Poleszak Julita, Szabat Przemysław, Szabat Marta, Boreński Grzegorz, Wójcik Magdalena, Milanowska Joanna. Biofeedback in psychiatric and psychological clinical practice. Journal of Education, Health and Sport. 2019;9(5):346-353. eISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.3228936
http://ojs.ukw.edu.pl/index.php/johs/article/view/6932

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 28.04.2019. Revised: 28.04.2019. Accepted: 26.05.2019.

Biofeedback in psychiatric and psychological clinical practice

Julita Poleszak[1*], Przemysław Szabat[1], Marta Szabat[1], Grzegorz Boreński[1], Magdalena Wójcik[1], Joanna Milanowska[2]

[1]*Student Science Club at the Department of Applied Psychology, Medical University of Lublin*
[2]*Department of Applied Psychology, Medical University of Lublin*

* E-mail adress: julita.poleszak@wp.pl
ORCID ID:
Julita Poleszak https://orcid.org/0000-0002-5166-6262
Przemysław Szabat https://orcid.org/0000-0001-5796-1900
Marta Szabat https://orcid.org/0000-0001-6309-2027
Grzegorz Boreński https://orcid.org/0000-0002-5359-7555
Magdalena Wójcik https://orcid.org/0000-0002-0999-6284
Joanna Milanowska https://orcid.org/0000-0001-9741-1583

ABSTRACT

Introduction: Biofeedback is about improving conscious control over emotional states and some physiological activities. It is a non-invasive, painless and completely safe technique of self-regulation of the body and mind through psychophysiology.

The aim of the study: The aim of this article was to present the effects of Biofeedback therapy in psychiatric and psychological clinical situations

Material and method: Standard criteria were used to review the literature data. A search of articles was carried out in the PubMed and Google Scholar database.

Description of the state of knowledge: Biofeedback is a promising form of behavioral therapy. It can support the work of the mind in healthy people and intensify the treatment of

many psychological and psychiatric conditions. The analysis of the research shows that the effectiveness of BFB therapy is high in conditions such as: anxiety disorders, increased stress levels, ADHD, depressive disorders, and insomnia.
Summary: The versatile effectiveness of BFB should therefore lead clinicians to encourage this form of therapy during therapeutic treatment of their patients.

Keywords: Biofeedback, Neurobiofeedback, psychological disorders, psychiatric disorders

1. INTRODUCTION

Biofeedback (BFB) is a non-invasive, painless and completely safe technique of self-regulation of the body and mind through psychophysiology [1]. The aim of biofeedback is to improve the conscious control over emotional states and some physiological activities [2]. BFB therapy involves providing feedback to people about changes in their physiological state. The patient observes physiological processes of the body on the computer monitor, such as brain activity, heartbeat, breathing, blood pressure or muscle tension, which are presented in the form of a computer game [1]. By observing changes in the functioning of your body (feedback), patients try to modify their psychological and physiological reactions. In this way, patients become more aware of their own body and are able to learn to control certain physiological processes and reactions, which allows to alleviate the negative symptoms of various ailments and cause the body to function more effectively.

The BFB technique is used in various areas of life. It is used as a training method for healthy people in order to improve cognitive functions, which may be useful for learners, pilots or athletes [3]. However, the largest and most promising application is in clinical practice. Studies published so far have shown that biofeedback is effective in various disease states, particularly in the field of psychiatry and psychology [2].

The aim of this article was to present the effects of Biofeedback therapy in psychiatric and psychological clinical situations. To this end, scientific studies published in 2009-2019 were reviewed. Articles were searched in the PUBMED database and Google Scholar database. We identified 105 articles; 23 of them are included in this review.

2. BIOFEEDBACK TYPES

One of the most groundbreaking experiments with biofeedback was conducted by M.B. Sterman et al. at the end of the 1960s. In studies with cats, they proved that they can learn to increase the amplitude of the 12-15 Hz wave in the region of sensorimotor cortex [4]. Subsequent experiments have shown that this also applies to people. Sterman wrote that patients with epilepsy, who train this sensorimotor rhythm, as defined by him with the SMR wave, have fewer seizures. During the last years, technical and substantive progress has resulted in the introduction of further forms of biofeedback, which have found more and more applications in clinical practice. Currently 9 types of biofeedback are used (Table 1).

