The Myth of Neurofeedback – Can We Really Train our Brains?

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Abstract

Starting with the 'Decade of the Brain', initiated by the United States Congress in the 1990s, the field of neuroscience has made tremendous progress, including the development and advancement of techniques for functional brain imaging. Early studies focusing on the effect of behavior on neural responses revealed insights into the neuroscience underlying cognitive processes and psychopathology (Val-Laillet et al., 2015). These insights have been taken up in neurofeedback (NF), a recent neuroscience breakthrough subsuming techniques directed towards the non-invasive alteration of brain functions by providing individuals real-time brain activity feedback. Specifically, neural activity is quantified and shown to participants through a visual signal. Participants are asked to actively alter this signal in an *a priori* defined direction; successful trials are positively reinforced (= operant conditioning). Against previously described aberrant brain activity patterns in clinical relative to healthy samples (e.g. Val-Laillet et al., 2015), NF may constitute a pertinent treatment option that normalizes brain activity (Haugg, Renz, et al., 2020). Yet, a major limitation of NF studies is the so-called "inefficacy problem": a significant proportion of participants does not benefit from NF treatment in terms of voluntary control over brain activity or improvements in clinical symptomatology (Alkoby et al., 2018).

Most of the empirical support for the clinical efficacy of NF has been obtained for attention-deficit/hyperactivity disorder (ADHD), where targeting neurophysiological alterations via NF markedly improves symptoms, including impulsivity (Cortese et al., 2019). Binge-eating disorder (BED), the most prevalent eating disorder, shows overlapping characteristics with ADHD, most importantly, shared problems with impulsivity. BED is characterized by recurrent binge-eating episodes without regulatory compensatory weight control behaviors. My first dissertation study supported previous reports showing that the impulsive behavior in BED is accompanied by neurophysiological alterations relative to individuals with normal weight and obesity that are pronounced for food cues. Despite large improvements in binge eating following psychotherapy, the first-line treatment of BED, further improvement of long-term outcomes is warranted. Promising findings for NF in ADHD treatment have given the impetus for our laboratory to perform the feasibility study "Near Infrared Spectroscopy Neurofeedback for Binge-Eating Disorder" (DRKS00014752), where patients with BED were randomly assigned to 12 sessions of EEG or functional near-infrared spectroscopy (fNIRS) NF.

As long as the NF inefficacy problem, including high variability in regulatory performance (Alkoby et al., 2018) and symptom outcomes (Haugg, Sladky, et al., 2020), persists, the clinical utility of NF remains a myth. My dissertation aims to open this black box by examining whether brain signals do indeed change during and after NF, and how potential brain-based changes relate to symptom improvements. For better understanding heterogeneous NF responses, pertinent baseline neuropsychological and clinical measures (e.g., eating disorder psychopathology) are assessed as predictors of treatment success and compared between EEG and fNIRS to disentangle modality-dependent mechanisms. Overall, the dissertation scrutinizes the clinical utility of NF and pretreatment variables determining NF success, possibly providing prognostic and general information on the potential of NF as a stand-alone or treatment adjunct for BED, which may ultimately reduce the inefficacy problem (Alkoby et al., 2018).

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