Real-time fMRI neurofeedback in adolescents with attention deficit hyperactivity disorder


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Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is associated with poor self-control, underpinned by inferior frontostriatal deficits. Real-time functional magnetic resonance neurofeedback (rtfMRI-NF) allows participants to gain self-control over dysregulated brain regions. Despite evidence for beneficial effects of electrophysiological-NF on ADHD symptoms, no study has applied the spatially superior rtfMRI-NF neurotherapy to ADHD. A randomised controlled trial tested the efficacy of rtfMRI-NF of the right inferior prefrontal cortex (rIFG), a key region that is compromised in ADHD and upregulated with psychostimulants, on the improvement of ADHD symptoms, cognition, and inhibitory fMRI activation. To control for region-specificity, an active control group received rtfMRI-NF of the left parahippocampal gyrus (lPHG). Thirty-one ADHD boys were randomly allocated and had to learn to upregulate their target brain region in an average of 11 rtfMRI-NF runs over 2 weeks. Feedback was provided through a video-clip of a rocket that had to be moved up into space. A transfer session without feedback tested learning retention as a proximal measure of transfer to everyday life. Both NF groups showed significant linear activation increases with increasing number of runs in their respective target regions and a significant reduction in ADHD symptoms after Neurotherapy and at 11-month follow-up. Only the group targeting rIFG, however, showed a transfer effect, which correlated with ADHD symptom reductions, improved at trend level in sustained attention, and showed increased IFG activation during an inhibitory fMRI task. This proof-of-concept study demonstrates for the first time feasibility, safety, and shorter- and longer-term efficacy of rtfMRI-NF of rIFG in adolescents with ADHD.