NeuroRegulation

ISNR INTERNATIONAL SOCIETY FOR NEUROREGULATION & RESEARCH

The Effects of the PowerMens Methodology on the Measurement and Training of Attention in Young Footballers: A Pilot Study

Paolo Tirinnanzi[1, 2, 3]

[1]Sport Psychology SPPA, Study of Psychology and Psychotherapy of Arezzo, Arezzo, Italy
[2]Arezzo Sports Society srl, Psychophysiological Area, Arezzo, Italy
[3]AIAC Italian Football Coaches Association, Florence, Italy

Abstract

In sport psychology, the use of biofeedback (BFB) is increasingly frequent, a noninvasive experimental procedure that allows the person to regulate their psychobiological functions and helps to become aware of internal processes that are not consciously controlled. Based on this, a new method was devised, PowerMens, which for the first time investigates these concepts integrated with specific training on visual attention.

The subjects were 20 professional youth football players, divided into experimental and control groups. The research was conducted in pretest, training, and posttest, where the pre- and posttest consisted of a stress attention task. The experimental group conducted the BFB PowerMens training which integrates the BFB with Mental Games software promoting the control of the arousal level and the restoration of homeostasis.

The aim of this research was to examine the psychophysiological reaction to the visual attention tasks that cause attentional and cognitive stress, predicting greater self-regulation and restoration of body homeostasis in the experimental group.

The results are auspicious because they showed a better capacity for cognitive and emotional self-regulation, a restoration of homeostasis, and also an improvement in posttest time.

Keywords: sport psychology; sport performance; biofeedback; football; PowerMens

Citation: Tirinnanzi, P. (2022). The effects of the PowerMens methodology on the measurement and training of attention in young footballers: A pilot study. *NeuroRegulation*, *9*(1), 2–15. https://doi.org/10.15540/nr.9.1.2

***Address correspondence to**: Dr. Paolo Tirinnanzi, SPPA Study of Psychology and Psychotherapy of Arezzo, Località Olmo, 21, 52100 Arezzo, Italy. Email: dr.tirinnanzi@studio-psicologia-arezzo.it

Edited by:
Rex L. Cannon, PhD, SPESA Research Institute, Knoxville, Tennessee, USA

Reviewed by:
Rex L. Cannon, PhD, SPESA Research Institute, Knoxville, Tennessee, USA
Tanya Morosoli, MSc: 1) Clínica de Neuropsicología Diagnóstica y Terapéutica, Mexico City, Mexico; 2) ECPE, Harvard T. H. Chan School of Public Health, Boston, Massachussetts, USA

Introduction

In the world of sport, both professional and competitive, athletes who aspire to success must learn to face competitions with a psychological framework that allows them to excel despite environmental or mental variables.

In recent years, the scientific literature relating to sport psychology is bringing out a dimension, the mental one, as an essential component for achieving high-level performance (Bompa, 1999; Cox, 2002; Issurin, 2007). Today it is essential for athletes who aspire to have an excellent performance to learn to face performances and competitions with a psychological framework that allows them to be successful in a performance context with environmental (external) or psychological (internal) aversive variables (Blumenstein et al., 2007; Dahl, 2013). The sport involves fine motor skills, in which

the psychological aspect plays a key role in sporting performance during a competition (Rogulj et al., 2006).
Soccer is an unpredictable, acyclical team sport involving combined movements of the upper and lower limbs, which often must be performed at or near maximum speed, a frequent number of times during the entire duration of a match. These are complex movements of different types, often unpredictable and sudden and with mainly short recovery times. Cognitive involvement is therefore constant, and integrated coordination with a technical gesture is essential, especially in motion. The individual performance of each player coordinates with that of his teammates and opponents and actively contributes to any collective action. Subjective performance is, therefore, an essential part of a complex system that involves actions and reactions of the players of both teams and requires constant training as the information to be selected and processed is many, at any age (Chmura et al., 2017; Stølen et al., 2005).

The literature in sport psychology highlights how the attention processes in complex and sport-specific decision-making tasks are relevant for performance purposes; in fact, training in this regard can involve a faster evaluation of stimuli (Hack et al., 2009) and an improvement in one's own mental strength and hardness (Jones, 2002). In football, however, there are not many studies that specifically investigate attention; some highlight how cognitive skills related to attention play a fundamental role in the efficient execution of specific tasks (Memmert et al., 2020; Shimi et al., 2021; Verburgh et al., 2014). High-level footballers can perform the steps relevant to the information processing task (such as visual information processing, stimulus evaluation, and motor response output) in a shorter time than lower-level footballers. By studying and analyzing their event-related potentials (ERPs), the P100 and P300 latencies of the high-performance group were significantly shorter than those of the low-performance group (Matsutake et al., 2018). This would be very complex if the brain did not have cortical plasticity (Kandel, 1999).

Attention training, however, may not be sufficient to maintain performance consistency because the sporting context is characterized by the presence of elements, stress factors, which can affect performance (Brandão et al., 2021; Michailidis, 2014; Nippert & Smith, 2008; Santos et. al., 2014). Stress factors are stimuli of different nature that lead the organism and the psyche to experience stress and can be physical, environmental, cultural, metabolic, psychological, affective, or alimentary (Bhargava & Trivedi, 2018; Yaribeygi et al., 2017). The repercussions that stress factors can have are related to attentional bias (i.e., a reduction in attention and concentration during the performance). This results in a change in the direction in which a person focuses their attention in response to a stimulus associated with their illness or in response to a stimulus perceived as threatening (Keogh et al., 2001; O'Toole, 2014). Other studies show that there is a clear correlation between attentional bias and mental states, such as with anxiety (Bar-Haim et al., 2005; Tirinnanzi, 2007) and with depression (Harvey et al., 2004). Anxiety and depression, associated with insomnia, are the symptoms that most aggravate highly stressful and traumatic situations. The recent pandemic due to COVID-19 has shown how these symptoms have drastically increased in the collective population (Casagrande et al., 2020; Huang & Zhao, 2020; Tirinnanzi & Bianchi, 2020; Tirinnanzi & Bianchi, 2021) and in football players (Cavarretta et al., 2021; Rampinini et al., 2021).

Therefore, stressors can bring the stress level beyond a subjective threshold and can affect physiological activation, which affects the activity level of certain bodily functions such as changes in heart rate (HR), respiratory rate (bpm), skin conductance (GSR), sweating, and body temperature. These functions are controlled by the autonomic nervous system (ANS) and often escape the conscious control of the person, but there are techniques, such as biofeedback (BFB), which allow you to voluntarily manage some of these functions (Biagioli, 2013). The BFB is a noninvasive experimental procedure that can be used by a person to regulate their psychobiological functions and helps to become aware of internal processes that are not typically controlled at the level of consciousness (Zaichkowsky & Fuchs, 1988).

