Chapter 15
Biosensors, Biofeedback, and Neurofeedback

Pedro Monteiro
Escola Superior de Saúde, Politécnico do Porto, Portugal

Diana Leal Tavares
Escola Superior de Saúde, Politécnico do Porto, Portugal

Luís Mourão
Instituto Superior de Engenharia, Politécnico do Porto, Portugal

Henri P. A. Nouws
REQUIMTE/LAQV, Instituto Superior de Engenharia, Politécnico do Porto, Portugal

Gisela Maia
Escola Superior de Saúde, Politécnico do Porto, Portugal

ABSTRACT

In this chapter, the authors write about the processes of biofeedback, giving an insight about the sensors that might be used, the overall concept of biofeedback, as well as the evidence regarding the effectiveness of neurofeedback for the treatment of mental disorders.The main goal is to provide those introducing to the biofeedback as a self-regulation technique, used now for more than 50 years, with concise information about the sensors that might be used to detect the most common measured responses, the main types of physiological biofeedback, and the state-of-the-art evidence about neurofeedback as a form of brain training for individuals with the most prevalent mental disorders. Biofeedback and neurofeedback are guided therapies that include a vast and rowing variety of methodologies aimed to return information to the individual, regarding the physiological functions of the organism itself, in order to enable the modification of those otherwise considered unconscious physiological responses, designed to improve the individual's health and wellness.

SUMMARY

In this chapter we will focus on the processes of biofeedback, giving an insight about the sensors that might be used, the overall concept of biofeedback, as well as the evidence regarding the effectiveness of neurofeedback for the treatment of some mental disorders.

The main goal is to provide an introduction to the biofeedback as a self-regulation technique, used now for more than fifty years, with concise information about the sensors that might be used to detect the most common measured responses, the main types of physiological biofeedback, and the state-of-the-art evidence about neurofeedback as a form of brain training for individuals with the most prevalent mental disorders.

Biofeedback (BF) and neurofeedback (NFB) are guided therapies that include a vast and rowing variety of methodologies aimed to return information to the individual, regarding the physiological functions of the organism itself, in order to enable the modification of those otherwise considered unconscious physiological responses, designed to improve the individual's health and wellness. This can be performed as a straight operant conditioning model relying on the reinforcement of the signals displayed for the individual to change the physiological responses.

In spite of emerging therapeutic and performance approaches and methodologies, in this chapter the authors focus upon the self-control ability to modulate physiological conditions like, for example, muscle tension evidenced by electromyography (EMG), electrodermal activity (EDA), heart rate (HR), heart rate variability (HRV) and bioelectrical brain activity based on electroencephalogram (EEG). These approaches constitute de physiological basis of biofeedback (EMG, EDA, HR and HRV) and neurofeedback (EEG), that can be applied in order to control a wide range of central, peripheral and autonomic nervous system symptomatology. Both BF and NFB modalities are designed in order to improve a healthy condition and reduce abnormal body activity. When that first condition is achieved, a positive visual (videogame or movie control) and/or auditory (on/off) feedback are given, not target if an unwanted second condition is recorded.

To address the effect of BF and NFB in neurodevelopment and mood disorders, throughout this chapter the main clinical EEG-based neurofeedback and biofeedback protocols applied in attention deficit hyperactivity disorder (ADHD), autism spectrum disturbances and in other adult disorders whose anxiety and/or depression symptoms are present (major depression, post-traumatic stress disorder, obsessive-compulsive disorder and insomnia) are covered.

BIOFEEDBACK

Biofeedback is a process whose basic operating principle is the monitorization of a normally automatic physiological function, providing information that may be used to train someone to self-control and improve such function. Traditionally, a biofeedback system is made upon and based in physiological information obtained noninvasively by a sensor attached directly to the body. It is a valuable supplementary treatment and complements rehabilitation protocols to recover healthy functions, mainly related to neuromuscular (Giggins *et al.*, 2013; Spencer *et al.*, 2021) and psychiatric disorders (Schoenberg and David, 2014; Markiewicz, 2017; Tolin *et al.*, 2020).

The ability to modulate physiological conditions like, for example, muscle tension evidenced by electromyography (EMG), electrodermal activity (EDA), heart rate (HR), heart rate variability (HRV)

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