setting, thought management, biofeedback training, self-talk and focus (*Vealey, 2007*). In his study where Behncke (*2004*) drew attention to the importance of biofeedback technique, progressive muscle relaxation and meditation in mental training, he stated that the breathing exercises required for all these techniques should be planned according to the needs of the athlete or team.

In line with this information, the aim of the study is to examine the effect of a mental training program to be applied twice a week for 40 minutes for 12 weeks on the psychophysiological response, selected physical fitness and psychological skills of football players. Mental exercises used to improve the performance of athletes are important practices for psychological preparation (*Eklund & Tenenbaum, 2014*). These practices include the athlete's mental state, personality traits, psychological skills, and the techniques and strategies used to improve them (*Gould & Maynard, 2009*). Mental studies using the BFB method along with new developments are valuable in terms of providing immediate feedback. Thus, unlike similar studies, our study is important as an experimental study in which selected physical fitness and psychological skill measurement results are evaluated together with psychophysiological results measured by the biofeedback method.

2. METHOD

2.1. Research Model

This study, which aimed to examine the effect of the mental training program on psychophysiological response, selected physical fitness components and psychological skills, was implemented as a quantitative study including pre-test and post-test. Of the 30 football players identified according to the convenience sampling method, 15 were divided into the experimental group and 15 into the control group. The independent variables are mental training and time, and dependent variables are psychophysiological response, selected physical fitness components and psychological skills. The independent variables are mental training and time, and dependent variables are psychophysiological response, selected physical fitness components and psychological skills.

2.2. Working Group

The sample size for the study was calculated at a 95% confidence level using the "G.Power 3.1.9.2" program. Taking a similar study as a reference, the effect size of the study was calculated based on the difference between the experiment and the control, and for the independent sample t-test, an alpha value of .05; an effect size of 1.70 and a theoretical power of 99% were taken. The experimental (EXP) and control (CON) groups were planned as 15 persons of experimental and 15 persons of control groups from the athletes of both teams according to their positions. With this method, each athlete in the team was distributed equally to both groups according to their positions. In this distribution, the probability of each athlete being selected was evaluated and the random number method was used. The population of the study consists of all football players in the U16-U18 age group, and the sample consists of 30 male football players in Muğla Sports U16-U18 categories. The control group and the experimental group continued their studies at different times. Since the football players' perspective on the mental element was that physical training was more important, no misconceptions arising from any expectations were realized. At the end of the study, it was observed that awareness was created especially in the experimental group.

2.3. Data Collection Tools

Height and Body Weight Measurement: Height was measured with a Seca brand digital height meter with a precision of .01 cm, and body weight was measured with a Seca brand electronic scale with an accuracy of .1 kg. (*Saygın et al., 2012*).

2.3.1. Biofeedback Method- HeartMath İnner Balance:

The biofeedback method we used in the study was applied using the HeartMath Inner Balance wearable technological device. HR, HRV, heart-mind coherence and maximum heart-mind coherence measurements were performed with this device. Measurement results give feedback to the person about body systems, and thus the individual learns how to change these systems (*Moss & Andrasik, 2008*). This wearable technology provides feedback on real-time HR, HRV and coherence. The sensor device is attached to the earlobe, connected to any smart device via Bluetooth, and graphic and numerical data

about psychophysiological responses begin to be reflected on the screen (HeartMath, n.d.). Thus, the results obtained from the device give feedback to the person about the body systems and enable the individual to learn how to change these systems (*Moss & Andrasik, 2008*). Wearable technological devices are devices that work in conjunction with a computer or similar information and communication technology and consist of clothing or accessories that are suitable for the human body and can be easily worn (*Tehrani & Michael, 2014*). Wearable technologies, unlike computers and smartphones, have the ability to monitor and detect the individual. For this function, it collects data without the need to connect to another device and the data can be monitored on the screen on the device (*Demirci, 2018*). It is suitable for the individual using connectivity and portability (*Thapliyal et al, 2017*). Wearable devices are frequently used, especially in the field of health and sports. In our study, football players' HR, HRV, Heart Mathematics and Mental compatibility were measured with the Heartmath Inner Balance device. Measurements were made to determine the difference between the mental training practices studied with the experimental group athletes before and after the study. It is thought that the effect of the program, which includes mental exercises that will help them achieve the necessary stress control during the competition and increase psychological skills, on the football players will be measured through a wearable device and clearer results will be achieved. This device creates a special field that allows communication between the heart and mind. Inner Balance HeartMath device, in addition to measuring, provides support for the individual with anxiety by regulating the heart rhythm with guidance and breathing techniques (HRV). In practice, the device's sensor is attached to the ear. The internal balance coherence sensor includes an advanced heart rate monitor that allows measurement of even tiny changes in heart rhythms. As a result of the measurement made on athletes, the athlete's heart-mind harmony is above 2.00. A result below is considered to be low, and a value above 2.00 is considered to be a high fit. HRV analysis is an important non-invasive measurement that describes the heart-brain interaction and the autonomic nervous system, which is especially sensitive to changes in emotional state (HeartMath, n.d).