Today the BFB, thanks to modern technology, allows us to become aware of the effectiveness of the techniques we are implementing, allowing us to progressively adapt our behavior in real time through objective and measurable feedback, generally presented to the athlete on a PC screen. In this way the athlete, on the basis of the information or feedback received from the body, learns to control self-regulation, to consciously change their behavior in order to improve their health and performance while increasing awareness and physiological activity of one's organism. This process leads to the development of mental skills, such as attention and concentration, and facilitates the achievement of better sports performance (Blumenstein et al., 1997;

Blumenstein & Orbach, 2014; Galmonte et al., 2011).

In football, therefore, the BFB, combined with relaxation and/or activation techniques, can be used successfully in order to obtain systematic learning of the psycho-regulation process, allowing the player to subjectively define and actively face situations (Rijken et al., 2016). Based on the findings of the BFB equipment and the subjective needs of the players, various objectives can be outlined that optimize performance, such as activation control, attention and concentration management, reduction of performance anxiety, pain and fatigue management, increase in muscular effort, and restoration of homeostasis (Biagioli, 2013; Saha et al., 2013). A study by Wilson et al. (2006) highlighted how the use of the BFB may have positively supported the Italian national team during the World Cup won by the same national team in Germany.

Today, technology-based interventions include biofeedback, neurofeedback, virtual reality (VR), augmented psychology, and video game devices (Pallavicini et al., 2009; Russoniello et al., 2009; Tarrant et al., 2018; Thompson & Thompson 2007). The latter, video games, seem ideal for training on stress exposure, for learning stress management in the presence of stressors and for maintaining this ability. Furthermore, they are correlated with attention; that is, people with video game experience, unlike nonexpert people, are more superior in the domains of visual attention (Schubert et al., 2015). The attentional component is also very present in young people; for example, children are better performing than adults in directing attention to irrelevant stimuli (Plebanek & Sloutsky, 2017) and this opens up important reflections, especially on the youth sectors. Video games are designed to increase arousal (Reinecke, 2009), so a stress management software or program built into a video game can help combat and manage stress while performing an arousal activity. BFB video games can, therefore, be an effective technique for teaching relaxation skills (Bouchard et al., 2012).

For footballers, a probable advantage in integrating specific attention work with BFB could be being able to manage and control stress factors, without allowing the subjective threshold that affects physiological activation and affects performance to be exceeded. In this way, the internal resources, instead of being invested in restoring body homeostasis, will probably be greater for the purpose of sports performance.

The BFB uses instruments equipped with sensors and transducers (converters) that provide information on the status of biological functions that are usually not subject to voluntary control. In this research, skin conductance (GSR) and heart rate (HR) were detected.

EDA – Electrodermal Activity

The galvanic skin response (GSR) is a physiological response of electrodermal activity (EDA) and is a measured manifestation (Boucsein, 2012) of the activation of the ANS, in particular of the sympathetic partition (Fontanella et al., 2012). GSR is one of the most used methods in psychophysiology and is considered the golden standard (Fontanella et al., 2012). External emotional stimuli (sudden noise, sigh, phrase or word pronounced by someone) or internal (imagine erotic, fearful, or otherwise emotional scenes) cause a drop in the RS (skin resistance), due to the psycho-galvanic reflex. GSR is affected by sweat gland activity and skin responses on the palmar surface of the hand. The sweat glands are activated only by sympathetic activity. If the sympathetic branch of the ANS is very excited, the activity of the sweat glands increases and, consequently, the variations in the values of GSR.

Electrodermal activity (EDA) is linked to autonomic emotional and cognitive processing and is used as a sensitive index of emotional processing and sympathetic activity. This coupling between cognitive states, arousal, emotion, and attention allows EDA to be used as an objective index of emotional states and can also be used to examine implicit emotional responses that may occur without conscious awareness or are beyond cognitive intent. Furthermore, electrodermal activity is also a useful indicator of attention processing per se, in which salient stimuli and resource-demanding tasks evoke an increase in EDA responses (Boucsein, 2012).

EDA reflects changes in conductance at the skin surface on behalf of sweat gland activation and consists of two components: a highly subject-dependent tonic skin conductance level (SCL) and phasic response from a series of transient peaks known as skin conductance responses (SCR) found in reaction to surprise events, cognitive activity, emotional arousal, and even spontaneously (Boucsein, 2012).

Individuals and experimental situations vary greatly; there are in the literature very general estimates of "typical" force values. In terms of phasic SCRs, amplitudes can typically vary around 0.10–0.60 microsiemens (μS) on average when scores are normalized and average between 2 and 16 μS for SCL (Venables & Christie, 1980).

HRV – Heart Rate Variability

Heart rate variability (HRV) BFB is also an approach to help athletes with regular stress, and it can help the athlete cope with the stress of competition and improve neuromuscular function (Lagos et al., 2008).

The heart is innervated by both the parasympathetic and sympathetic systems. These act in an antagonistic way to normalize the time interval between consecutive heartbeats; that is, greater sympathetic activity leads to an increase in heart rate, while the addition of parasympathetic activity slows down the frequency itself.

Therefore, HRV can be used as a measure of stress and can be viewed as a phenomenon under partial voluntary control. This statement is due to the fact that fluctuations in the beat-to-beat period are driven by the respiratory cycle, as the heart rate increases during inspiration and decreases during exhalation. A study by Vaschillo et al. (2006) found that these fluctuations reach a maximum in respiratory rate of about 6 breaths per minute. Thus, considering that respiration can affect HRV, this is considered to be a phenomenon under partial voluntary control.

The hope of this research lies in finding a tangible and objective result of the effectiveness of the BFB PowerMens method in psychological work with footballers, in being able to highlight how psychophysiological and mental variables, so far very abstract in the football scene, can be observed and studied in a concrete and objective way.

Furthermore, consequently, the professional Sports Psychologist within professional clubs could have crucial importance not only in the management of the psychological and mental area but also in the maintenance and increase of the economic value of the players, the heritage of sports clubs.

Methods

Participants

Twenty (n = 20) male footballers from the professional youth sector of SS Arezzo srl, during the Italian U18 Primavera 3 football championship, were randomly selected and divided into an experimental and control group, each made up of 10 units. The two groups did not show a significant difference between them, $t(18) = 1.17$ and $p = 0.13$. The mean age of the group was 17.5 years (SD = 0.85), and the mean age of the control group was 17 years (SD = 1.05).

Before the experiment, the players provided their informed consent. To participate in the study, they had to be over the age of 16, have experience in national categories for at least one year, and be uninjured.

Compliance with Ethical Guidelines

All ethical principles have been considered in this article. Participants were briefed on the purpose of the research, confidentiality of their information was assured, and they were informed that, if desired, the results of the research would be available to them.

Materials

In this study, MindPlace ThoughtStream technology (MindPlace, Eastsound, WA), Firstbeat heart rate monitors (Firstbeat Technologies Oy, Jyväskylä, Finland), Microgate Witty SEM (Microgate, Mahopac, NY), and a Toshiba A40 laptop were used to collect data on skin conductance (GSR) and heart rate (HR).

