Near-Infrared Spectroscopy-Based Frontal Lobe Neurofeedback Integrated in Virtual Reality Modulates Brain and Behavior in Highly Impulsive Adults.

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Abstract

Based on neurofeedback (NF) training as a neurocognitive treatment in attention-deficit/hyperactivity disorder (ADHD), we designed a randomized, controlled functional near-infrared spectroscopy (fNIRS) NF intervention embedded in an immersive virtual reality classroom in which participants learned to control overhead lighting with their dorsolateral prefrontal brain activation. We tested the efficacy of the intervention on healthy adults displaying high impulsivity as a sub-clinical population sharing common features with ADHD. Twenty participants, 10 in an experimental and 10 in a shoulder muscle-based electromyography control group, underwent eight training sessions across 2 weeks. Training was bookended by a pre- and post-test including go/no-go, n-back, and stop-signal tasks (SST). Results indicated a significant reduction in commission errors on the no-go task with a simultaneous increase in prefrontal oxygenated hemoglobin concentration for the experimental group, but not for the control group. Furthermore, the ability of the subjects to gain control over the feedback parameter correlated strongly with the reduction in commission errors for the experimental, but not for the control group, indicating the potential importance of learning feedback control in moderating behavioral outcomes. In addition, participants of the fNIRS group showed a reduction in reaction time variability on the SST. Results indicate a clear effect of our NF intervention in reducing impulsive behavior possibly via a strengthening of frontal lobe functioning. Virtual reality additions to conventional NF may be one way to improve the ecological validity and symptom-relevance of the training situation, hence positively affecting transfer of acquired skills to real life.