2.3.2. Agility Measurement:

Illinois Agility Test (IAT) was applied for agility measurement. This testing track; It is 10 m. long, 5 m. wide and consists of three cones lined up at 3.3 m. intervals in the middle. It is a test consisting of 20 meters of slalom between cones and 40 meters of straight running, with 180º turns every 10 meters. After the Illinois Test was established, a two-door, photocell electronic stopwatch that evaluates with an accuracy of .01 seconds was placed at the beginning and end. Before the test, the test participants were given the necessary explanations and the course was introduced, and then they were allowed to practice at a low tempo for 3-4 trials. Before starting the testing phase, the subjects were given 5 minutes. Warm-up and stretching exercises were performed. During the test, at the beginning of the track, the person taking the test started lying face down and with their hands in contact with the ground, brought to shoulder level. The time to complete the test was recorded in seconds, and the test was repeated twice. A full rest was given between repetitions, and the best value was recorded (*Hazır et al., 2010; Miller et al., 2006*).

2.3.3. Flexibility Measurement:

In this study, the *Sit and Reach* Test (SRT) of the Eurofit physical fitness test battery, which is most commonly used in flexibility measurement in football, was applied to measure flexibility. The participants were kept for 1 second at the point they reached on the fourth repetition of the movement along the measurement scale, and the best value was recorded (*Beam & Gene, 2013*).

2.3.4. Reaction Time Measurement:

Reaction time measurement, which is an important element of physical fitness variables, was carried out with the Newtest 1000 device in three different ways: visual, auditory and complex. The athletes whose reaction time was measured with visual, auditory and then complex stimuli were asked to repeat it 5 times, the minimum and maximum values were subtracted, the arithmetic average of the remaining 3 results was taken and the measurement results were converted into seconds and recorded (*Tamer, 2000*).

2.3.5. Athletic Psychological Skills Inventory (APSI):

The psychological skill dimension of the study was measured with the " Athletic Psychological Skills Inventory (APSI) developed by Smith et al. (*1995*) and adapted into Turkish by Erhan et al. (*2005*). Scoring was scored between 0 and 3 according to the expressions "almost never", "sometimes", "often" and "almost always". Questions 3, 7, 10, 12, 19 and 23 of

the scale are negative, and should be reverse numbered. Scoring for the sub-dimensions varies between 0 and 12, and the increase in the score obtained from the scale indicates that the athlete's psychological skills are good. This tool, developed for athletes, consists of 28 items, 7 sub-dimensions and 4 items in each sub-dimension. The seven sub-dimensions were created by Smith et al., (*1995*) and interpreted by Smith and Christensen (*1995*). The sub-dimensions are goal setting and mental preparation, performing well under pressure, getting rid of worries, ability to cope with difficulties, being open to learning, concentration, confidence and motivation for success. Scoring for these sub-dimensions varies between 0 and 12, and an increase in the score obtained from the scale indicates that the athlete's psychological skills are good. *Ability to Cope with Challenges:* Measures whether an athlete can be positive, enthusiastic, calm, controlled and able to quickly recover from mistakes, even when the situation gets worse. *Being Open to Learning:* It measures whether the athlete is open to learning and whether he/she accepts constructive criticism without taking it personally or getting upset. *Concentration:* This subscale measures whether an athlete is easily distracted and remains focused on his or her task even in unexpected adverse situations, both in training and during a match. *Confidence and Achievement Motivation:* Measures whether an athlete is self-confident and positively motivated during training and matches. *Goal Setting and Mental Preparation:* Measures whether an athlete sets specific performance goals and works towards them. *Ability to Perform Well Under Pressure:* Measures whether an athlete performs better under pressure. *Getting Rid of Worries:* It measures whether the athlete creates pressure with the anxiety of performing poorly or making a mistake (*Smith & Christensen, 1995*). Necessary permissions were obtained for the use of the scale in the study.

