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Amygdala Neurofeedback Training in Borderline Personality Disorder: Capturing Improvements in Emotion Regulation

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The way we regulate emotions is a powerful determinant of behavior and directly impacts affect and physiology. Many mental disorders, such as borderline personality disorder, are in large part disorders of emotion dysregulation. Because of its important role in mental health, research has endeavored to understand the mechanisms and biological underpinnings of emotion regulation and to create trainings and specific clinical programs that aim to augment the ability to regulate emotions. The assessment of psychophysiological responses represents an important complementary method to quantify emotion regulation in both studies on healthy individuals and studies assessing clinical emotion regulation trainings. However, psychophysiological effects have been inconsistent across literature, which impedes informed decisions about suitable psychophysiological variables of emotion regulation experiments and clinical trainings. A new technique assumed to improve emotion regulation is amygdala neurofeedback training. Because patients with borderline personality disorder show hyperreactivity of the amygdala likely underlying the severe emotion regulation problems they suffer from, amygdala neurofeedback training may be a candidate training to improve emotion regulation in these patients. Until now, it has been unclear which aspects of psychopathology and emotion regulation may change with neurofeedback-aided amygdala downregulation in borderline personality disorder, which is urgently needed to determine a primary outcome measure for future randomized controlled trails. To fill these gaps, the present doctoral thesis identified the effects of psychophysiological responses of emotion regulation as well as important moderators and identified primary outcome measures of emotion dysregulation after neurofeedback training in patients with borderline personality disorder. In total, three studies were conducted. In Study I, a total of 1353 studies on psychophysiological responses of emotion regulation were screened through a systematic search of articles and meta-analyses were used to evaluate effect sizes of instructed downregulation strategies on common autonomic and electromyographic measures. Following this, Study II systematically tested effects of the startle probe timing on startle responses during emotion regulation in 47 healthy individuals. Study II aimed at optimizing emotion regulation assessment with the emotion-modulated startle that was then used in Study III. In Study III, a four-session amygdala neurofeedback training was tested in 24 female patients with borderline personality disorder. Before and after the neurofeedback training, as well as at a 6-week follow-up assessment, measures of emotion dysregulation and borderline personality disorder psychopathology were tested at diverse levels of analysis. Results from Study I demonstrate that effects of emotion regulation on autonomic measures, even if significant, were small and heterogeneous across studies, while electromyographic measures were more homogeneous and revealed medium effect sizes. Important study characteristics such as the study design, control instruction and trial duration moderated some autonomic effects of suppression and reappraisal. Study II demonstrated a significant inhibition of the startle response with emotion downregulation. Startle probes delivered at >7 seconds into the regulation phase were useful to quantify reappraisal effects, although earlier probes did not yield significantly smaller effects. Finally, Study III demonstrated that the inhibition of the startle with emotion downregulation increased after the training, suggesting improved emotion regulation abilities. In addition, we could demonstrate that general BPD psychopathology as well as affective instability and negative affect in daily life improved after training. However, after correction for multiple comparisons, observed effect sizes did not surpass the significance level and some effects (e.g., startle) faded to the 6-week follow-up assessment. In sum, the present thesis provides the groundwork for future randomized controlled trials of amygdala neurofeedback training and enables future laboratory and clinical studies to gain more stable effects in psychophysiological measurements of emotion regulation. In particular, the findings implicate that with regard to emotion regulation research, autonomic measures appear to

be highly variable and thus should be selected carefully. In addition, we need more comparable psychophysiological set-ups in the empirical study of emotion regulation. The emotion-modulated startle not only proved to be a robust measure to quantify emotion regulation effects in general, but also appeared to be suitable to track improvements in emotion regulation in the context of a neurofeedback training targeting emotion dysregulation. With respect to emotion regulation outcome measures for future amygdala neurofeedback studies, further improvement of the specific paradigms is needed. In addition, the neurofeedback training itself should be optimized in terms of e.g. training time and booster sessions. Future placebo-controlled trials must then confirm that the treatment is effective in improving emotion regulation in those with borderline personality disorder.