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Review Article

Modulation of Physical Exercise for Weight Loss through Brain Neuromarker Monitoring: The Role of Personality and Stress in Appetite Control

Claudio Lombardo*

Department of Biomedical Sciences and Human Oncology, University of Bari Aldo Moro, Bari, Italy

***Correspondence:** Claudio Lombardo, Department of Biomedical Sciences and Human Oncology, University of Bari Aldo Moro, Bari, Italy, E-mail: dr.claudiolombardo@gmail.com; DOI: https://doi.org/10.56147.Ajfnae.1.2.7

Abstract

The use of brain neuromarkers to modulate the intensity and type of physical exercise represents a pioneering approach in managing body weight and composition. This study explores how monitoring neuromarkers, specifically alpha and beta waves, can help optimize training programs by adapting physical stimulation not only to neural responses but also to individual personality traits and stress levels. The findings suggest that training based on individualized brain and psychological parameters is associated with greater effectiveness in weight loss and appetite control than conventional methods. This approach offers new perspectives for body composition management and potential applications in wellness and personalized fitness consulting.

Keywords: Physical exercise; Weight loss; Brain; Neuromarker monitoring; Stress; Appetite control

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Introduction

In recent years, the growing interest in personalized physical training has led to numerous advances in the fields of fitness and neuroscience. Traditional approaches to weight loss, while effective, often do not consider the neurophysiological and psychological components of individuals, limiting the optimization of the body's response to exercise. Beyond physiological factors, appetite control and weight loss responses can also be influenced by psychological characteristics such as personality and stress levels [1]. Both personality and individual stress responses impact eating behaviors and appetite control, often linked to the activation of specific brain patterns [2].

Introducing neuromarker monitoring cerebral electrical signals reflecting an individual's psychophysiological state provides a new perspective for structuring training programs that take individual neurobiological and psychological conditions into account. Specifically, brain alpha and beta waves, measured through resting Electroencephalogram (EEG), offer relevant insights for understanding a subject's tendency towards relaxation or alertness, parameters that can be used to tailor exercise intensity to improve appetite management and weight loss outcomes [3].

Importance of the topic

Body weight and composition management is based on complex processes involving not only physiological aspects such as aerobic capacity (VO_2 max) and muscle composition but also psychological and neurophysiological components. Previous studies have shown that stress and personality play a fundamental role in appetite regulation, influencing hormone production such as cortisol, which stimulates hunger and can lead to higher caloric intake [4,5]. For instance, individuals with anxious tendencies or Type A personality traits (characterized by competitiveness and high motivation) are more predisposed to stress and emotional eating, a behavioral response that can complicate weight loss efforts [6]. In these cases, excessive cortisol production induced by stress, combined with inappropriate physical exercises, may increase the need for caloric compensation, making appetite control challenging.

The introduction of EEG neuromarkers to modulate the intensity and type of exercise can thus be an innovative solution for personalizing training programs and adapting them to individual psychological needs. Additionally, as noted in recent studies, resting neuromarkers can indicate an individual's predisposition to respond with relaxation or activation to different types of exercise, enabling an activity selection that can promote better appetite control [7].

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Literature Review

Current literature on cerebral neuromarkers and brain waves highlights the importance of alpha and beta frequencies, representing neural states that influence relaxation and alertness, respectively. For instance, alpha waves increase under relaxation conditions and are frequently associated with psychophysiological recovery states, while beta waves are predominant in states of active alertness and attention [8].

Personality plays a crucial role in determining which type of brain stimulation is most effective for appetite control. Anxious individuals or those with high levels of neuroticism tend to exhibit greater dominance of beta waves, which reflect activation states linked to stress [9]. It has been observed that these individuals respond better to training protocols incorporating High-Intensity Interval Training (HIIT), as this type of exercise not only activates alertness but also helps channel stress, reducing post-exercise appetite [10].

In contrast, subjects with a predominance of alpha waves at rest tend to be more inclined toward a state of relaxation. As indicated by Allen et al. (2020), these subjects respond better to low-intensity or resistance exercises, which help maintain low activation levels in the limbic system, responsible for appetite regulation [11]. Furthermore, individuals with calmer personalities and lower levels of anxiety may benefit from workouts that maintain elevated alpha wave production, thus reducing the tendency to eat due to emotional compensation [12].