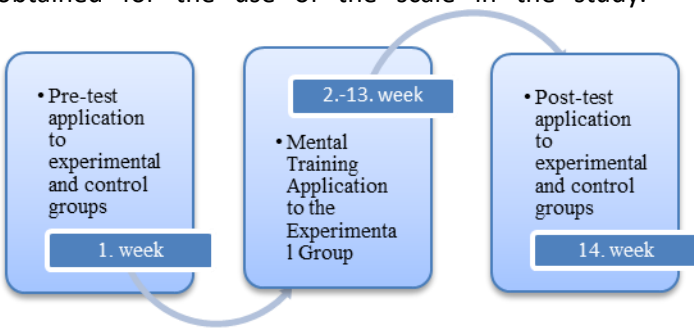

Figure 1
Study Design

2.4. Data Collection

In the study, the data were collected face to face by the researcher, and laboratory and sports facilities of Faculty of Sports Sciences at Muğla Sıtkı Koçman University were used as data collection location. Participants in the experimental and control groups first filled out the scale for the pre-test and performed the basic HR, HRV, heart-mind coherence and maximum heart-mind coherence measurements required for psychophysiological measurements in a quiet and calm environment without any stimulation. Following BFB measurements, agility, flexibility and reaction time measurements were performed. After the pre-test, 15 athletes in the experimental group participated in both the physical training provided by the club coach and the 12-week mental training, which was the application of the research. The 15 athletes in the control group participated only in the physical training provided by the club coach. The mental training application was carried out by the researcher, who has Mental Performance Coaching IC/ACSTH and Sports Psychology Training certificates, and is also a Breathing and Meditation Training Trainer. This application was applied to the experimental group as a group and regularly before football training, twice a week for 12 weeks, away from the effect of fatigue. Via the WhatsApp Messenger group created with the experimental group participants, they were reminded of the practices they should do daily (breathing exercises, relaxation and focus exercises, etc.) and support was provided to answer their questions. Diaphragm breathing technique was carried out with the experimental group during the mental training program consisting of goal setting, breathing exercises, visualization, step-by-step relaxation, mindfulness exercises, attention and focus, positive thinking and thought control. At the end of 12 weeks, 30 athletes in the experimental and control groups were given post-test measurements, and the results were assessed and reported. At the end of 12 weeks, 30 athletes in the experimental and control groups were first asked to fill out the scale, and then a final test measurement was made with the BFB Inner Balance device in a quiet and calm environment. Finally, the results obtained from the football players to whom physical fitness measurements were applied were evaluated and compiled into a report. In our study, a mental training program whose theoretical framework is based on Cognitive-Behavioral intervention program and MMTS program was applied (*Baltzell & Akhtar, 2014; Beswick, 2001; Dosil, 2006; Ekmekçi, 2022; McArdle & Moore, 2012; Olmedilla &*

Domínguez-Igual, 2016). The activities included in the mental training are aimed at maximizing the performance of the football players, both individually and as a team, and were planned to make a positive contribution to their physical abilities along with the acquisition of psychological skills. While focus and attention exercises were carried out with games for reaction time, relaxation, breathing exercises and positive thinking practices were applied for HR, HRV and coherence consistency. Flexibility and agility components were tried to be increased through visualization exercises. The content of the study is as follows and this procedure was applied regularly to the experimental group participants.

Table 1

Descriptive Statistics of the Participants

Variables	n	Min.	Max.	$\bar{X}$	ss
Age(yıl)	30	16	18	17.03	.76
Height(cm)	30	162	183	173.70	5.84
Body weight (kg)	30	57.5	82.2	66.35	6.02

1 st Month

WEEK 1: Meeting, Introducing the Program and Goal Setting
WEEK 2: Breathing Exercises 1
WEEK 3: Breathing Exercises 2
WEEK 4: Step by step Relaxation Exercises

2 st Month

WEEK 5: Imagery 1
WEEK 6: Imagination 2
WEEK 7: Mindfulness Exercises
WEEK 8: Attention and Focus

3 st Month

WEEK 9: Positive Thinking and Thought Control
Week 10: Combining all mental training exercises and working in harmony
Week 11: Combining all mental training exercises and working in harmony
Week 12: Evaluation of the Mental Training process, reflection on life and self-evaluation of
the athlete

*Mental Training practices have become a lifestyle with the breathing exercises, mental visualization, conscious awareness, focus and positive thinking exercises that football players will do regularly every day. The researcher provided necessary reminders by constantly communicating with the study group (*Whatsapp and Zoom*) for 12 weeks (*Baltzell & Akhtar, 2014; Beswick, 2001; Dosil, 2006; Ekmekçi, 2022; McArdle & Moore, 2012; Olmedilla & Domínguez-Igual, 2016*).

