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Different types of biofeedback applications in health and disease

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Abstract

Biofeedback treatment is among the methods proposed to prevent and treat many organic and mental problems. Many experts carry out biofeedback application since it is applied by psychiatrists, psychologists, doctors, social workers, nurses, and physiotherapists. Biofeedback is a non-invasive, natural method that does not require drugs, although it can be used along with medicines. It is based on the learning and training of individuals on their body's normal functions such as muscle pain, brain waves, heart rate, pain perception, skin conductivity, and blood pressure. It is often used to treat stress, anxiety, headaches, insomnia, tension, urinary incontinence, muscle aches, and other problems. It can be applied in conjunction with other therapies when necessary, such as psychotherapy, meditation, or other alternative therapies. It has many applications with no side effects, does not create dependencies, and can be interrupted at any time.

Keywords: HRV, EEG, EMG, thermal biofeedback, biofeedback

1. Introduction

1.1. Definition of Biofeedback

Biofeedback is a process by which a person's ordinary activity, such as brain waves, heart function, respiration, muscle activity, and skin temperature, is accurately measured. The means used for the measurement provide fast and accurate feedback information to the user ^[1]. This information, often combined with changes in thinking, emotions, and behaviour, supports the desired physiological changes where they can be sustained over time without the constant use of a medium ^[2]. Biofeedback provides visible and experiential proof of mind-body connection; it is a therapeutic tool for learning self-regulation of the autonomic nervous system that facilitates health-improving functions ^[3]. A more accurate term to describe the biofeedback process would be psychophysiological feedback. During this process, any normal function that is being monitored should be recorded continuously and accurately so that the changes that occur at any given time are observable. Changes in psychophysiological quantities must be directly reflected in the learner who attempts to bring this function under control as the goal is to learn how to influence the physiological changes observed ^[4] and, in particular, to bring to a conscious level and under his control every normal function ^[5]. There are many different biofeedback applications applied, and the most appropriate method is used depending on the individual's problem.

2. Biofeedback Applications

2.1. The HRV Application

HRV application refers to heart rate variability. Heart rate variability (HRV) is an indicator of a healthy body, and a low HRV indicator may indicate increased morbidity. The application of HRV can reduce the symptoms of many heart and respiratory diseases such as chronic respiratory disease and asthma. Mental relaxation with diaphragmatic breathing contributes to the increase of the HRV index ^[6]. This method essentially supports treating various disorders such as asthma or depression since there is a positive response to this form of cardiorespiratory training ^[7].

According to Karavidas *et al.* [8], who performed a study with the HRV of eleven patients suffering from major depressive disorder, ten weekly HRV sessions increased heart rate variability. The results showed significant improvements in the Hamilton depression scale (HAM-D) and the Beck Depression Inventory (BDI-II). This study concluded that HRV biofeedback appears to be a beneficial adjunctive therapy for major depressive disorder as it achieves increased HRV.

In a study with asthma patients, who underwent HRV biofeedback sessions, the results showed improvements in the average level of asthma severity. The estimation of forced oscillation pneumography showed similar improvement in pulmonary function. In contrast, the placebo drug showed an improvement in asthma symptoms but not in pulmonary function. The findings were that HRV biofeedback might be a useful adjunct in treating asthma and may help reduce steroid dependence [9].

2.2. The EEG Application

The EEG method is applied to treat psychiatric conditions such as substance use disorders, including alcohol, resulting in severe cognitive function and behavioural impairment. It is well known that chronic or acute drug use leads to a significant change in brain activity detected by EEG methods [10].

A systematic review conducted to rehabilitate people with the application of EEG Biofeedback, patients with mental disorders, who were receiving medication, showed that the treatment positively affects cognitive processes, mood, and stress levels. The application of EEG biofeedback, whether used as the primary method or as an auxiliary, its positive effects and usefulness are confirmed. The mental disorders, which were clinically diagnosed and used in the various biofeedback studies, included depression, anorexia, dyslexia, schizophrenia, substance abuse, substance abuse anxiety, attention deficit hyperactivity disorder, and Alzheimer's disease [11].