Table 1. Characteristics of particular types of biofeedback

Type of biofeedback	Neurophysiologicalbasis	Examples of use
EEG-Biofeedback	brainelectromagneticwaves	ADHD; autism; epilepsy; stress [5]
SCP-Biofeedback	free cortical potentials (changes in the polarization of the cerebral cortex)	epilepsy [6]
EMG-Biofeedback	muscletension	pelvic floor pain; pain in the lumbar region, stress urinary incontinence; chronic constipation; retention of urine, ADHD [7]
HRV-Biofeedback	heart-rhythm	cardiovasculardiseases; stress, depression [7]
GSR-Biofeedback	skin tension (electrical resistance of the skin), depends on the nervous system stimulation	hypertension; bronchial asthma; excessive sweating; epilepsy [8]
HEG-Biofeedback	head temperature and cerebral flow	migraine; head injuries; dyslexia; dysgraphia; epilepsy [7]
RSP-Biofeedback	respiratory rate	cardiovascular diseases, respiratory diseases, epilepsy [7]
Temperature biofeedback	body temperature	lower limb ischemia, rheumatic disease, asthma [7]
RSA-Biofeedback	combines HRV and respiratory elements of BFB	ADHD, respiratory diseases, psychosomatic disorders, stress [7]

EEG-Biofeedback (Neurofeedback, NF) is the most-used form of BFB. It uses "brain plasticity", which relies on the ability of nerve cells in the brain to create permanent functional transformations [9]. During NF training, sensors are attached to the patient's head, which receive the brain waves of the subject, recorded on the monitor in the form of a computer game [10]. By changing the state of concentration, the patient changes the frequency of brain waves. When the brain waves reach the desired frequency - the patient acquires points in the game, while in the production of other wave frequencies - loses points. In this way, the subject learns to manage the brain in such a way as to produce the brain waves most desirable in a given situation. The basic protocols of NF training are: 1. SMR / theta training; 2. SMR / delta training; 3. beta1 / delta training and 4. beta1 / theta training. They consist in the stimulation of SMR or beta1 waves and the inhibition of theta and delta waves [11].

SCP-Biofeedback (Slow Cortical Potentials Biofeedback) in the initial phase resembles traditional EEG-Biofeedback training. In this type of training, slow and relatively small deviations in the EEG signal are observed at frequencies lower than 1-2Hz (delta waves) [12].

EMG-Biofeedback (Miofeedback) with the aid of an electromyograph and specialized software for analyzing and visualizing received signal, enables to display the activity of the

subject's muscles in the form of a graph, diodes or sounds [13]. In this way, the patient is more aware of the use of specific muscle groups (e.g, uterine fundus, sphincter muscles), which strengthens the muscles and increases control over their activity. Rehabilitation with the use of Miofeedback allows you to restore muscle performance, as well as to relieve muscle pain as a result of muscle relaxation [14].

HRV-Biofeedback (Heart Rate Variability Biofeedback) allows the assessment, reporting and training of changes in the heart rate [15]. Through training, the patients trie to match the rhythm of their breathing in a way that have a beneficial effect on the rhythm of their heart. Thanks to technology, people can learn to enter into a state of immediate relaxation. In this way, patients are able to control their mind and emotions more effectively.

GSR Biofeedback (Galvanic Skin Response Biofeedback), thanks to electrodes spreadon fingers, measures the electrical conductivity of the skin. It depends on the degree of skin hydration, which is controlled by the sympathetic system by changing the activity of sweat glands [8]. High results (low sweating) mean low sympathetic activity, and low - high activity of the nervous system, which is usually caused by an increased level of stress. If the subject learns to control breathing, heart action and skin resistance, one will be more controlled and less susceptible to stressful situations [16].

HEG Biofeedback (Hemoencehpalography Biofeedback) records blood flow in certain areas of the brain [17]. The blood supply in a given area of the cerebral cortex is an accurate reflection of brain activity [18]. The HEG-BFB method allows the patient to observe changes in blood flow in the prefrontal areas and learn to change it.

