

Exploring the Physiological Mechanisms and Clinical Applications of Biofeedback in Emotion Regulation

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Abstract: Biofeedback is a behavioral intervention technology based on psychophysiology, which uses various electronic devices to collect the physiological activities of individuals in real time and provides them to themselves through various ways, so that people can actively change their own physiological changes when they perceive the changes in some physiological functions of their own, and consciously control the physiological functions of various aspects of the autonomic nervous system within a fixed range. It can play a role in improving physical health status, preventing and treating some somatic diseases. Studies have shown that biofeedback relaxation training can make the training subjects learn to regulate their own physiological functions and psychological activities, improve negative emotional states such as depression and anxiety by regulating the body function, and can also be used to assist in the treatment of other clinical diseases. As a new psychological intervention, biofeedback relaxation training has great development potential and can be better applied to the prevention and treatment of physical and mental diseases in the general population in the future.

Keywords: Biofeedback; Physiological mechanism; Clinical application

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1. Introduction

In recent years, with the rapid development of science and technology and the social economy, the patterns of human production, life, and behavior have changed significantly. The advent of the era of information network has provided more convenience for people's life, but at the same time, the spectrum of human diseases has also changed significantly with the change of living environment, the acceleration of life rhythm, and the intensification of social competition. The prevalence of psychosomatic diseases such as anxiety and depression, emotional disorders, cardiovascular and cerebrovascular diseases, diabetes, and malignant tumors has shown an increasing trend year by year, and the age of patients is younger^[1]. A large number of practices have proved that treatment of this kind of disease by drugs, surgery, and other therapies is not effective. "Heart disease also requires

psychosomatic medicine”. In the process of the transformation of medical model and the prevention and treatment of psychosomatic diseases, biofeedback therapy, which integrates the latest research results of various disciplines, emerged as The Times require. Its emergence and development provide a new way for human beings to prevent and treat diseases and improve health^[2].

2. Overview of biofeedback to improve emotional health and its application in clinical treatment

Biofeedback technology is to measure the normal and abnormal physiological and electrical signals of the nerve, muscle, and autonomic nervous system through electronic equipment. These physiological and electrical signals are considered to reflect the physiological and psychological conditions of the human body, and these physiological and electrical signals are selectively amplified into auditory or visual signals, and then feedback to patients. In the process of receiving treatment, patients can understand the changes of body conditions that are not previously perceived by them through biofeedback instruments. By controlling the external feedback signals provided by biofeedback devices, patients can train and adjust their physiological and psychological changes, and finally achieve the purpose of treatment and prevention of specific diseases.

Biofeedback is an effective combination of biofeedback technology and relaxation therapy, which can help subjects establish a new behavior pattern, restore the normal operation mode of the body, and then relieve emotions and improve sleep. It has been used in the treatment of depression, anxiety, schizophrenia, sleep disorders, and so on^[3, 4]. Data show that biofeedback can effectively regulate various physiological and psychological indicators, combat stress, and stabilize visceral function, so biofeedback has a good therapeutic effect on a variety of visceral system diseases^[5]. Wang *et al.* demonstrated that biofeedback can also improve HRV of healthy subjects, and cardiac autonomic nerve function changes in the direction of enhanced vagal nerve excitation and remains at a suitable stable level, thus improving the physical and mental health of subjects by improving the homeostasis of the internal environment^[6].

3. Research on the electrophysiological mechanism of the biofeedback relaxation training center

Biofeedback relaxation training is based on biofeedback technology, so that the subjects can master the method of their own body function regulation, understand the characteristics of their own mind and body changes, and learn to take care of their own body, and effectively regulate the autonomic nervous activity and psychological consciousness activity under relaxed conditions. In order to achieve a non-invasive treatment method to enhance physical and mental health and improve somatic symptoms, cardiac electrophysiological psychology is the key to it. For example, Electromyography biofeedback relaxation training is often accompanied by respiratory regulation and muscle relaxation. When patients relax, they will experience slow breathing, lower heart rate, lower blood pressure, lower skeletal muscle tension of the whole body, warm limbs, a clear mind, a happy mood, and comfort. It can also be used to relieve mental trauma and negative emotions, relax spastic and tense muscles, and enhance the feeling and control ability of physiological information in the pain area^[7]. The electrical activity of the heart is affected by the emotional state. In adverse emotional states such as tension and anxiety, the heart rate is accelerated and the heart rhythm is disordered. Biofeedback enables patients to learn to self-regulate and control their own

diseases through real-time detection and playback of the patient's heart rate, blood pressure, and other data, which is conducive to promoting the improvement of clinical efficacy. Clinical experiments have shown that biofeedback therapy can significantly improve the anxiety and depression of patients^[8].