2.5. Analysis of Data

Data analysis was performed using SPSS (version 20) program. Shapiro-Wilk was used to determine whether the data showed normal distribution. Parametric tests were used in the study where it was determined that the data showed normal distribution with the bell curve. Independent Sample T-Test Analysis was applied in the comparison between groups, and Paried Sample t Test was applied in the pre-posttest comparison. The significance level was accepted as ($p<.05$).

3. RESULTS

When the descriptive information table of the participants was examined, it was seen that the average height of the 16 and 18 age group football players with an average age of 17.03±.76 was 173.7 ±5.83, and their average body weight was 66.34±6.01.

Table 2

Normal Distribution Analysis of Measurements Related to Variables in EXP and CON Groups with Shapiro Wilk Test

Variables	Exp. Groups	Con. Groups		
	$\bar{X}$±ss	$\bar{X}$±ss	t	p
HR(bpm)	75.06±5.6	72.80±9.73	.78	.44
Heart-mind Coherence (ms)	1.20±.40	1.22±.40	-.18	.86
Maksimum Heart-Mind Coherence (ms)	3.73±1.5	3.32±1.03	.86	.39
IAT (sn)	16.63±.56	16.39±.45	1.29	.21
SRT (cm)	6.80±4.8	7.86±4.03	-.71	.48
Visual Reaction Time (ms)	.47±.05	.47±.08	-.21	.83
Auditory Reaction Time (ms)	.45±.09	.46±.09	-.097	.92
Complex Reaction Time (ms)	.47±.06	.474±.099	.00	1.00
APSI	39.8±6.01	43.8±7.49	-1.63	.11
Coping with Difficulties	4.60±2.19	5.80±2.56	-1.37	.18
Being Open to Learning	6.06±1.09	5.86±1.40	.43	.67
Concentration	4.86±1.40	5.46±1.50	-1.19	.27
Confidence and Achievement Motivation	8.13±1.35	8.73±1.94	-.98	.33

Goal Setting, Mental Well-being	4.93±1.22	5.86±1.80	-1.66	.11
Good Performance Under Pressure	5.60±1.72	5.86±1.30	-.48	.64
Getting Rid of Worries	5.60±1.35	6,26±1.33	-1.35	.18

In the light of the findings stated in Table 2, it was concluded that the experimental and control groups' HR, heart-mind coherence and maximum heart-mind coherence; agility, flexibility, visual reaction, auditory reaction and complex reaction variables which are physical fitness parameters; and coping with difficulties, being open to learning, concentration, confidence and achievement motivation, goal setting- mental well-being, good performance under pressure, getting rid of worries variables, which are parameters of APSI and its subgroups, showed normal distribution according to the results of Shapiro-Wilk Test (p>.05).

Table 3

Independent T-test Analysis of Pre-Test Measurement Comparisons Between Groups

Variables	Experimental Groups	Control Groups		
	$\bar{X}$±ss	$\bar{X}$±ss	t	p
HR (bpm)	75.06±5.61	72.80±9.73	.78	.44
Heart-mind Coherence (ms)	1.20±.40	1.22±.40	-.18	.86
Max.Heart-mind Coherence (ms)	3.73±1.50	3.32±1.03	.86	.39
IAT (sn)	16.63±.56	16.39±.45	1.29	.21
SRT (cm)	6.80±4.17	7.86±4.03	-.71	.48
Visual Reaction Time (ms)	.47±.050	.47±.08	-.21	.83
Auditory Reaction Time (ms)	.46±.09	.46±.09	-.10	.92
Complex Reaction Time (ms)	.47±.06	.47±.09	.00	1.00
APSI	39.8±6.01	43.8±7.49	-1.63	.11
Coping with Difficulties	4.60±2.19	5.80±2.56	-1.37	.18
Being Open to Learning	6.06±1.09	5.86±1.40	.43	.67
Concentration	4.86±1.40	5.46±1.50	-1.13	.27
Confidence and Achievement Motivation	8.13±1.35	8.73±1.94	-.98	.33
Goal Setting, Mental Well-being	4.93±1.22	5.86±1.80	-1.66	.11
Good Performance Under Pressure	5.60±1.72	5.86±1.30	-.48	.64
Getting Rid of Worries	5.60±1.35	6.26±1.33	-1.35	.18

According to the findings stated in Table 3, as a result of Independent T Test Analysis for pre-test measurement comparisons between groups, it was seen that there was no significant difference (p>.05) considering the experimental and control groups' HR, heart-mind coherence and maximum heart-mind coherence; agility, flexibility, visual reaction, auditory reaction and complex reaction variables which are physical fitness parameters; and APSI and its subgroups of coping with difficulties, being open to learning, concentration, confidence and achievement motivation, goal setting, mental well-being, good performance under pressure, getting rid of worries variables.

