FMRI neurofeedback: Novel interventions for depression

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Kymberly Young, an Associate Professor of Psychiatry at the University of Pittsburgh School of Medicine, discusses neurofeedback as a novel non-invasive intervention for depression

Major depressive disorder (MDD) is a chronic, disabling, and devastation condition that is the leading cause of disability worldwide (Friedrich, 2017). Up to two-thirds of patients who seek standard interventions will not respond, while only one-half of patients who do will achieve sustained remission (Cain, 2007). Therefore, there is a pressing need to research and develop novel non-invasive interventions for MDD, particularly in those who have failed to respond to previous treatments such as antidepressant medications.

fMRI Neurofeedback and regulating signals

Real-time functional magnetic resonance imaging (rtfMRI), in which blood-oxygen-level dependent (BOLD) data processing and display are performed at the same time as image acquisition, has enabled rtfMRI neurofeedback (rtfMRI-nf), allowing a person to see and regulate the fMRI signal from their own brain (deCharms, 2008).

Why the amygdala?

In our intervention for MDD, we provide neurofeedback information regarding activity of the amygdala. The amygdala plays a critical role in emotional processing and responding to both negative and positive stimuli and plays a central role in neurobiological models of MDD. Relative to healthy individuals, patients with MDD have increased amygdala responses to negative stimuli and decreased responses to positive stimuli, including positive memories (Young, Siegle, Bodurka, & Drevets, 2016). Indeed, previous work from our lab has shown that the more active the amygdala is when recalling positive memories, the less severe the patient's depression and the more specific their positive memory recall is. As most interventions for MDD target reducing these enhanced responses to negative information, we have chosen to focus on the blunted response to positive stimuli. We specifically focus on the left amygdala as it has been implicated in detailed and effortful response to stimuli. The right is implicated in rapid/automatic detection of emotional stimuli and may be more difficult to gain control over.

How positive stimuli affects the condition

The positive stimuli we focus on are autobiographical memories. Patients with MDD have difficulty recalling specific positive memories (e.g., I met a friend at a coffee shop this morning) and instead recall over-general memories (e.g., I often meet up with friends at a coffee shop). Increased over-generality, particularly for positive memories, is associated with more difficulties in problem-solving, imagining future events, and emotion regulation, suggesting that this memory impairment has significant effects on daily functioning (Raes et al., 2005).

Why is fMRI necessary?

Simply asking patients to recall positive memories actually makes their symptoms worse (Joormann, Siemer, & Gotlib, 2007). We believe the key is recalling positive memories while bringing the right brain regions online. By engaging the amygdala during positive memory recall, the memories become more important and useful to participants, allowing them to use memories for things like problem- solving and emotion regulation.

The Amygdala Neurofeedback Intervention

The current project focuses on patients with treatment-resistant depression – those who have tried but failed to benefit from at least 2 previous antidepressant treatments. Under double-blind conditions, participants are randomly assigned to receive neurofeedback from the left amygdala or a parietal region. The parietal region serves as a control – participants can increase activity here by thinking of positive memories, but this region has not been implicated in depression.

Therefore, both groups have the same high-tech train-your-brain intervention where they learn to control activity in a brain region. The only difference is that one of these regions is implicated in depression and should improve symptoms while the other likely will have no effect on symptoms. Participants are instructed to recall any positive memory from their life to increase the level of a thermometer representing the activity in one of these regions. Two sessions are provided over a one-week period. Depressive symptoms are measured throughout the intervention and for 3 months following completion.

Our preliminary work showed that this procedure resulted in decreased depressive symptoms, with remission rates like that seen with antidepressant medications (Young et al., 2017). However, participants were only followed up for one week and we do not know how long these symptom improvements persist. The current clinical trial follows participants for three months, allowing us to chart the long-term effects of this intervention.

Neurofeedback does not work for everyone. Indeed, up to 30% of patients will not be able to regulate their brain activity. Another goal of the current study is to determine which patients are best suited for this intervention – whether demographic, clinical, or brain activity data are related to response to this intervention. Ultimately, we hope to provide a new, neuroscience-based intervention for individuals suffering from MDD and determine which patients will benefit from this intervention.

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