2.3. The Brain Boy Universal Professional Application

It is a biofeedback application that seeks the cooperation and balanced functioning of the two cerebral hemispheres. This result is achieved through a series of exercises with visual and auditory stimuli. It uses the senses of hearing and sight. These exercises have difficulty levels from which the person gradually passes until he reaches the final level of difficulty. The exercises performed by the person in each session are eight. With this application, the person gains the maintenance of his inner homeostasis every time he is exposed to stressful events which can deregulate it. In this way, he succeeds in managing the events that stress him and thus maintains his internal balance.

According to Zafeiri *et al.* [12], in a study conducted with fifty patients who were either diagnosed with an anxiety disorder or experienced acute stress, anxiety, or fear that disorganized them, it was found that before the intervention with the biofeedback method Brain Boy Universal Professional, had 26% mild to moderate stress, 12% moderate stress and 62% severe anxiety. The results after the intervention were transformed into 78% mild to moderate stress, 12% moderate stress, and 10% severe stress from 62% before the intervention. According to the literature, the population moved from severe stress levels to lower stress levels, which can have a protective effect on the individual. In particular, mild stress contributes to greater vigilance and faster

preparation for action and preventive measures¹³. This study concluded that the Brain Boy Universal Professional biofeedback application was suitable for managing anxiety disorders.

2.4. The EMG application

Electromyography (EMG) is a biofeedback method that measures the electrical activity of muscle fibers produced by muscles when they move or contract. In a study conducted on the voice therapy of women with behavioural dysphonia, using electromyography, it was found that after eight sessions of biofeedback therapy (twice a week, each lasting thirty minutes), there were positive results in voice quality as well as in electrical muscle activity. The treatment of voice dysphonia with bio-reflective electromyography was more effective than traditional therapy in muscle electrical activity. It had effects that remained for a more extended period in women with this condition [14].

A meta-analysis where biofeedback was used as an adjunct tool for monitoring muscle tension dysphonia or voice training found that electro muscular biofeedback applied to speech therapy was an effective treatment for the dysphonia caused by the muscles. The data showed that changes in neural networks responsible for speech could change the quality of voice broadcasting quality. These results created two lines of research for speech therapists to explain this challenge of electro muscular biofeedback. The first line of research was dedicated to improving its methodology, and the second line of research to researching the neural processes related to and bringing about a change in the heart of normal and dysphonic patients [15].

2.5. Thermal Biofeedback

With thermal biofeedback, the body temperature is measured, specifically the upper and lower extremities, as when the person is under stress by stimulation of the sympathetic system. Cold skin is produced while in the relaxation phase, activation of the parasympathetic system, followed by warm skin. This application also achieves stress control and stress relief using skin temperature as a tool [16].

A case study performed on a 22-year-old man who suffered an injury to his left arm and specific electrical burns to his left wrist, mainly to the venous fold that resulted in tendon and flexion coagulation, thermal biofeedback was applied. An initial measurement showed total loss of sensation and motor of the median and suprapubic nerves. After applying thermal biofeedback and during the study period, nerve regeneration began seven months after the injury. After a total of fourteen sessions of thermal biofeedback and passive relaxation, the person was able to increase the temperature of the injured hand, thereby reducing pain. It quickly became apparent that healing, movement, and control progressed significantly [17].

Scharff *et al.* [18] reported that thermal biofeedback has been applied in many pediatric studies for migraines and found that the effect is consistently therapeutic. In a study of thirty-six children and adolescents, thirty-four of them completed the treatment. The evaluation included anxiety and depression questionnaires for parents and children. The results showed that children in the thermal biofeedback group were more likely to improve migraine. The results were maintained for up to six months after treatment and confirm the results of other previous similar studies.

Marcus *et al.* [19] reported that drug-free migraine treatment with relaxation training and thermal biofeedback could be essential for the non-medical treatment of choice for migraine

since a large percentage (41.3%) of the individuals in the study reported a significant reduction in headaches.

3. Discussion

Considering what was presented in the present publication, it is understandable that biofeedback can help prevent and treat many organic and mental health problems. Its contribution, either when used along with other therapies or as an autonomous therapy, is essential since it is a non-invasive and valuable tool. Its great advantage is that it relies on the individual's learning and training on his normal functions. It is a treatment that promotes the deep knowledge and understanding of the function of the human body and autonomy since its goal is for the individual to set under his control his normal functions and the processes that occur automatically. It does not require the use of drugs, and thus it is a method that can be applied even to patients who cannot take medication. This fact leads to the optimistic message for its application in a variety of problems.

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