RSP Biofeedback (Respiratory Biofeedback) analyzes the frequency and length of breaths [19]. Physiological and mental state affects on the way of breathing mechanism [20]. Frequent, shallow breathing may lead to hyperventilation, which in turn may cause feelings of anxiety or dizziness. However, the quietening of breathing leads to relief of emotions, cognitive processes as well as relaxation of the body. Diaphragmatic breathing slows down the heart rate, lowers blood pressure and releases the frequency of brain waves. In addition, it stimulates the immune system, reduces sweating and increases the peripheral temperature of the body.

Temperature biofeedback monitors the temperature of the skin, which the patient is trying to increase during training [21]. Temperature biofeedback is used for relaxation training, but also in medicine for the treatment of limb ischemia, rheumatic disease, and asthma.

RSA Biofeedback (Respiratory Sinus Arrhythmia Biofeedback) combines elements of HRV-BFB and respiratory BFB [22].

3. BIOFEEDBACK IN PSYCHIATRY AND PSYCHOLOGY

Biofeedback techniques are widely used in a number of disease states, most commonly in the field of psychiatry and psychology. This is confirmed by numerous scientific papers, which show that considering this form of behavioral therapy in some states is justified.

The analysis of the available publications is the basis for stating that the effectiveness of using Biofeedback to reduce anxiety is high. Many researchers have shown this, including A. Aritzeta et al. who, conducting a study on 233 Spanish students, concluded that BFB therapy significantly reduces the level of anxiety and allows to achieve higher results in study [23]. Similar conclusions were presented by Z. GholamiTahsini et al., according to which BFB assisted by relaxation training causes a significant alleviation of the symptoms of anxiety and affective disorders in students with high scores in the Depression, Anxiety, and Stress Scale [24]. V. Goessl et al. in 2017 presented results of meta-analysis in which they analyzed the researches on the impact of HRV-BFB on symptoms of anxiety and stress of respondent people [25]. The authors identified 24 studies in which 484 participants took part. The

analysis showed that HRV-BFB is associated with a large reduction in reported stress and anxiety. Relieving stress through the BFB technique can be useful not only to students. It is useful in many other ailments related to anxiety. It allows reduction of pre-operative anxiety in patients and consequent reduction of pain associated with dental procedures [26]. HRV-BFB by reducing anxiety levels also allows to increase the performance of athletes [27]. The HRV-BFB tool, which consists of controlling low rate of breathing and active generation of positive emotions, affects autonomic nervous system and reduces heart rate and the level of perceived anxiety [28]. These changes contribute to better self-control and "flexibility" of central nervous system, which in the further consequence causes the ability to control stress. Despite of limited number of studies so far, these findings suggest that HRV-BFB is an effective, safe and easy-to-use method for athletes to improve athletic performance [29]. A similar position was presented by N. Pusenjak et al. who conducted a study to check whether the 8-week period of biofeedback training can improve control over fear of competition and improve sports performance of athletes [30]. Participants in this study were athletes from various sports disciplines. The experimental group consisted of 18 athletes (4 women, 14 men), while control group consisted of 21 athletes (4 women, 17 men). All subjects were between ages of 16 and 34. The researchers showed that subjects from the research group are better able to control respiration and heart rhythm than the control group, which resulted in better sports results. In addition, the acquired skills were able to use also a year after completing BFB training.

Biofeedback programs seem to produce more effective results in reducing the level of chronic stress than commonly known relaxation techniques. R. Fehring, comparing the effects of Benson's relaxation technique with biofeedback therapy, showed that biofeedback enables a significantly lower level of anxiety than Benson's technique [31].

The results of the presented research promise new solutions in alleviating the negative consequences of stress and promoting general mental health.