MindPlace ThoughtStream technology is a modern GSR BFB system for the measurement and feedback of the electrical resistance of the skin. ThoughtStream interface software, or the corresponding graphical analysis software, is a program that allows more accurate real-time recordings of GSR data and is particularly suitable for evaluating them. The Mental Games multimedia software analyzes the tiny changes in your skin resistance values (GSR) sent by the ThoughtStream biofeedback system to the personal computer. The training modules of the Mental Games "feel" based on the variation of the activity of the sweat glands, the responses of the skin on the palmar surface of the nondominant hand, and how concentrated and relaxed a person is and then will change its response according to mental state.

Firstbeat heart rate monitors assess your heart rate using a strap positioned around the chest, a standard heart rate monitor belt that is comfortable and with excellent elastic properties.

Microgate Witty SEM is a technology composed of “intelligent traffic lights” composed of a matrix of multicolored 7x5 LEDs capable of managing different symbols and colors. Thanks to the proximity sensor it contains, Witty SEM is the ideal solution for planning and managing specific tasks on reactivity, agility, and attentional and cognitive-motor skills in the best possible way.

Procedure

The experimental design in this study consists of a pretest and posttest, within which the experimental group was trained with the BFB PowerMens method, while the control group was trained with the mental preparation techniques related to sport. Both groups received the necessary information about the task and were informed about the intent of the research.

The hypothesis of this pilot research is to find in the experimental group a better restoration of homeostasis in the organism and a lower activation during a task that causes attentional stress; this would lead to an improvement in internal self-regulation and also to an improvement in attention if the results of the posttest were better than the pretest.

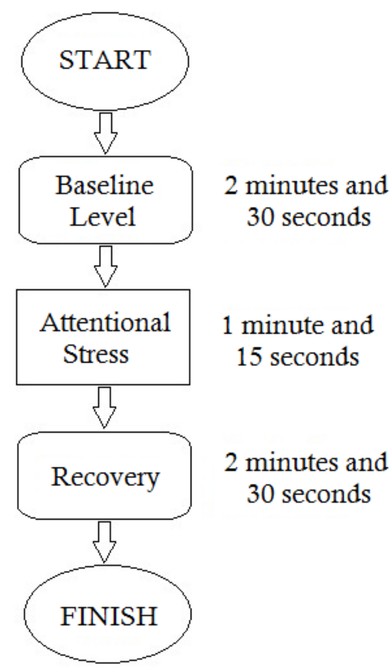
The pretest and the posttest were performed in the same way, and both were characterized by a succession of well-coded procedures that gave a psychophysiological profile of the player: (1) baseline level, (2) attentional stress, and (3) recovery. Total duration, 6 min and 15 s (Figure 1).

For an even more accurate investigation, the attentional stress phase was divided into two parts, Onset of Stress and End of Stress, in which the data were acquired.

Once seated, the football player had the experimenter place electrodes on the fingers of the nondominant hand, then relaxed for 2 min and 30 s. Baseline condition was observed and recorded via the BFB parameters discussed above, such as GSR and HR. Once the 2.5 min of relaxation were over, the athlete experienced a load of attention stress for 1 min and 15 s, where he performed the task presented by the four Witty SEMs with the dominant hand; that is, to move the hand in front of the photocell in which the target stimulus appears while in the other three traffic lights. There are other random stimuli that act as distractors; if the athlete places his hand in front of the wrong photocell, the traffic lights do not change sequence, but time goes by. The attentional stress load ends after 60 sequences are carried out correctly, or without fails after 1 min and 15 s.

After the load, the athlete had 2 min and 30 s available for the recovery phase, characterized by relaxation in place, similar to phase 1.

Figure 1. *Pre- and Posttest Protocol. Baseline Level, Attentional Stress Task, Recovery.*



Intervention with the BFB PowerMens Method – Experimental Group. The experimental group of 10 athletes each performed a path of 12 sessions of BFB PowerMens, consisting of 15 min each session, twice a week. The instrumentation used was the MindPlace ThoughtStream technology and the associated Mental Games software. During the 12 individual sessions, the athletes were instructed on the BFB; they learned how to manage their breathing and how to consciously control their psychophysiological responses. Breathing was trained by decreasing respiratory cycles per minute (bpm) in a range between 5 and 7 (Jerath et al., 2006; Song & Lehrer, 2003; Zaccaro et al., 2018).

In these sessions, techniques such as relaxation, focusing, and breathing associated with Mental Games were introduced. Mental Games are similar to classic personal computer games; however, they run through Mental Games multimedia software which analyzes small changes in skin resistance values (GSR) sent by the MindPlace ThoughtStream biofeedback system to the notebook or PC. The psychophysiological and sensorimotor levels were used in the study. The psychophysiological trains the athlete to move specific objects, in this case a hot air balloon, on the screen as he learns to become relaxed and focused. The players in this way find out about managing their internal state in order to land the hot air balloon on a certain platform. If the psychophysiological parameters are "active," the hot air balloon will not descend and will remain suspended or swing upwards. It is important for the athlete to focus not only on relaxation and respiratory regulation but also on being present, here and now, leaving thoughts and images outside the present moment of exercise.

The sensorimotor level involves another game and the use of the mouse to perform a screen capture task. The athlete must click on each of the 10 ants that move randomly on the screen. If the psychophysiological parameters are active, the ants will move quickly, if the athlete learns to manage his inner state according to the previous psychophysiological level, then during the task the ants will move more slowly and it will be easier to catch them. The task is repeated twice, as once you have captured all the ants they will become ladybugs, and in turn, by clicking on each of them they will fly away. The goal of this game is to make all the ladybugs fly away.

Step 2 of this interface has the opposite effect; that is, the calmer and more relaxed the athlete is, the faster the ants will move. If the athlete learns to become active with his own internal physiology, the ants will move more slowly such that it will be easier to catch them to make them become ladybugs and then make them fly away.

At the completion of each session of the Mental Games, the players had to wait for the result relating to the detected skin conductance shown by the software. That way they could see their personal progress session after session.

This structured work allows the athlete to increase self-management and control in the face of stressful stimuli always present during sports, effectively coordinating the cognitive processes involved such as perception, attention, learning, thinking, and decision-making.

Intervention with the Mental Coaching Method – Control Group. The control group of 10 athletes followed a parallel path to the experimental group, with 12 sessions each, twice a week and for a duration of 15 min, in which each athlete followed a plan relating to the development of concentration and motivation through the use of specific mental coaching techniques, such as visualization, inner dialogue, definition and planning of goals, watching motivational videos, improving the ability to concentrate, creating beliefs, and winning mental habits.

Statistical Analysis

Microsoft Excel 2007 (Microsoft Inc., Redmond, WA) software (Verma, 2019) analyzed the data to decide means and standard deviations (*SD*). A paired sample *t*-test was applied to examine the differences in each group before and after treatment. In addition, an independent samples *t*-test was applied in order to examine the differences between the two groups before and after treatment. Descriptive data are expressed as mean ± standard deviation (*SD*), and all statistical tests were performed at a significance level $p < .05$.

