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Training of brain self-regulation with amygdala neurofeedback

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Providing neurofeedback on the activation of limbic brain activation may improve neural self-regulation in patients with mental disorders involving limbic hyper-responding, like borderline personality disorder. The work described in this thesis is dedicated to the question whether real-time functional magnetic resonance imaging neurofeedback could enhance the down-regulation of emotion-related limbic brain activation. Major aims were to identify a potential target region for the intervention, implement and test the feasibility in a proof-of-concept study, and assess effects of neurofeedback training on emotion-related brain networks.

In a first step, dynamics of neural responding were analyzed to identify limbic brain regions with a sustained response to aversive picture blocks that could be used as target regions for limbic down-regulation. The amygdala showed this kind of response, in contrast to the anterior insula which responded with a transient time course. A second study had the aim to investigate the feasibility of amygdala down-regulation with neurofeedback. In a proof-of-concept study, healthy participants successfully down-regulated their amygdala response to aversive picture blocks. The experimental group diminished the amygdala response in a subsequent transfer run too, and the comparison with a sham-group provided evidence for an effect of neurofeedback on target region regulation. Additionally, amygdala neurofeedback and not control region feedback was associated with a modulation in functional amygdala connectivity with several brain regions associated with emotion regulation. Particularly, connectivity of the right amygdala with the ventromedial prefrontal cortex was increased when participants of the experimental group regulated the feedback-signal, and the increase of connectivity was associated with ratings of larger emotional arousal of pictures. To provide initial data for the transferability of the results to the clinical context, brain connectivity was analyzed in borderline patients undergoing amygdala neurofeedback on four training sessions. Patients altered functional amygdala-ventromedial prefrontal cortex connectivity with repeated training sessions. Connectivity patterns from the session number four were in accordance with the results from the healthy participants, showing larger connectivity in the 'regulate'- compared to the 'view'-condition where subjects naturally responded to aversive pictures. In addition, borderline patients reported an improvement in emotional awareness and a reduction in dissociation.

Taken together, the data support the feasibility of amygdala down-regulation with real-time functional magnetic resonance imaging neurofeedback and show, that brain networks associated with the processing and regulation of emotions are altered by amygdala neurofeedback training. In addition, the data from a patient pilot-study indicate a potential benefit of the intervention to improve aspects of disturbed emotion regulation in borderline patients. This is groundwork for further research on the application of amygdala neurofeedback in the treatment of patients with disturbed emotion regulation mechanisms. Moreover, a significant contribution is made to the understanding of the neural networks involved in amygdala neurofeedback down-regulation that may stimulate future research.