The latest international literature emphasizes the significant influence of neurofeedback in treatment of attention deficits and hyperactivity disorder (ADHD) [32]. In children with ADHD, increased theta brain activity is observed, especially in frontal region, which is responsible for hyperactivity, as well as reduced activity of alpha and beta waves [33]. Patient through consciously controlling emotional and psychological states (mainly increased attention), contributes to the change in brain wave function. The therapy aims to reduce the theta-to-beta wave ratio resulting in a reduction of inattention, hyperactivity and impulsiveness. Results of the studies published so far indicate a positive clinical response in approximately 75% of patients treated with NF [32]. It has been demonstrated that the short-term effects of treatment with NF are comparable to effects of drugs on the behavioral and neuropsychological level. From research by J.H. Hou et al. it follows that after two treatment cycles the mean ratio of theta to brain wave in 30 children with ADHD was significantly reduced from 12.32 ± 4.35 (before treatment) to 6.54 ± 1.27 ($p < 0.01$). [34]. On the other hand, one of the researchers, analyzing paper on the effectiveness of the NF method, pointed out that the majority of studies did not meet the double-blind test criterion, thus excluding the placebo effect [35]. In addition, the influence of drugs on the course of NF therapy is not known and attention has not been focused on side effects of therapy. Although there are not many well-documented studies on efficacy of neufeedbback in treatment of children with ADHD, EEGBFB therapy has been recognized as a form of behavioral therapy in the International Register of Medical Papers [36]. Therefore, this method should be considered in patients who do not respond to pharmacological agents [37].

Effective effects of use of NF training in depression therapy are confirmed by M.Hampson's research [38]. He argues that NF therapies that rely on the recall of positive autobiographical memories affect the amygdala causing an increase in its activity, which in

turn leads to alleviation of the symptoms of depression and improves well-being. Similar conclusions were presented by Yuan et al., who found that training NF improves nerve conduction between the temporal region and the amygdala, and this reduces the severity of disease symptoms [39].

The choice of appropriate protocol for NF training in mood disorders should depend on bioelectrical activity of brain registered in the EEG test. In the case of advantage of alpha waves in the left frontal region, Rosenfeld protocol training should be applied, which involves the stimulation of alpha waves of the right frontal region, in order to obtain symmetry of alpha waves [40]. However, in case of the need to modulate activity of the left hemisphere, the classic Theta / SMR protocol of Jay Gunkelman should be used.

In depressive disorder, cardiac rhythm is often reduced, and HVR-biofeedback can also be used in treatment of depression [41]. Caldwell et al. compared the results of a group of depressed patients receiving HVR-BFB and psychotherapy with a group of patients treated only with psychotherapy [42]. The authors showed that the group using a combination of psychotherapy and HVR achieved a greater increase in heart rate and a greater decrease in depressive symptoms compared to the control group. The results of the study confirm the effectiveness of HVR-BFB in intensifying the treatment of depression.

There are also publications on the use of BFB in the treatment of insomnia [43, 44]. BFB, through its ability to relax, can help improve total length of sleep (TST) even for chronic, severe forms of insomnia [45].

4.SUMMARY

To summarize this work, biofeedback should be considered as a promising form of behavioral therapy. It can support the work of the mind in healthy people and intensify the treatment of many psychological and psychiatric conditions. The analysis of the research shows that the effectiveness of BFB therapy is high in such disorders as: anxiety disorders, increased stress levels, ADHD, depressive disorders, and insomnia. BFB is also used in other areas of medicine such as neurology, urology, cardiology or pulmonology. The versatile effectiveness of BFB should therefore encourage clinicians to cosider this form of therapy during the therapeutic treatment of their patients.

References

1. Schwartz MS, Andrasik F. Bofeedback, Fourth Edition: A Practitioner's Guide. Medicine & Health Science Books. 2016. ISBN: 9781462522545
2. Šecić A, Cvjeticanin T, Kes VB. Biofeedback Training And Tension-Type Headache. *ActaClin Croat.* 2016; 55(1): 156-60.
3. Basmajian JV. Biofeedback: Principles and practice for clinicians. Oxford, England: Williams & Wilkins. 1979.
4. Sterman MB, Friar L. Suppression of seizures in an epileptic following sensorimotor EEG feedback training. *Electroencephalography&ClinicalNeurophysiology*. 1972; 33(1): 89-95.
5. http://www.eeg-biofeedback.com.pl
6. Nagai Y. Biofeedback treatment for epilepsy. *Nihon Rinsho*. 2014; 72(5): 887-93.
7. http://biofeedback-polska.com/index/pytania/biofeedback
8. Khanna A, Paul M, Sandhu JS. A study to compare the effectiveness of GSR biofeedback training and progressive muscle relaxation training in reducing blood pressure and respiratory rate among highly stressed individuals. *Indian J PhysiolPharmacol*. 2007; 51(3): 296-300.
9. Astor MH. An introduction to biofeedback. *Am J Orthopsychiatry*. 1977; 47(4): 615-625.