Results

The mean (in microsiemens μS) Baseline Level (pre and post) skin conductance responses (SCR) scores of the experimental group participants were 0.201 (*SD* = 0.076) and 0.219 (*SD* = 0.071), respectively, and the mean SCR scores (pre and post) of the participants in the control group were 0.196 (*SD* = 0.082) and 0.222 (*SD* = 0.046), respectively. The mean Onset of Stress scores (pre and post) of the participants in the experimental group were 0.324 (*SD* = 0.085) and 0.253 (*SD* = 0.073), respectively, and the mean (pre and post) scores of the participants in the control group were 0.309 (*SD* = 0.081) and 0.296 (*SD* = 0.077), respectively. The mean End of Stress scores (pre and post) of the experimental group were 0.375 (*SD* = 0.083) and 0.285 (*SD* = 0.074), respectively, and the mean scores (pre and post) of the control group were 0.336 (*SD* = 0.039) and 0.347 (*SD* = 0.030), respectively. Finally, the mean recovery phase scores (pre and post) of the experimental group were 0.340 (*SD* = 0.045) and 0.221 (*SD* = 0.06), respectively, and the mean (pre and post) scores of the control group were 0.319 (*SD* = 0.054) and 0.287 (*SD* = 0.055), respectively (Table 1).

An independent sample *t*-test was applied to examine differences in pre- and posttest scores between the two groups. The *t*-test results showed that the mean of both pretest and posttest Baseline Level and Onset of Stress scores did not differ between the two groups (Table 1). Furthermore, the mean End of Stress and Recovery scores in the pretest did not differ well between the two groups, while the mean End of Stress and Recovery scores in the posttest differed well between the two groups.

The Recovery phase in the experimental group showed the best results suggesting that the PowerMens sessions were more effective than the control group training (Table 1).

Table 1
The Phases of the Pretest and Posttest of the Experimental Group and Control Group (N = 20)

SCR Variables (in microsiemens μS)		**Experimental Group (n = 10)** *M*	*SD*	**Control Group (n = 10)** *M*	*SD*	***t***	***p*-value**
Baseline Level							
	Pretest	0.201	0.076	0.196	0.082	0.14	.446
	Posttest	0.219	0.071	0.222	0.046	−0.09	.462
Onset of Stress							
	Pretest	0.324	0.085	0.309	0.081	0.40	.345
	Posttest	0.253	0.073	0.296	0.077	−1.28	.107
End of Stress							
	Pretest	0.375	0.083	0.336	0.039	1.35	.097
	Posttest	0.285	0.074	0.347	0.030	−2.47**	.012
Recovery							
	Pretest	0.340	0.045	0.319	0.054	0.95	.178
	Posttest	0.221	0.060	0.287	0.055	−2.57*	.010

Note. In the posttest, the phases of End of Stress and Recovery related to the responses of skin conductance (SCR) differ statistically in the scores (** $p < .05$; * $p < .1$).

The Baseline Level (pre and post) mean heart rate variability (HRV) scores (in bpm) of the experimental group participants were 77.0 (*SD* = 7.19) and 75.4 (*SD* = 9.82), respectively, and the mean HRV scores (pre and post) of the participants in the control group were 78.1 (*SD* = 8.27) and 75.1 (*SD* = 12.68), respectively. The mean Onset of Stress scores (pre and post) of the participants in the experimental group were 88.1 (*SD* = 10.42) and 80.6 (*SD* = 9.52), respectively, and the mean (pre and post) scores of the participants in the control group were 83.1 = 4.68) and 80.5 (*SD* = 2.27), respectively. The mean End of Stress scores (pre and post) of the experimental group were 93.1 (*SD* = 7.17) and 85.0 (SD = 8.71), respectively, and the mean scores (pre and post) of the control group were 91.5 (*SD* = 5.19) and 88.5 (*SD* = 7.01), respectively. Finally, the mean Recovery phase scores (pre and post) of the experimental group were 84.4 (*SD* = 14.26) and 72.0 (*SD* = 11.43), respectively, and the mean (pre and post) scores of the control group were 82.3 (*SD* = 7.13) and 80.3 (*SD* = 4.35), respectively (Table 2).

An independent sample *t*-test was applied to examine the differences in pre- and posttest scores between the two groups. The results showed that the mean of both pretest and posttest Baseline Level, Onset of Stress, and End of Stress scores did not differ between the two groups (Table 2). Furthermore, the mean Recovery scores in the pretest did not differ between the two groups, while the mean Recovery scores in the posttest differed between the two groups (Table 2).

In addition, the paired sample *t*-test was used to understand the differences between pretest and posttest indices of Baseline Level, Onset of Stress, End of Stress, and Recovery within the same group of players. The average SCR scores of the players of the experimental group in the Baseline Level and Onset of Stress phase did not differ significantly, while the pretest and posttest of End of Stress and Recovery showed a marked statistical difference, noting that the sessions of the PowerMens method provided athletes with better and more effective management of subjective resources to cope with a task of high attentional stress (Table 3).

The control group in the SCR detections showed some visible improvements in the mean values in the Recovery phase, suggesting that the mental training pursued may have made a contribution, but these data did not emerge as statistically significant (Table 3).

Table 2
Pretest and Posttest Phases of the Experimental Group and Control Group (N = 20)

HRV Variables (in bpm)		**Experimental Group (*n* = 10)** *M*	*SD*	**Control Group (*n* = 10)** *M*	*SD*	***t***	***p*-value**
Baseline Level							
	Pretest	77.0	7.19	78.1	8.27	−0.31	0.377
	Posttest	75.4	9.82	75.1	12.68	0.05	0.477
Onset of Stress							
	Pretest	88.1	10.42	83.1	4.68	1.38	0.09
	Posttest	80.6	9.52	80.5	2.27	0.03	0.487
End of Stress							
	Pretest	93.1	7.17	91.5	5.19	0.57	0.287
	Posttest	85.0	8.71	88.5	7.01	−0.99	0.168
Recovery							
	Pretest	84.4	14.26	82.3	7.13	0.42	0.341
	Posttest	72.0	11.43	80.3	4.35	−2.15	0.046

Note. In the posttest, the Recovery phase relating to heart rate variability (HRV) differs statistically in the scores detected.

Table 3
Mean and Standard Deviation (SD) of the Skin Conductance Responses (SCR) of Each Group in the Pretest and Posttest

SCR Variables		**Experimental Group (*n* = 10)**				**Control Group (*n* = 10)**			
(in microsiemens μS)		*M*	*SD*	*t*	*p*-value	*M*	*SD*	*t*	*p*-value
Baseline Level									
	Pretest	0.201	0.076	−0.49	.314	0.196	0.082	−0.81	.220
	Posttest	0.219	0.071			0.222	0.046		
Onset of Stress									
	Pretest	0.324	0.085	1.80	.052	0.309	0.081	0.39	.353
	Posttest	0.253	0.073			0.296	0.077		
End of Stress									
	Pretest	0.375	0.083	2.25**	.025	0.336	0.039	−0.77	.231
	Posttest	0.285	0.074			0.347	0.030		
Recovery									
	Pretest	0.340	0.045	4.54*	.001	0.319	0.054	1.42	.095
	Posttest	0.221	0.060			0.287	0.055		

Note. As shown in the table, there is a statistically significant difference between the participants' mean scores before and after the test in the experimental group in terms of the variation in SCR in the End of Stress and Recovery phases (** $p < .05$; * $p < .1$), but no difference was observed in the control group.