Table 4

Examination of In-Group Pre-Post Test Independent Sample T Test Means

Variables	Groups	n	Pre Test	Post Test	t	p
			$\bar{X}$±ss	$\bar{X}$±ss		
HR (bpm)	Exp	15	75.06±5.61	75.20±6.62	-.62	.95
	Con	15	72.80±9.73	77.73±10.47	-1.62	.12
Heart-mind Coherence(ms)	Exp	15	1.20±.40	3.11±.80	-8.49	.00**
	Con	15	1.22±.40	1.24±.64	-.12	.89
Max Heart-mind Coherence(ms)	Exp	15	3.73±1.50	4.94±.99	-2.85	.01*
	Con	15	3.32±1.03	3.75±.74	-1.65	.12
IAT (sn)	Exp	15	16.63±.55	16.49±.51	3.18	.00**
	Con	15	16.39±.45	16.97±.44	-9.06	.00**
SRT (cm)	Exp	15	6.80±4.17	12.10±2.95	-11.2	.00**
	Con	15	7.86±4.03	9.70±4.16	-4.53	.00**
Visual Reaction Time(ms)	Exp	15	.46±.04	.36±.04	5.76	.00**
	Cont	15	.47±.08	.50±.07	-2.00	.06
Auditory Reaction Time(ms)	Exp	15	.45±.09	.28±.07	5.64	.00**

	Con	15	.46±.09	.43±.11	.69	.49
Complex Reaction Time (ms)	Exp	15	.47±.06	.35±.05	6.74	.00**
	Con	15	.47±.09	.52±.09	-2.21	.04*
APSI	Exp	15	39.80±6.01	72.20±3.87	-16.50	.00**
	Con	15	45.13±8.06	48.93±7.6	-3.08	.00**
Coping with Difficulties	Exp	15	4.60±2.19	10.53±1.30	-9.22	.00**
	Con	15	5.80±2.56	6.06±1.86	.53	.60
Being Open to Learning	Exp	15	6.06±1.09	11.60±.73	-15.80	.00**
	Con	15	5.86±1.40	8.26±2.08	-4.75	.00**
Concentration	Exp	15	5.00±1.25	6.00±1.36	-2.48	.02*
	Con	15	5.46±.38	5.80±1.47	-.89	.38
Confidenceand Achievement Motivation	Exp	15	8.53±1.50	11.40±.63	-7.15	.00**
	Con	15	8.73±1.94	8.86±1.55	-.30	.76
Goal Setting, Mental Well-being	Exp	15	4.93±1.22	11.20±.56	-16.88	.00**
	Con	15	5.86±1.80	6.06±1.53	-.45	.65
Good Performance Under Pressure	Exp	15	6.80±1.47	9.73±1.38	-5.12	.00**
	Con	15	5.86±1.30	7.13±1.30	-3.83	.00**
Getting Rid of Worries	Exp	15	5.60±1.35	7.86±1.68	-4.27	.00**
	Con	15	6.26±1.33	6.60±1.24	-.70	.49

**p<.01; *p<.05

According to Table 4, there was no significant difference in the HR pre-posttest of the experimental and control groups (p>.05). Pre-post test results of heart-mind coherence, maximum heart-mind coherence, agility, audio-visual-complex reaction time variables were found to be significant in favor of the experimental group (p<.01). Flexibility component averages showed a significant change in both groups in the pre-posttest (p<.01). The pre-posttest measurement results of the APSI and its subgroups such as coping with difficulties, being open to learning, concentration, confidence and success motivation, goal setting and mental well-being, and getting rid of worries were found to be significant in favor of the experimental group (p<.01). The dimensions of openness to learning and good performance under pressure showed significant differences in both groups (p<.01). In the control group, the increase in agility and complex reaction components was observed to be negative.