Electroencephalogram (EEG) is the electrical activity of cerebral cortex, which reflects the excitation and inhibition of human brain neurons. In biofeedback relaxation training, that is, when the aim is to relax through people's self-regulation, the most concern is the EEG changes, because people's cognition, emotion, attention, and other mental processes are affected by the human EEG. There are five kinds of brain waves: δ wave, θ wave, α wave, β wave, and γ wave, among which α wave and β wave are more important. Alpha waves are a kind of brain wave generated when people are awake. In the relaxation training of electromyography biofeedback, when the body gradually relaxes, the frequency of alpha waves will increase. This indicates that the excitability of the cerebral cortex is decreasing. At the same time, it can also be seen that the human body is relaxed, the mood is relatively peaceful, and the attention is relatively concentrated. α waves can be used to assist in the diagnosis and treatment of mental diseases. Behavioral medicine research shows that when the α wave activity of patients with depression in the quiet state of closed eyes is higher than that of normal people^[9], behavioral medicine has found that the biofeedback method of muscle training for abnormal brain waves can repeatedly train θ waves, β waves, and SMR waves to correct abnormal brain waves. In this way, the brain α wave of patients with depression can be trained to the normal value, so that their depression can be improved^[10]. In contrast, beta waves occur when the brain is stressed and focused. When EMG biofeedback relaxation training is applied, it requires initial focused effort to regulate physical and mental relaxation. This early stage of concentration often leads to the emergence of beta wave activity. With continued practice of relaxation training, individuals gradually learn to relax both the body and mind more effectively, which can lead to the emergence of alpha wave activity.

4. Clinical application of biofeedback relaxation training in emotion regulation and adjuvant treatment of diseases

4.1. The application of biofeedback in the treatment of anxiety and depression symptoms

In order to study the application value of electroencephalogram (EEG) biofeedback instrument in the treatment of anxiety disorders, 100 patients with anxiety disorders were randomly divided into observation group and control group. The control group was treated with traditional treatment, and the observation group was treated with EEG biofeedback instrument on the basis of the control group. After four weeks of treatment, Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) were used to reflect the psychological state of patients. The final results showed that compared with the traditional treatment alone, Joint EEG biofeedback group in remission time, electromyography and psychological recovery on the rating scale (SAS)/SDS were showed significant advantage contrast between group ($P < 0.05$). In conclusion, the addition of EEG biofeedback to traditional treatment can help to improve symptoms, brain function, and promote the rehabilitation of patients^[11].

4.2. The effects of psychotherapy, medicine, and traditional Chinese medicine combined with biofeedback on depression and anxiety

It can be seen from the above studies that EEG biofeedback combined with traditional treatment can significantly shorten the remission time of symptoms in all dimensions of anxiety disorder patients, improve the electromyography function, and reduce SAS/SDS scores compared with the control group ($P < 0.05$), indicating

that the synergistic effect of biofeedback technology on traditional treatment may have a synergistic effect on regulating brain function ^[11]. Combined with this consideration, the treatment combination of other treatments (psychotherapy, drug therapy, traditional Chinese medicine treatment) combined with biofeedback can clarify the characteristics of the effect between each group. For example, biofeedback combined with drug therapy may accelerate the improvement of symptoms through “physiological-pharmacological” dual pathways. Biofeedback combined with psychotherapy may improve patients’ ability to regulate their own emotions. In addition, the combination of traditional Chinese medicine treatment can alleviate the anxiety and depression symptoms of some patients to a certain extent.

4.3. Biofeedback for the treatment of depression or anxiety after recovery from some diseases

Wen *et al.* confirmed that combined biofeedback therapy can achieve better effects on stroke depression and anxiety, and can effectively improve the negative mood of patients, improve the safety of patients, and improve the quality of life of patients with prognosis, which has definite promotion value ^[12]. In addition, through the comparative analysis of randomized parallel controlled experiments, Ma *et al.* found that: On the basis of the same case, 100 elderly patients with stable COPD were treated with conventional EEG biofeedback (WB biofeedback) method and WB + FP method for 2 weeks and 4 weeks, respectively. The SAS and SDS scores of the subjects before the test and the PSQI index before FP showed that the SAS and SDS scores of the subjects before test were significantly higher than those of the conventional model. In other words, their efficacy is better ^[13]. That is, this treatment method is more effective for elderly patients with COPD complicated with anxiety and depression, which can effectively regulate the negative emotions of patients and significantly improve the quality of sleep. The important factor for improving the quality of life is psychological factors, so as to promote the improvement of the overall health status ^[13]. In addition, it is a non-drug treatment method without drug side effects, which has an irreplaceable role in the intervention of various conditions such as depression and anxiety that occur after the cure of the disease, and the side effects of biofeedback method are small. With the passing of time, the effect of treatment will be stronger and stronger, which has an extremely broad prospect for the rehabilitation of chronic diseases, neurological diseases, psychosomatic diseases, and other diseases, and also provides a good auxiliary treatment for patients with such diseases.

4.4. The application of biofeedback in mental health education of college students

From the existing literature, Sun *et al.* believed that EEG biofeedback could improve the anxiety of mobile phone addicts and reduce their degree of mobile phone dependence ^[14]. Liu introduced biofeedback training into the mental health education of college students, and found that it was helpful for college students to have a good mental state, learn to regulate emotions, relieve pressure, and develop both body and mind comprehensively. To some extent, it was conducive to promoting the development of mental health education in colleges and universities ^[15].

5. Conclusion

In summary, under the background of the rapid development of artificial intelligence and biotechnology, biofeedback technology has been widely used in the field of health care, and plays a positive role in promoting

rehabilitation medicine, clinical quality, and mental health. This technology can use the real-time detection and analysis of the physiological signals of the human body, such as brain waves and electrocardiogram, to strengthen the perception of the physiological state of the human body, and ultimately achieve the purpose of accurate intervention and regulation. This technology has a significant application effect in the field of medical practice: through the real-time monitoring of the patient's electromyography activity, a targeted rehabilitation training program can be generated, so as to promote the overall improvement of rehabilitation efficiency. It can be said that with the continuous optimization of the technical system and the in-depth integration with different disciplines, it will provide a more prominent contribution to the long-term development of public health.

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