The paired sample *t*-test was also used for the analysis of HRV values in order to understand the differences between the four indices detected in the pretest and posttest.

In the control group, there were no significant differences, as well as in the experimental group the mean total scores in the Baseline Level and Onset of Stress phase did not differ significantly, while the pretest and posttest of End of Stress and Recovery showed a marked difference (Table 4).

Table 4

Mean and Standard Deviation (SD) of the Heart Rate Variability (HRV) of Each Group in the Pretest and Posttest

HRV Variables (in bpm)	Experimental Group (*n* = 10)				Control Group (*n* = 10)			
	M	*SD*	*t*	*p*-value	*M*	*SD*	*t*	*p*-value
Baseline Level								
Pretest	77.0	7.19	1.14	0.142	78.1	8.27	0.88	0.199
Posttest	75.4	9.82			75.1	12.68		
Onset of Stress								
Pretest	88.1	10.42	1.63	0.068	83.1	4.68	1.68	0.063
Posttest	80.6	9.52			80.5	2.27		
End of Stress								
Pretest	93.1	7.17	2.73	0.023	91.5	5.19	1.38	0.099
Posttest	85.0	8.71			88.5	7.01		
Recovery								
Pretest	84.4	14.26	2.92	0.017	82.3	7.13	0.64	0.266
Posttest	72.0	11.43			80.3	4.35		

Note. As shown in the table, there is a statistically significant difference between the participants' mean scores before and after the test in the experimental group in terms of HRV variation in the End of Stress and Recovery phase, but no difference was observed in the control group.

In addition to this, the paired sample *t*-test was also used to examine the average scores of the times used by the players in performing the high attention stress task with Microgate Witty SEM traffic lights. The analysis shows how the experimental group decreased the execution times to perform the task and that this difference is statistically significant, while, despite the difference also obtained from the control group, this did not emerge significant in the statistical analysis (Table 5).

Table 5

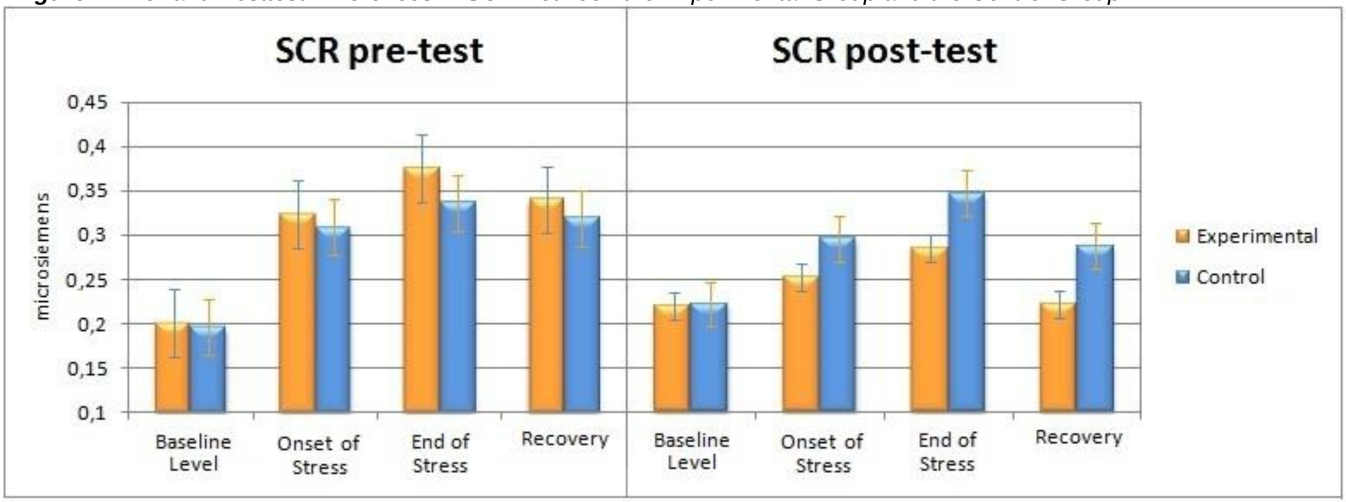
Mean and Standard Deviation (SD) of the Time Taken (in Minutes, Seconds, and Hundredths) in Carrying out the High Attention Stress Task of Each Group in the Pretest and Posttest

Attentional Stress Task Time	Experimental Group (*n* = 10)				Control Group (*n* = 10)			
	M	*SD*	*t*	*p*-value	*M*	*SD*	*t*	*p*-value
Pretest	01.05.45	00.10.37	1.94	0.042	01.05.57	00.03.27	1.31	0.111
Posttest	01.01.35	00.05.18			01.03.39	00.02.22		

Note. There is a statistically significant difference between the average scores of the participants before and after the test in the experimental group in terms of less time performed, while in the control group, although an improvement in the average time was found, no statistical difference was found significant.

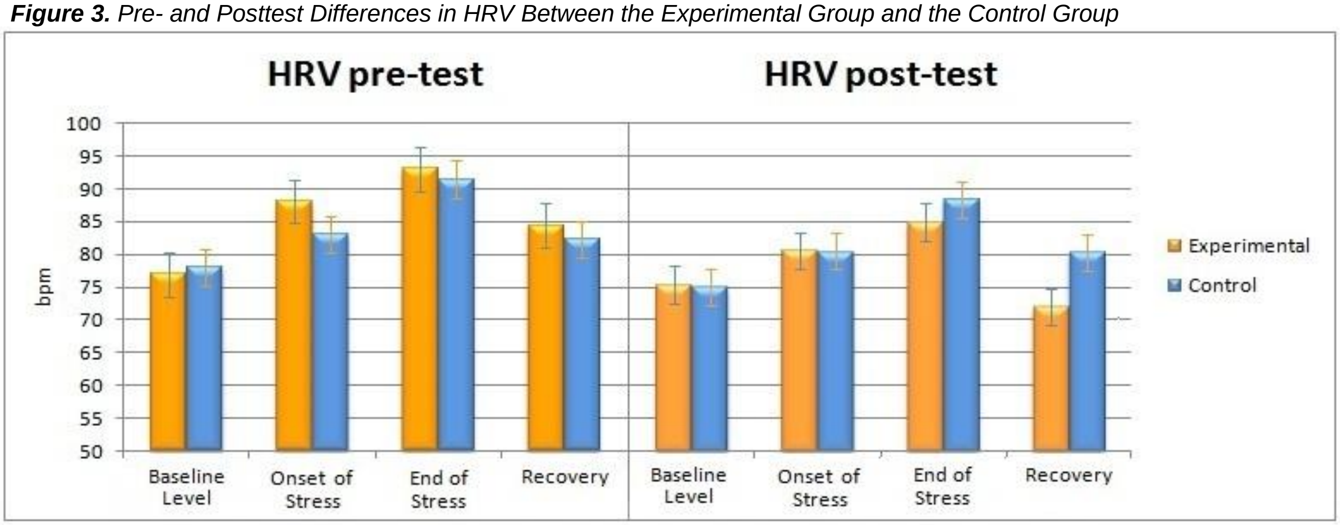
An independent sample *t*-test was then applied to examine the differences between the two groups in the pretest and posttest in the SCRs. The scores in the pretest did not differ statistically, indicating that the two groups were similar before taking the training path. In the posttest; however, the scores differed statistically (Figure 2).

