Developing a neurofunctional intervention for emotion regulation under stress

ABSTRACT:

Background

Stress may influence emotional behaviour, cognition, and decision-making. In addition, the brain regions responsible for decision-making are sensitive to stress-induced changes. Thus, chronic stress may disrupt the ability to cognitively regulate choices.

On contrary, neuromodulation strategies can successfully increase neural activity in prefrontal-parietal regions, which will help in increasing cognitive reappraisal capacities. Among the different neuromodulation techniques, neurofeedback (NFB) is certainly the less invasive approach, although further research is warranted to fully develop its anticipated possibilities in intervention contexts. Functional magnetic resonance imaging (fMRI)-neurofeedback (NFB) is a non-invasive approach which allows real-time monitoring and self-regulation of regional brain activity. However, it lacks generalizability to ecological contexts, and the costs of such an intervention prevent its wide use. Electroencephalography (EEG)-NFB, by contrast, overcomes these limitations, but lacks the regional resolution of fMRI.

In this work we intended to explore the effects of chronic stress on cognitive regulation of decision making and to develop a neurofunctional intervention protocol using fMRI-EEG-NFB to regulate the levels of stress.

Aims

1. To study the impact of chronic stress on cognitive regulation of decisions using an fMRI task.
2. To develop a neurofunctional intervention protocol based on the combined use of fMRI- and EEG-NFB for increasing cognitive reappraisal capacities in subjects with different levels of perceived stress.

Method

Task 1

We used a fMRI task where fourteen control and fifteen chronically stressed students had to cognitively upregulate or downregulate their craving before placing a bid to obtain food. The task consisted of two parts: a pre-scan rating task that provided us with a measure of the baseline value for food, and an in-scan bidding and regulation task that measured the food value under the influence of regulation. Subjects also filled the Perceived Stress Scale (PSS), the Beck Anxiety Inventory (BAI) and the Beck Depression Inventory (BDI).

Task 2

The protocol consists of a combined fMRI (Siemens 3T) and EEG (Brain Vision BrainAmp MR 64 channels) acquisition, including a resting state; a localizer cognitive reappraisal task; NFB runs; and another resting-state. During the cognitive reappraisal task, images are shown for the conditions ‘observe’ (neutral images), ‘experience’ (negative images letting their feelings flow),

and 'regulate' (negative images to be regulated). During the NFB runs, when they successfully regulate their emotions (increasing prefronto-parietal network activation), the image slowly disappears. Subjects also filled the PSS.

Results

Task 1

The stress group revealed higher levels of perceived stress. No statistically significant differences were found for BAI and BDI between groups. Stressed participants placed lower bids to get the reward and chose less frequently higher bid values for food. Nevertheless, we did not find neural and behavioral differences during cognitive regulation of craving. We found a main effect of the cognitive regulation condition in the left hemisphere in the superior (Brodmann area 22) and middle temporal gyrus (Brodmann area 21), the rolandic operculum, and the precentral gyrus (Brodmann area 6).

Task 2

After NFB training we found increased functional connectivity within the salience network (middle/inferior frontal and precentral gyrus). These connectivity values were negatively correlated with the effort self-reported during NFB (Spearman $r = -0.834$, $p = 0.008$). PSS scores ranged between 11 and 29 (N=16).

Conclusions

Our results revealed that chronic stress impacts decision-making after cognitive regulation of craving by reducing the valuation of food rewards but not cognitive modulation itself. We also described a technique to successfully regulate cognitive stress appraisal.

Keywords

Cognitive regulation, Neurofeedback, EEG-fingerprint, Stress, fMRI

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