Table 5

Examination of Pre-Post Test Independent Sample T Test Means Between Groups

Variables	Test	t	p
HR (bpm)	Pre test	.78	.44
	Post test	-.79	.43
Heart-mind Coherence(ms)	Pre test	-.18	.86
	Post test	6.99	.00**
Maksimum Heart-mind Coherence(ms)	Pre test	.86	.39
	Post test	.86	.00**
IAT (sn)	Pre test	1.29	.20
	Post test	-2.78	.01*
SRT (cm)	Pre test	-.71	.48
	Post test	1.82	.08
Visual Reaction Time (ms)	Pre test	-.21	.83
	Post test	-6.73	.00**
Auditory Reaction Time(ms)	Pre test	-.10	.92
	Post test	-4.41	.00**
Complex Reaction Time(ms)	Pre test	.00	-5.79
	Post test	1.00	.00**
APSI	Pre test	-1.64	10.47
	Post test	.11	.00**
Coping with Difficulties	Pre test	-1.37	10.47
	Post test	7.59	.00**
Being Open to Learning	Pre test	.43	.67
	Post test	5.83	.00**
Concentration	Pre test	-1.13	.27
	Post test	8.49	.00**
Confidence and Achievement Motivation	Pre test	-.98	.58
	Post test	12.17	.00**
Goal Setting, Mental Well-being	Pre test	-1.66	.11
	Post test	8.49	.00**
Good Performance Under Pressure	Pre test	-.48	.64
	Post test	5.29	.00**
Getting Rid of Worries	Pre test	-1.36	.18
	Post test	2.34	.03*

**p<.01; *p<.05

According to Table 5, it was observed that there was no significant difference between the pre-posttest averages (p>.05) in HR and flexibility between the groups, and that there were significant differences in being open to learning and performance under pressure (p<.01) sub-dimensions of the APSI. The significant difference between the groups observed in other variables was in favor of the experimental group (p<01).

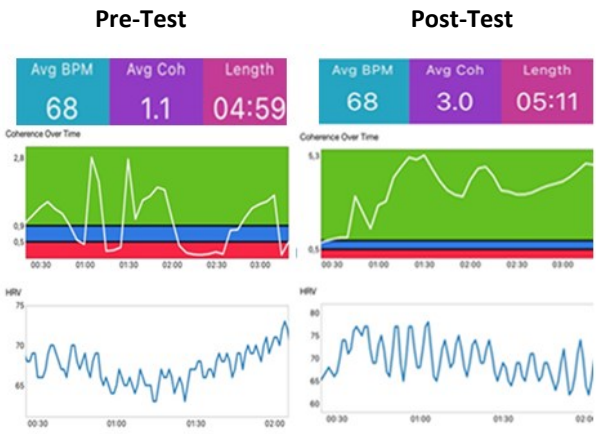

Figure 2
Screenshot of Pre-Post Test HR, HRV, Avarage Coherence, Maximum Coherence Over Time Measurements of Experimental Group Athlete

In the pre-test presented in Figure 2, heart-mind compatibility changed from 1.1 ms to 3.0 ms, and maximum heart-mind compatibility highted from 2.8 ms to 5.3 ms. It was concluded that there was a statistically significant difference between the pre-post test score averages of heart-mind alignment and maximum heart-mind alignment. In addition, a significant change was observed between the pre- and post-test in the HRV graphical view, and unlike the pre-test, it was observed that there were smooth and harmonious ups and downs.

Figure 3

Screenshot of Pre-Post Test HR, HRV, Avarage Coherence, Maximum Coherence Over Time Measurements of Control Group Athlete

The screenshot seen in Figure 3. shows, the pre-posttest BGB method measurement result of the control group athlete who did not undergo mental training. There was no statistically significant difference between the pre-post test score averages of the heart-mind alignment and maximum heart-mind alignment. According to the HRV graph, while ups and downs and an incompatible course were observed in the pre-test, similar ups and downs continued in the post-test and no change was observed.

4. DISCUSSION

The Effect of Mental Training on Psychophysiological Responses with the BFB Method

In our study where we examined the effects of mental training on football players' psychophysiological responses, selected physical fitness elements and psychological skills, psychophysiological measurements produced very valuable results. Because BFB applications allow athletes to realize their physiological conditions through measurements and make healthy adjustments in line with this information. Awareness-raising BGB measurements provide the information that needs to be learned about the situation being performed (*Paul et al., 2012*). These applications, which are generally used to reduce sympathetic arousal and for balance and harmony, have many measurement purposes (*Schwartz & Andrasik, 2003*). Biofeedback (BGB) applications provide clear feedback about the user's emotional state using physiological sensors, and this process supports the individual in learning how to change their physiological activities over time in order to stay healthy and improve the athlete's performance. In this regard, Aktop (*2008*) in his study in which he applied mental training with BFB, stated that there was a higher increase in the dart performances of the participants compared to the control group, the structure of this increase differed between the groups, and trait and state anxiety values showed a significant decrease in the experimental group at the end of the 14-week period. Tuna (*2018*), who applied BFB with electroencephalogram (EEG), found significant differences in the cognitive and physical anxiety scores of the scale, between the group and measurement interaction, in the group and measurement interaction for the sensory motor rhythm (SMR) value, and in the auditory response control score, which is one of the subscales of the attention test. In their study, Bernier et al. (*2011*) measured the stress of soldiers by using visual and auditory biofeedback in the military environment, and concluded that this practice was effective in reducing stress. In another study, Canton et al. (*2022*), who examined the extent to which 16 amateur