Figure 2. *Pre- and Posttest Differences in SCR Between the Experimental Group and the Control Group.*



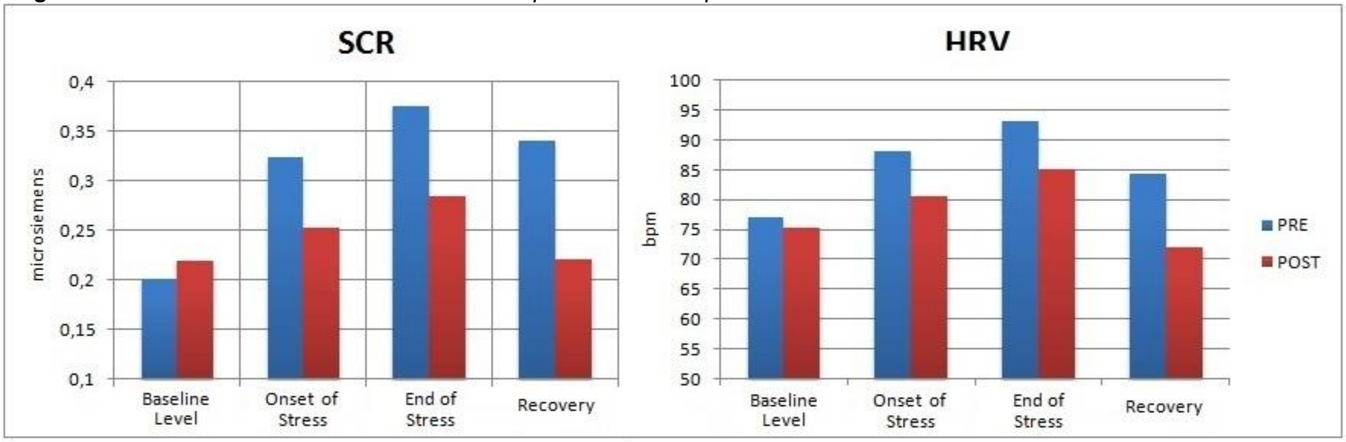
Similarly, the *t* independent sample *t*-test was applied to examine the differences between the two groups in the pretest and posttest in HRV. As in the SCRs the scores in the pretest did not differ statistically, while in the post-test the scores differed statistically (Figure 3).

Figure 3. *Pre- and Posttest Differences in HRV Between the Experimental Group and the Control Group*



Finally, the paired sample *t*-test within the same group of players was applied in the pretest and posttest, both in the SCR and in the HRV. In both psychophysiological parameters, a statistical difference was found in the level of Fine Stress and Recovery, to highlight how the BFB PowerMens method has provided the players with an added value in internal self-regulation (Figure 4).

Figure 4. *Differences in the Pre- and Posttest Experimental Group in SCR and HRV.*



Discussion

The purpose of this research was to study and investigate, in footballers, the measurement of attention and its related training, focusing on the effect of BFB PowerMens training sessions on cognitive and emotional self-regulation in the players of the experimental group, in particular in the ability and efficiency in regulating the response to attentional stress and improving performance in selective visual attention exercises.

The focus of BFB intervention was to present physiological information in a way that not only improves the players' awareness of visceral states, such as high arousal during the high attention stress task but also guides them towards the desired state such as low arousal or relaxation.

The BFB PowerMens training in footballers acted both at the baseline level where physiological information was presented directly to the athlete via the notebook, and via Mental Games where physiological information is incorporated into the game and the game itself adapts to the physiology of the player. In this way, the athlete can directly experience a way to lower the arousal or to raise it in a conscious way.
The results were promising; in fact, they indicate that the BFB PowerMens training sessions significantly reduced stress levels, especially activation or arousal during a task that causes attentional stress, and made the Recovery phase more effective, essential to restore homeostasis in the organism and favor the interaction between the central nervous system and the vegetative system. Not only that, but the significant difference in the shorter time taken in the posttest attentional stress task suggests that the players increased attention during the task itself, maintaining a more regular autonomous state organically during the task itself, indicating a greater psychophysiological balance of athletes during the stressful task.

Despite these auspicious results, a limit for this study may be the limited number of participants: it would be interesting to extend this research to a larger sample. Furthermore, even the number of training sessions, 12, if they were higher and continuous, for example evaluated from the beginning to the end of the sports season, could potentially affirm these results more markedly. Another limit relates to an unassessed psychophysiological parameter, the respiratory rate (RR), for instrumental reasons relating to the equipment. It could be interesting in the future to increase this research also with this parameter.

In general, based on the encouraging results, it seems that the BFB PowerMens method allowed the players of the experimental group to increase a better inner regulation than the control group.

Conclusions

The better performance of the experimental group compared to the control group seems to show the impact that the PowerMens sessions had in dealing with, managing, and overcoming the attention stress situations that the footballers were experiencing at the time of the assignment. The possibility of working in an integrated way with the psychophysiological and sensorimotor level and breath management seems to have provided the players with the necessary resources to face the breakdown of internal homeostasis due to a stressful event such as the pretest and posttest causes attentional stress and favoring the interconnection

between the central and autonomic nervous systems.
The average SCR and HRV scores in the Fine Stress and Recovery phase of the experimental group differ statistically, and these results could provide an important reference for the field of applied Sport Psychology and could open interesting insights also in the clinical setting on the mental health prevention of people as a response to stress.

Author Declarations

Acknowledgements, Grants and Funding. The author thanks the AIAC, the SS Arezzo club, and its staff for having granted availability to research during the sporting season with difficulties due to the COVID-19 pandemic, and the athletes for their maximum participation in the study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest. The author declares no conflicts of interest.

Author's Contribution. Paolo Tirinnanzi participated in designing the study, the literature review, the acquisition and evaluation, performing the sessions, interpreting and analyzing the data, and writing the manuscript. The author contributed to and has approved the final manuscript.

References

Bar-Haim, Y., Lamy, D., & Glickman, S. (2005). Attentional bias in anxiety: A behavioral and ERP study. *Brain and Cognition*, *59*(1), 11–22. https://doi.org/10.1016/j.bandc.2005.03.005

Bhargava, D., & Trivedi, H. (2018). A study of causes of stress and stress management among youth. *IRA–International Journal of Management & Social Sciences, 11*(3), 108–117. https://doi.org/10.21013/jmss.v11.n3.p1

Biagioli, T. (2013). Il cervello dell'atleta. Studi neuroanatomici strutturali, funzionali e tecnica del Biofeedback. *Rivista di Psicoanalisi Neofreudiana.* Retrieved Anno XXV, n.1.