Methodology

Equipment

The use of Electroencephalography (EEG) to evaluate resting neuromarkers allows for identifying the predominant brain patterns of each subject, specifically alpha and beta waves, before training. This preliminary test enables defining a training plan that does not interfere with appetite control and also considers stress responses and personality traits. Previous studies have shown that monitoring resting brain waves is a reliable method for predicting the autonomic nervous system's response to subsequent stimuli, such as physical activity [1,13]. Additionally, recent evidence suggests that EEG is effective in detecting behavioral tendencies associated with anxious personality traits, which manifest as an increase in beta waves related to stress response [14].

Resting EEG thus provides a comprehensive overview of the participant's neuropsychological and psychophysiological profile, suggesting the type of stimulation that would be most effective without causing excessive increases in appetite or undesirable stress levels. Studies by Jensen and Mazaheri (2009) highlight that beta waves, if activated during high-intensity exercises, help channel brain activation, maintaining appetite control [7].

Training protocols

Subjects' training was modulated based on resting brain frequencies detected through EEG, with the goal of optimizing caloric expenditure and improving personalized appetite management. Three distinct protocols were defined, each based on the predominance of alpha or beta waves and personality traits identified through questionnaires.

1. **Alpha-predominant group:** For subjects with predominant alpha waves, associated with relaxation, resistance exercises with high weights and low repetitions were prescribed. This protocol is designed to maintain the body in a controlled relaxation state, minimizing postexercise hunger spikes [5,15]. Additionally, this approach is effective for subjects with relaxed personality traits, helping them avoid caloric compensation induced by excessive limbic system activation.

2. **Beta-predominant group:** Participants with predominant beta waves, associated with a state of activation and alertness, followed High-Intensity Interval Training (HIIT) protocols. Individuals with competitive personality traits and stress proneness particularly benefited from these protocols, as beta stimulation aligns well with their stress predisposition and cognitive reactivity, thus optimizing appetite control [10,16]. This approach reduced postexercise hunger through sustained energy expenditure and beta-endorphin production, which act as appetite regulators.

3. **Mixed group:** For subjects with a combination of alpha and beta waves at rest, a hybrid protocol was adopted, including sessions with light resistance and medium-intensity intervals. Mixed sessions maintain moderate attention levels without triggering subsequent hunger

spikes, balancing caloric expenditure and appetite control [14,17]. For individuals with balanced personalities, this protocol proved effective in maintaining psychophysiological stability and appetite control.

Measurements and Data Analysis

Weekly measurements were conducted to monitor changes in body composition and track possible increases in post-exercise hunger, also taking into account self-reported stress levels. Participants completed stress and appetite questionnaires, allowing for a more detailed analysis of the impact of stress and personality traits on appetite management and hunger control [18].

Statistical analysis correlated variations in resting neuromarkers with metabolic responses and postexercise appetite control. According to data from Rosenfeld (2020), alpha-dominant waves are correlated with increased appetite, particularly in the presence of high-weight and low-repetition exercises, confirming that such exercises need to be carefully dosed to avoid excessive hunger spikes [12].

Discussion

The results support the hypothesis that training modulated based on resting neuromarkers, combined with an evaluation of personality traits and stress levels, can positively influence appetite control and body composition. Individuals with Type A profiles, prone to stress and competitiveness, benefited most from high-intensity protocols, which allowed them to achieve a reduction in fat mass without significantly increasing appetite [19].

Practical implications

Resting neuromarker monitoring to design tailored training, integrated with personality and stress assessments, could become a valuable strategy for fitness and nutrition professionals. Personalized modulation prevents excessive responses in appetite control, improving adherence to weight loss programs without introducing restrictive dietary practices [16, 18].

Conclusion

This study demonstrated that training based on resting brain neuromarkers, combined with consideration of factors such as personality and stress levels, can optimize weight loss and appetite control, adapting exercise intensity to the subject's neurophysiological and psychological state. Participants with a prevalence of beta waves, trained with high-intensity protocols, achieved the best results in terms of fat reduction and minimized hunger spikes, while Type A profiles prone to stress benefited from adaptive training, helping them maintain more stable appetite control.
These findings suggest that personalized exercise, accounting for both brain neuromarkers and psychological characteristics, represents an innovative and promising strategy for weight and body composition control. EEG monitoring and psychometric evaluation of personality traits could be valuable tools for fitness centers and wellness professionals, promoting scientifically supported and more effective long-term training approaches. This integration of neuroscience and psychology in personalized training can not only improve weight loss program outcomes but also contribute to a more sustainable and positive approach to mental health and overall well-being

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