10. Heinrich H, Gevensleben H, Strehl U. Annotation: neurofeedback-train your brain to train behaviour. *J Child Psychol Psychiatry.* 2007; 48: 3-16.
11. Escolando C, Navarro-Gil M, Garcia-Campayo J, et al. The effects of individual upper alpha neurofeedback in ADHD: An open-label pilot study. *Appl. Psychophysiol. Biofeedback.* 2014; 39: 193–202
12. Leins U, Goth G, Hinterberger T, et al. Neurofeedback for children with ADHD: a comparison of SCP and Theta/Beta protocols. *ApplPsychophysiol Biofeedback.* 2007; 32(2): 73-88.
13. Angarita JIG, Vargas JAM, Salazar OA. Bio-feedback in muscle analysis and rehabilitation. DOI: http://dx.doi.org/10.22517/23447214.5687
14. Li P, Nie Y, Chen J, et al. Application progress of surface electromyography and surface electromygraphic biofeedback in low back pain. *ZhongguoXiu Fu Chong Jian Wai KeZaZhi.* 2017; 31(4): 504-507.
15. Prinsloo GE, Rauch HG, Derman WE. A brief review and clinical application of heart rate variability biofeedback in sports, exercise, and rehabilitation medicine. *PhysSportsmed*. 2014; 42(2): 88-99.
16. Nagai Y, Jones C, Sen A. Galvanic Skin Response (GSR)/Electrodermal/Skin Conductance Biofeedback on Epilepsy: A Systematic Review and Meta-Analysis. *Front Neurol.* 2019; 24(10): 377.
17. Gomes JS, Ducos DV, Gadelha A, et al. Hemoencephalography self-regulation training and its impact on cognition: A study with schizophrenia and healthy participants. *Schizophr Res*. 2018; 195: 591-593.
18. Dias AM, Van Deusen AM, Oda E, et al. Clinical efficacy of a new automated hemoencephalographic neurofeedback protocol. *Span J Psychol.* 2012; 15(3): 930-41.
19. Liu GZ, Huang BY, Wang L. A Wearable Respiratory Biofeedback System Based on Generalized Body Sensor Network. *Telemed J E Health.* 2011; 17(5): 348–357
20. Kajander R, Peper E. Teaching diaphragmatic breathing to children. *Biofeedback*. 1998; 26 (3), 14-17
21. Moser DK, Dracup K, Woo MA, et al. Voluntary control of vascular tone by using skin-temperaturebiofeedback-relaxation in patients with advanced heart failure. *AlternTherHealth Med.* 1997; 3(1):51-9.
22. Munafò M, Patron E, Palomba D. Improving Managers' Psychophysical Well-Being: Effectiveness of Respiratory Sinus Arrhythmia Biofeedback. *ApplPsychophysiol Biofeedback.* 2016; 41(2): 129-39.
23. Aritzeta A, Soroa G, Balluerka N, et al. Reducing Anxiety and Improving Academic Performance Through a Biofeedback Relaxation Training Program. *ApplPsychophysiol Biofeedback*. 2017; 42(3): 193-202.
24. Gholami TZ, Makvand HS, Kianersi F, et al. Biofeedback-Aided Relaxation Training Helps Emotional Disturbances in Undergraduate Students Before Examination. *ApplPsychophysiol Biofeedback*. 2017; 42(4): 299-307.
25. Goessl VC, Curtiss JE, Hofmann SG. The effect of heart rate variability biofeedback training on stress and anxiety: a meta-analysis. *Psychol Med.* 2017; 47(15): 2578-2586.
26. Morarend QA, Spector ML, Dawson DV, et al. The use of a respiratory rate biofeedback device to reduce dental anxiety: an exploratory investigation. *ApplPsychophysiol Biofeedback*. 2011; 36(2): 63-70.
27. Paul M, Garg K. The effect of heart rate variability biofeedback on performance psychology of basketball players. *ApplPsychophysiol Biofeedback.* 2012; 37(2): 131-44.