Blumenstein, B., Bar-Eli, M., & Tenenbaum, G. (1997). A five-step approach to mental training incorporating biofeedback. *The Sport Psychologist*, 11, 440–453.

Blumenstein, B., Lidor, R., & Tenenbaum, G. (2007). Periodization and planning of psychological preparation in individual and team sports. *Psychology of sport training* (pp. 137–161). London, UK: Meyer & Meyer Sports.

Blumenstein, B., & Orbach, I. (2014). *Biofeedback for sport and performance enhancement*. Oxford Handbooks Online. New York, NY: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199935291.013.001

Bompa, T. O. (1999). *Periodization: Theory and methodology of training* (4th ed.). Champaign, IL: Human Kinetics.

Bouchard, S., Bernier, F., Boivin, E., Morin, B., & Robillard, G. (2012). Using biofeedback while immersed in a stressful videogame increases the effectiveness of stress management skills in soldiers. *PloS ONE*, *7*(4), e36169. https://doi.org/10.1371/journal.pone.0036169

Boucsein, W. (2012). *Electrodermal activity*. New York, NY: Springer-Verlag.

Brandão, M. R. F., Polito, L. F., Hernandes, V., Correa, M., Mastrocola, A. P., Oliveira, D., Oliveira, A., Moura, L., Junior, M. V. B., & Angelo, D. (2021). Stressors in indoor and field Brazilian soccer: Are they perceived as a distress or eustress? *Frontiers in Psychology*, *12*, 623719. https://doi.org/10.3389/fpsyg.2021.623719

Casagrande, M., Favieri, F., Tambelli, R., & Forte, G. (2020). The enemy who sealed the world: effects quarantine due to the COVID-19 on sleep quality, anxiety, and psychological distress in the Italian population. *Sleep Medicine*, *75*, 12–20. https://doi.org/10.1016/j.sleep.2020.05.011

Cavarretta, E., D'Angeli, I., Giammarinaro, M., Gervasi, S., Fanchini, M., Causarano, A., Costa, V., Manara, M., Terribili, N., Sciarra, L., Calò, L., Fossati, C., Peruzzi, M., Versaci, F., Carnevale, R., Biondi-Zoccai, G., & Frati, G. (2021). Cardiovascular effects of COVID-19 lockdown in professional Football players. *Panminerva medica*, 10.23736/S0031-0808.21.04340-8. Advance online publication. https://doi.org/10.23736/S0031-0808.21.04340-8

Chmura, P., Andrzejewski, M., Konefał, M., Mroczek, D., Rokita, A., & Chmura, J. (2017). Analysis of Motor Activities of Professional Soccer Players during the 2014 World Cup in Brazil. *Journal of Human Kinetics*, *56*(1), 187–195. https://doi.org/10.1515/hukin-2017-0036

Cox, R. H. (2002). *Sport psychology: Concepts and applications* (5th ed.). New York, NY: McGraw Hill.

Dahl, K. D. (2013). *External Factors and Athletic Performance*. (347) [Senior Honors Theses, Liberty University]. Scholars Crossing.

Fontanella, L., Ippoliti, L., & Arcangelo, M. (2012). Multiresolution Karhunen Loéve analysis of galvanic skin response for psycho-physiological studies. *Metrika, 75*(3), 287–309. https://doi.org/10.1007/s00184-010-0327-3

Galmonte, A., Agostini, T., & Righi, G. (2011). Dalla psicologia sperimentale dello sport al biofeedback di secondo ordine. Riflessioni teoriche, metodologiche e sperimentali. In F. Lucidi, *SportivaMente*. *Temi di Psicologia dello Sport – I* (pp. 163–204). Rome, Italy: Edizioni Universitarie di Lettere Economia Diritto.

Hack, J., Rupp, A., & Memmert, D. (2009). Attentional mechanisms in sports via brain-electrical event-related potentials. *Research Quarterly for Exercise and Sport*, *80*(4), 727–738. https://doi.org/10.1080/02701367.2009.10599614

Harvey, P. O., Le Bastard, G., Pochon, J. B., Levy, R., Allilaire, J. F., Dubois, B., & Fossati, P. (2004). Executive functions and updating of the contents of working memory in unipolar depression. *Journal of Psychiatric Research*, *38*(6), 567–576. https://doi.org/10.1016/j.jpsychires.2004.03.003

Huang, Y., & Zhao, N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 epidemic in China: A web-based cross-sectional survey. *Psychiatry Research, 288*, 112954. https://doi.org/10.1016/j.psychres.2020.112954

Issurin, V. (2007). A modern approach to high performance training: The block composition concept. In B. Blumenstein, R. Lidor, & G. Tenenbaum (Eds.), *Psychology of sport training* (pp. 216–234). Oxford, UK: Meyer & Meyer Sport.

Jerath, R., Edry, J. W., Barnes, V. A., & Jerath, V. (2006). Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. *Medical Hypotheses*, *67*(3), 566–571. https://doi.org/10.1016/j.mehy.2006.02.042

Jones, G. (2002). What is this thing called mental toughness? An investigation of elite sport performers. *Journal of Applied Sport Psychology*, *14*(3), 205–218. https://doi.org/10.1080/10413200290103509

Kandel, E. R., Schwartz, J. H., & Jessel, T. M. (1999). Fondamenti delle neuroscienze e del comportamento. *CEA Casa Editrice Ambrosiana,* 321–340.

Keogh, E., Ellery, D., Hunt, C., & Hannent, I. (2001). Selective attentional bias for pain-related stimuli amongst pain fearful individuals. *Pain, 91*(1–2), 91–100. https://doi.org/10.1016/s0304-3959(00)00422-x

Lagos, L., Vaschillo, E., Vaschillo, B., Lehrer, P., Bates, M., & Pandina, R. (2008). Heart rate variability biofeedback as a strategy for dealing with competitive anxiety: A case study. *Biofeedback*, *36*(3), 109–115.

Matsutake, T., Natsuhara, T., Koido, M., Suzuki, K., Tabei, Y., Nakayama, M., & Asai, T. (2018). Brain information processing of high performance football players during decision making: A study of event-related potentials and electromyography reaction time. *Japanese Journal of Physical Fitness and Sports Medicine*, *67*(1), 107–123. https://doi.org/10.7600/jspfsm.67.107

Memmert, D., Noël, B., Machlitt, D., van der Kamp, J., & Weigelt, M. (2020). The role of different directions of attention on the extent of implicit perception in soccer penalty kicking. *Human Movement Science*, *70*, 102586. https://doi.org/10.1016/j.humov.2020.102586

Michailidis, Y. (2014). Stress hormonal analysis in elite soccer players during a season. *Journal of Sport and Health Science, 3*(4), 279–283. https://doi.org/10.1016/j.jshs.2014.03.016

Nippert, A. H., & Smith, A. M. (2008). Psychologic stress related to injury and impact on sport performance. *Physical Medicine and Rehabilitation Clinics of North America*, *19*(2), 399–418. https://doi.org/10.1016/j.pmr.2007.12.003

O'Toole, L. J. (2014). *Changing attention to emotion: A biobehavioral study of attention bias modification using event-related potentials*. [Doctoral dissertation, The City University of New York]. CUNY Academic Works.