marathon competitors were able to learn to control their autonomic responses through via the BFB pathway, reported that significant decreases were observed in psychophysiological activation, and that athletes learned to control autonomic responses. Aritzeta et al. (*2017*) examined the effect of the biofeedback relaxation training program on anxiety and academic performance in their study, and concluded that the anxiety levels of the experimental group students decreased, and their academic success increased after the program. Stating that the essence of psychophysiology is the scientific study of the mind and body connection, Levy and Baldwin (*2019*) discussed the applied psychophysiology and biofeedback research methodologies and results in their study, in which they noted that the interest in biofeedback training has increased to help athletes self-regulate and improve their performance. In parallel with our study, Dillon et al. (*2016*), who conducted a BFB study with a smartphone application, examined the effectiveness of smartphone application games combined with biofeedback in reducing physiological and psychological markers of stress. As a result of their study, it was observed that self-rated stress and heart rate decreased significantly in the experimental group compared to the control group. It was also stated that the experimental group playing smartphone games named "Relax and Race and The Lomm" in the BFB training reduced their self-rated stress by up to 50%, while the heart rate of the control group increased by 8%. All these studies, as in our research, reveal the importance of BFB applications in improving the athlete's performance. These applications used in mental training studies have an important place in the continuation of stability in success.

Effect of Mental Training on Selected Physical Fitness Parameters (Agility, Flexibility, Reaction Time)

There are increasing studies showing that physical fitness components improve positively with mental training practices. One of these studies, Özdal et al. (*2013*) concluded that the video-assisted mental training program had a positive effect on shooting skills in football, and that mental training combined with physical training was more effective than just physical or mental training alone. Cankurtaran (*2020*) studied with 308 volunteer archers participating in the Turkish Championship, and as a result, a positive and significant relationship was found between Athlete Mental Training Inventory responses and arrow shots. Aslan and Küçük (*2015*), who examined the effect of mental training techniques on learning the putting technique in golf beginners, formed three groups and gave only physical training to one, only mental training to the other group, and both physical and mental training to the third group. At the end of the study, the performance development of the three groups among themselves was observed; however, it was revealed that the group in which physical and mental training was applied together showed high improvement in the differences between the groups. In their study examining the effect of 10-week psychological skills training planned using mental training techniques on the psychological skills and shot accuracy rates of football players, Urfa and Aşçı (*2018*) stated that while there was a significant difference in the self-esteem and attention levels of football players, there was no difference in somatic anxiety, motivation, anxiety and shot accuracy scores. In their study, Karaca and Gündüz (*2021*) found a positive relationship between the mental training levels of orienteering athletes and their competition performances. Kaufman, Gloss, and Pineau (*2018*) emphasized the importance of mental training in their study, stating that incorporating systematic mental training discipline into sports at all levels not only improves performance and results, but also provides a greater and deeper sense of connection and satisfaction and, at least in some cases, the fusion of mind and body in a space that transcends the sense of a separate self that performs the performance. Batar (*2003*) examined the effect of 12 sessions of mental training on speed performance, and concluded that mental training has a positive effect on learning a new movement skill more easily and quickly, or executing an already known movement more accurately and fluently. Bar-eli and Blumenstein (*2004*) applied the Wingate five-stage approach to elite swimmers, and found that the 16–18-year-old experimental group improved their performance in both running and swimming, while the control group remained stable in two dependent measurements. Sheard and Golby (*2006*), as a result of psychological skills training consisting of goal setting, visualization, relaxation, concentration and thought stopping for 45 minutes a week for 7 weeks with 36 swimmers, concluded that there were significant improvements after the intervention program, and and positive changes in the positive psychological states of the participants in three separate swimming races, each of which was over 200 m. Andrade et al. (*2021*) determined that Olympic combat sports constitute 22% of sports branches, and that studies are needed to reveal the importance of the psychological factor for success in this process. In another study, Scanlan et al. (*2013*) examined the effects of physical and cognitive factors on reactive agility performance in male basketball players. As a result, it was determined that

cognitive measurements had a significant impact on reactive agility performance; therefore, they stated that reaction and decision-making practices should be included in the training of basketball players. Likewise, Robin et al. (*2019*) utilized video method and mental training techniques in free throw skills with 36 university basketball team athletes. As a result, it was observed that the athletes who watched the excellent skills of good athletes on video performed better than the control group. As can be seen from the results of the research, competition preparation cannot be considered as only physical preparation. Although the physical factor is considered as the main component in the preparation of many athletes, the psychological factor should not be ignored (*Andrade et al., 2016*). It seems that the results indicate that we were right in our journey with the hypothesis that mental training has a positive effect on physical fitness elements.

