Neurofeedback-enhanced mindfulness effectively modulates brain’s resting state in schizophrenia

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Background: Neuroimaging studies have consistently found hyperconnectivity of the Default Mode Network (DMN) in patients with schizophrenia, as well as reduced anticorrelations between DMN and Central Executive Network (CEN). This may reflect an inability to redirect resources away from internal thoughts and feelings towards external stimuli, leading to disorder related symptomatology. Moreover, greater DMN functional connectivity correlates with greater psychopathology (e.g auditory hallucinations (AH)) and reduced anticorrelations are associated with greater cognitive deficits. Mindfulness training (MT) has been shown to decrease DMN, engage CEN, and to ameliorate clinical symptoms of schizophrenia. We show evidence that schizophrenia patients can learn to increase the positive diametric activity (PDA, defined as increased CEN and decreased DMN activity) through fMRI neurofeedback-enhanced MT from these networks.

Methods: 8 schizophrenia patients underwent i) two 6 min. resting-state (RS) scans, ii) two no-feedback transfer task (TR) scans and iii) four feedback scans. RS-1 was used to extract the DMN & CEN networks. All processing was performed in FSL build 5.08. ICA was performed and the components correlated to the DMN/CEN of Yeo et al 2011, thresholded and binarized. rt-fMRI-neurofeedback sessions consisted of mental labeling (mindfulness practice) receiving feedback from DMN/CEN activity for 2.5 min, while BOLD fluctuations were measured using rtfMRI. Participants were instructed to try to move a white dot into an upper-yellow circle by performing the mindfulness practice. Connectivity analysis was performed using the Conn Toolbox.

Results: All patients could A) increase PDA by performing mental labeling while receiving real-time feedback (~76% of runs), B) increase anticorrelation of MPFC/rDLPFC at postTR df(7)=3.79, p=0.003, and C) reduce intrinsic DMN connectivity at RS-2 df(7)=4.0,p=0.002. The patients had a reduction in AH after training df(7)=2.79, p=0.01.

Conclusions: These results demonstrate that schizophrenia patients can modulate PDA by performing MT and that neurofeedback-enhanced MT produces an increase in anticorrelation of MPFC/rDLPFC connectivity and a reduction of intrinsic DMN connectivity. As a result these patients had a subsequent reduction in AH. Both, intrinsic DMN and DMN/CEN anticorrelations provide targets to study the neurobiology of this disorder and may aid the development of novel forms of interventions aiming to “normalize” the brain’s resting state while avoiding the severe side-effects of current treatment.