

Effective amygdala-prefrontal connectivity during emotion regulation: a meta-analysis of psychophysiological interactions

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Introduction

In recent years, a myriad of neuroimaging studies has investigated the neural basis of emotion regulation (ER), and substantial progress has been made toward building neurally plausible models of ER¹. However, single studies usually provide limited insight into the function of specific brain regions. Thus, to better understand **the role of the amygdala in emotion regulation**, we performed **coordinate-based meta-analysis on studies of emotion regulation related connectivity of the amygdala** which used **functional magnetic resonance imaging (fMRI)** and **psychophysiological interaction (PPI) analysis**².

Methods

- Literature research was conducted using PubMed (www.pubmed.com)
- Search terms: “emotion regulation” “affective regulation”, “reappraisal”, “fMRI”, “functional magnetic resonance imaging”, “functional MRI”, “effective connectivity”, “functional connectivity”, “PPI” and “psychophysiological interaction analysis”
- Time frame: 1st of January 2000 to 25th of February 2020 (Fig.1)
- Meta-analysis on experiments reporting PPI main effects and experiments that integrated individual difference factors (emotion regulation success or self-control)
- activation likelihood estimation (ALE) algorithm for coordinate-based quantitative meta-analyses of neuroimaging results as implemented in GingerALE 3.0.2³
- Seed region: Amygdala

Results

The meta-analysis revealed convergent connectivity with the amygdala during emotion regulation compared to a control condition in three regions:

- (1) the left inferior frontal gyrus (IFG)/vIPFC (BA47; $x = -34$, $y = 34$, $z = -9$, Volume [mm³] = 904)
- (2) the medial frontal gyrus (MFG)/dmPFC (BA8; $x = 4$, $y = 28$, $z = 46$, Volume [mm³] = 768)
- (3) the left claustrum ($x = -33$, $y = 4$, $z = 0$, Volume [mm³] = 736) (Fig. 2)

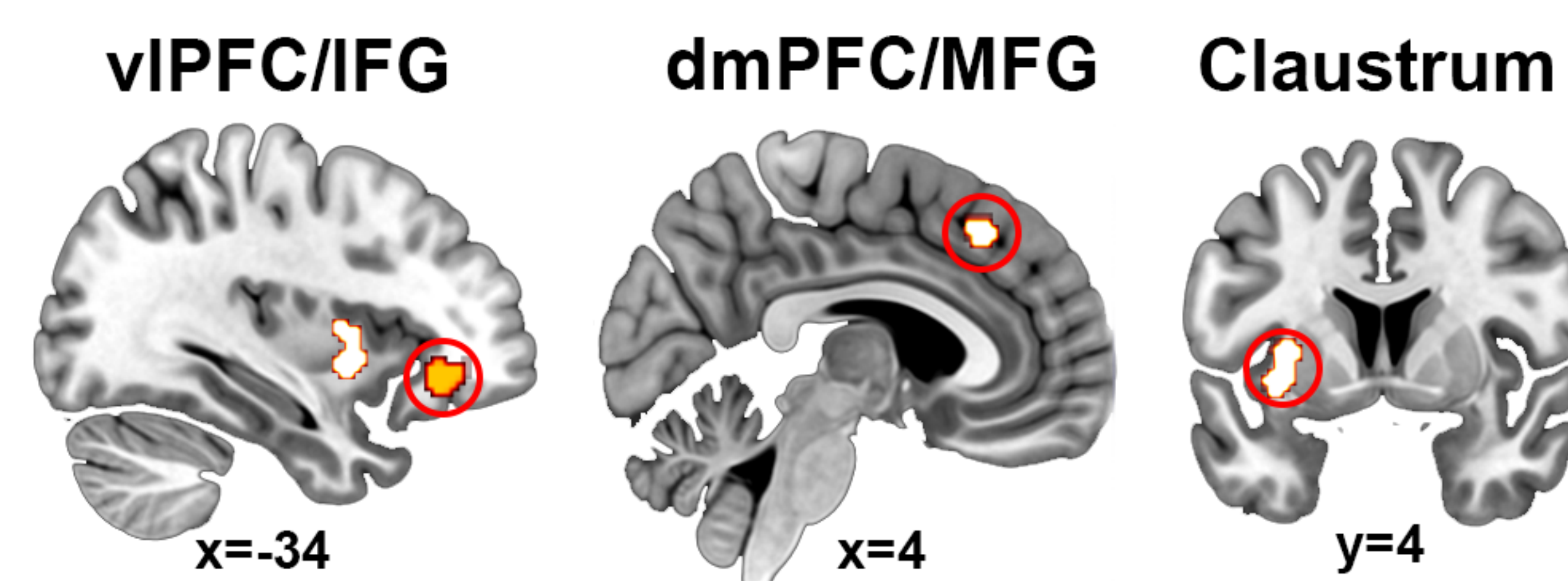


Fig. 2: Results of the meta-analysis revealed convergent connectivity between the amygdala and 3 regions during emotion regulation.

Conclusion

- The meta-analysis revealed convergent task-modulated coupling of the amygdala with prefrontal cortex regions such as the dmPFC and the left vIPFC, as well as the left claustrum.
- Both prefrontal regions have been implicated in emotion regulatory processes, specifically, the vIPFC in language processes and the dmPFC in the attribution of mental states. The claustrum cluster presumably represents an integral hub during the regulation of emotion.
- Our findings support the idea of dynamic modulation of connectivity between emotion generative and regulatory systems during the cognitive control of emotions, and highlight the robustness of task-modulated prefrontal-amygdala coupling.



Fig. 1: Flow Diagram outlining the study selection process. Studies included in the meta-analysis are described with regard to the investigated emotion regulation strategy, the regulation goal, the valence of the used stimuli and the seed region of the PPI analyses. n, number of studies; reapp, reappraisal; supp, suppression; distr, distraction; dec, decrease; inc, increase; neg, negative; pos, positive; L, left amygdala seed; R, right amygdala seed; av., left and right amygdala averaged as seeds.

References

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