The Effect of Mental Training Techniques on Psychological Skills

Nowadays, athletes and coaches have realized the importance of psychological state along with physical development (*Mahoney et al., 2014*), and psychological skill training has started to be included in training programs. Because the athlete's positive psychological development is achieved with this training, and their skills start to increase (*Williams, 2001*). As seen in our study, significant differences were observed in the psychological skill scores of the study group athletes after the mental training. Similarly, Crust and Azadi (*2010*) applied self-talk, emotional control and relaxation strategies with university student athletes who were preparing to compete in different branches, and the results showed that they obtained significant and positive results for competitions. In his book, in their study investigating the effects of mental skills training on pre-race anxiety and performance of non-elite riders, Wolframm and Micklewright (*2011*) included goal setting, relaxation techniques, self-talk, concentration and visualization exercises in the mental training intervention program. At the end of the mental training process, it was observed that there were positive effects on performance in the race they participated in. Before, during and after the intervention, Golby and Wood (*2016*) conducted a 6-month study on athletes who were new to rowing sports and as a result, positive improvements were observed in perceived self-efficacy, self-esteem and positive affect. It is a known fact that in order to be successful in sports, focus and determination as well as the athlete's ability to tolerate pressure are important. All of these require the athlete to be psychologically equipped (*Lawless & Grobbelaar, 2015*). It is seen that the results of the research reveal the importance of mental training and prove the validity of the hypothesis.

5. CONCLISUONS

According to the results of our study, which we think will make a significant contribution to studies on mental training, no statistically significant change was observed in HRV. The results of heart-mind alignment, maximum heart-mind alignment, agility, audiovisual-complex reaction time and psychological skills assessment scale were found to be significant in favor of the experimental group. Concerning the flexibility variable, while there was a significant difference between the experimental and control groups in the pre-posttest, no significant difference emerged according to the results of the intergroup analysis. This is thought to be due to the fact that both groups continued their physical training. It was observed that the scores of "coping with difficulties, concentration, confidence and success motivation, goal setting and mental well-being, getting rid of worries", which are among the sub-groups of APSI, increased significantly in favor of the experimental group. A statistically significant difference was found in the experimental and control groups in the sub-groups of "being open to learning" and “performing well under pressure”. It was predicted that this situation occurred due to the personality characteristics of the control group football players and the management style of their coaches. The athletes' motivation to be selected for the national team and the coach's disciplined approach to ensure that his athletes can be selected for the club's A team and transferred to different clubs may have paved the way for meaningful changes, especially in the control group. Thus, much as the hypotheses we determined at the beginning of the study were accepted, the final hypothesis, "there is no difference between the pre-posttest in all variables of the control group", was rejected because significant results were found in the two sub-groups of "being open to learning" and "performing well under pressure", which we thought to be due to reasons such as the personality traits of the football players, the way their coaches manage the team and the characteristics they have as leaders and the way their families raise the athletes.

In conclusion, it can be said that mental training has a positive effect on psychophysiological response, physical fitness components and psychological skills in football players. In other studies, to be conducted in the future, it is a matter of curiosity how the balance element will be affected by mental training exercises

based on this study. In addition, one of the suggested study topics is the effect of mental training practices in a study involving football-specific field performance. In addition, it is recommended that this study, which includes physical, psychological and psychophysiological measurements, be conducted in other studies to conduct a more in-depth evaluation of the pre- and post-mental training using the interview technique with athletes or coaches. From another perspective, it is recommended that research be carried out to investigate whether there will be a change in the physical performance of female football players after the mental training process and to examine the effect of mental training applied to athletes on the hormonal system.

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7. ETHICS STATEMENT

Ethical approval of the study was received by Muğla Sıtkı Koçman University Medicine and Health Sciences Ethics Committee 2 Sports-Health Decision Date 25.03.2022. Protocol number:36

8. AUTHOR CONTRIBUTIONS

Research Design- ÜEY, ÖS, RE Data Collection- ÜEY Statistical analysis- ÜEY Article preparation- ÜEY, ÖS

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