28. Dziembowska I, Izdebski P, Rasmus A, et al. Effects of Heart Rate Variability Biofeedback on EEG Alpha Asymmetry and Anxiety Symptoms in Male Athletes: A Pilot Study. *ApplPsychophysiol Biofeedback*. 2016; 41(2): 141-50.
29. Jiménez MS, Mora JA. Effect of Heart Rate Variability Biofeedback on Sport Performance, a Systematic Review. *ApplPsychophysiol Biofeedback*. 2017; 42(3): 235-245.
30. Pusenjak N, Grad A, Tusak M, et al. Can biofeedback training of psychophysiological responses enhance athletes' sport performance? A practitioner'sperspective. *PhysSportsmed*. 2015; 43(3): 287-99.
31. Fehring RJ. Effects of biofeedback-aided relaxation on the psychological stress symptoms of college students. *Nurs Res.* 1983; 32(6): 362-6.
32. Monastra VJ. Electroencephalographic biofeedback (neurotherapy) as a treatment for attention deficit hyperactivity disorder: rationale and empirical foundation. *Child AdolescPsychiatrClin N Am*. 2005; 14(1): 55-82
33. Clarke AR, Barry RJ, McCarthy R, et al. EEG analysis in attention-deficit/hyperactivity disorder: a compar-ative study of two subtypes. *Psychiatry Res.* 1998; 81: 19–29
34. Hou JH, Zhang Y, Xu C. Electroencephalographic biofeedback for the treatment of attention deficit hyperactivity disorder in children. *ZhongguoDangDai Er Ke Za Zhi*. 2008; 10(6): 726-7.
35. Kołakowski A. EEG-biofeedback (neurobiofeedback) a kompleksowe leczenie ADHD. *Psychiatr. Psychol. Klin.* 2012; 12: 40–51.
36. Friel PN. EEG biofeedback in the treatment of attention deficit hyperactivity disorder. *Altern Med Rev*. 2007; 12(2): 146-51.
37. Holtmann M, Stadler C. Electroencephalographic biofeedback for the treatment of attention-deficit hyperactivity disorder in childhood and adolescence. *ExpertRevNeurother.* 2006; 6(4): 533-40
38. Hampson M. Identifying Potential Mechanisms of Action Underlying Neurofeedback Treatment Response in Depression. *Biolog Psychitr*. 2017; 82(8): 547-548.
39. Yuan H, Young KD, Phillips R, et al. Resting-state functional connectivity modulation and sustained changes after real-time functional magnetic resonance imaging neurofeedback training in depression. *Brain Connect.* 2014; 4(9): 690-701
40. Baehr E, Rosenfeld P, Baehr R. Clinical Use of an Alpha Asymmetry Neurofeedback Protocol in the Treatment of Mood Disorders. *Journal of Neurotherapy*. 2000; 4: 11-18.
41. Blase KL, van Dijke A, Cluitmans PJ. Efficacy of HRV-biofeedback as additional treatment of depression and PTSD. *TijdschrPsychiatr.* 2016; 58(4):292-300.
42. Caldwell YT, Steffen PR. Adding HRV biofeedback to psychotherapy increases heart rate variability and improves the treatment of major depressive disorder. *Int J Psychophysiol.* 2018; 131: 96-101.
43. Cortoos A, De Valck E, Arns M, An exploratory study on the effects of tele-neurofeedback and tele-biofeedback on objective and subjective sleep in patients with primary insomnia. *ApplPsychophysiol Biofeedback.* 2010; 35(2): 125-34
44. Hammer BU, Colbert AP, Brown KA, et al. Neurofeedback for insomnia: a pilot study of Z-score SMR and individualized protocols. *ApplPsychophysiol Biofeedback*. 2011; 36(4): 251-64.
45. Nicassio PM, Boylan MB, McCabe TG. Progressive relaxation, EMG biofeedback and biofeedback placebo in the treatment of sleep-onset insomnia. *Br J Med Psychol.* 1982; 55(2): 159-66.