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Cardio-Musical Synchronization and Neurophysiological Performance: A Single-Case Study Using EEG Biofeedback in Moderate Activity

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Abstract

This study investigates the interaction between rhythmic auditory stimulation, autonomic response, and cortical activity in individuals with sedentary lifestyles or recreational physical habits. The primary objective is to determine whether real-time synchronization between musical tempo (BPMmusic) and heart rate (HR), mediated by an EEG biofeedback system (BrainLink Pro), optimizes cardiovascular efficiency and delays mental fatigue. A single-case experimental design (n=1) was employed, utilizing a 25-minute protocol divided into calibration, baseline, a ten-minute intervention, and recovery phases. Through a closed-loop modulation system, the software dynamically adjusts the musical rhythm to the subject's pulse (HR±2%) and enhances sonic intensity upon detecting decreases in Beta (?) power, a robust marker of cognitive fatigue. Preliminary results suggest that this synchronization acts as an ergogenic regulator that stabilizes neural attention and reduces the subjective perception of effort (Borg Scale). The success of this technical protocol not only enhances physical performance but also establishes a foundation for future applications in academic and occupational settings, utilizing music as an external pacemaker for optimizing cognitive focus and preventing mental burnout.

Keywords: Biofeedback; Cognitive Fatigue; Entrainment; Neuroergonomics; Rhythmic Stimulation