Pallavicini, F., Algeri, D., Repetto, C., Gorini, A., & Riva, G. (2009). Biofeedback, virtual reality and mobile phones in the treatment of generalized anxiety disorder (GAD): A phase-2 controlled clinical trial. *Journal of Cybertherapy and Rehabilitation*, *2*(4), 315–327.

Plebanek, D. J., & Sloutsky, V. M. (2017). Costs of Selective Attention: When Children Notice What Adults Miss. *Psychological Science*, *28*(6), 723–732. https://doi.org/10.1177/0956797617693005

Rampinini, E., Donghi, F., Martin, M., Bosio, A., Riggio, M., & Maffiuletti, N. A. (2021). Impact of COVID-19 Lockdown on Serie A Soccer Players' Physical Qualities. *International Journal of Sports Medicine*, *42*(10), 917–923. https://doi.org/10.1055/a-1345-9262

Reinecke, L. (2009). Games and recovery: The use of video and computer games to recuperate from stress and strain. *Journal of Media Psychology: Theories, Methods, and Applications, 21*(3), 126–142. https://doi.org/10.1027/1864-1105.21.3.126

Rijken, N. H., Soer, R., de Maar, E., Prins, H., Teeuw, W. B., Peuscher, J., & Oosterveld, F. G. J. (2016). Increasing Performance of Professional Soccer Players and Elite Track and Field Athletes with Peak Performance Training and Biofeedback: A Pilot Study. *Applied Psychophysiology and Biofeedback*, *41*(4), 421–430. https://doi.org/10.1007/s10484-016-9344-y

Rogulj, N., Nazor, M., Srhoj, V. & Božin, D. (2006). Differences between competitively efficient and less efficient junior handball players according to their personality traits. *Kinesiology, 38*(2), 158–163.

Russoniello, C. V., O'Brien, K., & Parks, J. M. (2009). The effectiveness of casual video games in improving mood and decreasing stress. *Journal of Cybertherapy and Rehabilitation*, *2*(1), 53–66.

Saha, So., Saha, Sr., Mazlan, M. A. B. M., & Arriffin, M. I. B. M. (2013). Effect of emotional regulation on performance of soccer skills. *Procedia – Social and Behavioral Sciences, 91,* 594–605. https://doi.org/10.1016/j.sbspro.2013.08.459

Santos, P. B., Kuczynski, K. M., Machado, T. A., Osiecki, A. C. V., & Stefanello, J. M. F. (2014). Psychophysiological stress in under-17 soccer players. *Journal of Exercise Physiology online, 17*(2), 67–80.

Schubert, T., Finke, K., Redel, P., Kluckow, S., Müller, H., & Strobach, T. (2015). Video game experience and its influence on visual attention parameters: An investigation using the framework of the Theory of Visual Attention (TVA). *Acta Psychologica*, *157*, 200–214. https://doi.org/10.1016/j.actpsy.2015.03.005

Shimi, A., Tsestou, V., Hadjiaros, M., Neokleous, K., Avraamides, M. (2021). Attentional Skills in Soccer: Evaluating the Involvement of Attention in Executing a Goalkeeping Task in Virtual Reality. *Applied Sciences, 11*(19), 9341. https://doi.org/10.3390/app11199341

Song, H.-S., & Lehrer, P. M. (2003). The effects of specific respiratory rates on heart rate and heart rate variability. *Applied Psychophysiology and Biofeedback*, *28*(1), 13–23. https://doi.org/10.1023/a:1022312815649

Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of soccer: An update. *Sports Medicine*, *35*(6), 501–536. https://doi.org/10.2165/00007256-200535060-00004

Tarrant, J., Viczko, J., & Cope, H. (2018). Virtual Reality for Anxiety Reduction Demonstrated by Quantitative EEG: A Pilot Study. *Frontiers in Psychology*, *9*, 1280. https://doi.org/10.3389/fpsyg.2018.01280

Thompson, M., & Thompson, L. (2007). Neurofeedback for stress management. In P. M. Lehrer, R. L. Woolfolk, & W. E. Sime (Eds.), *Principles and practice of stress management* (pp. 249–287). The Guilford Press.

Tirinnanzi, P., (2007). *Effects of anxiety on visual attention: A behavioral and electrophysiological investigation*. [Thesis on Experimental Psychology, University of Florence].

Tirinnanzi, P., & Bianchi, A. (2020). The Application of Integrative Psychotherapy During Covid-19 Pandemic. *Journal of Psychology and Psychotherapy Research*, 7, 85–97. https://doi.org/10.12974/2313-1047.2020.07.8

Tirinnanzi, P., & Bianchi, A. (2021). The Effects of Integrated Psychotherapy in Patients who have experienced Trauma: A Pre–Post Design During the COVID-19 Health Emergency. *Journal of Clinical & Developmental Psychology, 3*(1), 10–26. https://doi.org/10.6092/2612-4033/0110-2606

Vaschillo, E. G., Vaschillo, B., & Lehrer, P. M. (2006). Characteristics of resonance in heart rate variability stimulated by biofeedback. *Applied Psychophysiology and Biofeedback*, *31*(2), 129–142. https://doi.org/10.1007/s10484-006-9009-3

Venables, P. H., & Christie, M. J. (1980). Electrodermal activity. In I. Martin & P. H. Venables (Eds.), *Techniques in psychophysiology* (pp. 3–67). Chichester, UK: Wiley.

Verburgh, L., Scherder, E. J. A., van Lange, P. A. M., & Oosterlaan, J. (2014). Executive functioning in highly talented soccer players. *PloS ONE*, *9*(3), e91254. https://doi.org/10.1371/journal.pone.0091254

Verma, J. P. (2019). Application of Factor Analysis in Psychological Data. In *Statistics and Research Methods in Psychology with Excel* (pp. 567–588). Springer. https://doi.org/10.1007/978-981-13-3429-0

Wilson, V. E., Peper, E., & Moss, D. (2006). "The Mind Room" in Italian soccer training: The use of biofeedback and neurofeedback for optimum performance. *Biofeedback*, *34*(3), 79–81.

Yaribeygi, H., Panahi, Y., Sahraei, H., Johnston, T. P., & Sahebkar, A. (2017). The impact of stress on body function: A review. *EXCLI Journal, 16*, 1057–1072. https://doi.org/10.17179/excli2017-480

Zaccaro, A., Piarulli, A., Laurino, M., Garbella, E., Menicucci, D., Neri, B., & Gemignani, A. (2018). How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing. *Frontiers in Human Neuroscience*, *12*, 353. https://doi.org/10.3389/fnhum.2018.00353

Zaichkowsky, L. D., & Fuchs, C. Z. (1988). Biofeedback applications in exercise and athletic performance. *Exercise and Sport Science Review*, *16*, 381–421.

Received: November 24, 2021
Accepted: January 12, 2022
Published: March 28, 2022