Cognitive emotion regulation supresses learning effects of negative emotions

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Introduction:

Cognitive emotion regulation (CER) is a powerful way of modulating emotional responses at both the behavioural and brain level, shown to attenuate activity in the amygdala and insula[3,5,7]. CER even modulates brain responses to learned cues predicting emotional stimuli in the striatum, amygdala and medial PFC[1,2,6,8]. However, the effects of CER on adaptive or learning related processes in a negative emotional context are poorly understood.

Methods:

We combined classical aversive conditioning with varying contingencies and model-based functional MRI (fMRI).

On each trial, a neutral or a fearful face (CS) was presented, after which an aversive picture (US) followed on a proportion of trials. The participants' task was to predict the occurrence of the US after seeing a particular CS. The contingency between CS and US varied throughout the experiment, forcing participants to adapt their predictions (Fig. 1A).

Cognitive emotion regulation (CER) by self-distancing was employed in half of the experiment, with participants trying to regulate their reactions to the negative photos, as well as the expectation of negative photos (otherwise participants were instructed to passively observe the stimuli). Conditioning was modelled by the prediction error-based Rescorla-Wagner model, resulting in learning parameters of aversive prediction (P) and aversive prediction error (PE).

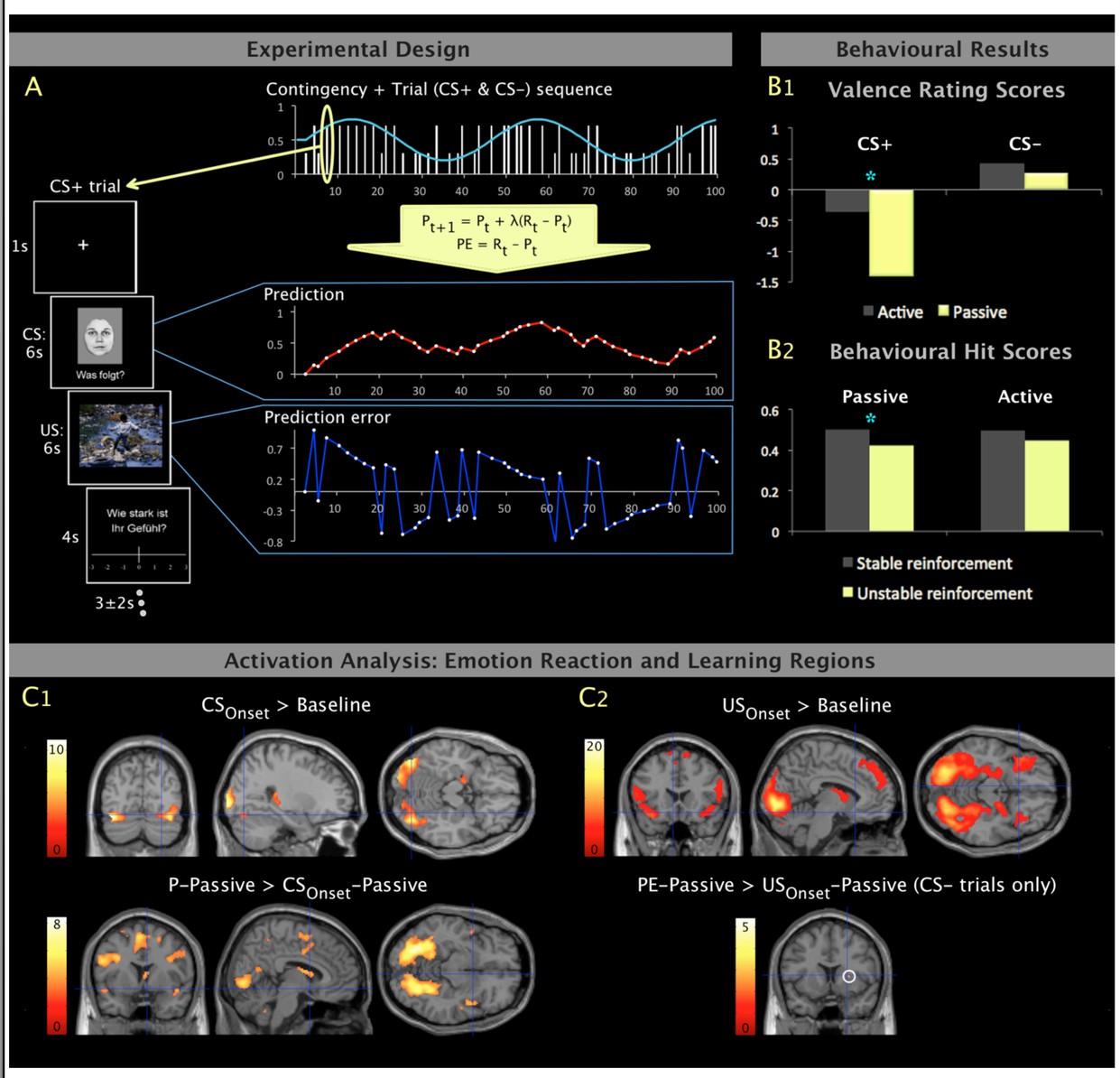

Figure 1: A) Experimental design. **B)** Behavioural results (*$p < 0.05$). **B1:** Valence rating scores were affected by CER. **B2:** Learning was more pronounced without CER. **C)** Basic activation analysis ($p < 0.001$, cluster corr.). **C1:** Brain regions activated by CS-onset (top) and regions showing P-related activity (bottom). **C2:** Brain regions activated by US-onset (top) and ROI analysis showing PE-related activity in the striatum (bottom).

Results:

① Emotion regulation by self-distancing reduced P- and PE-related activity in the striatum, insula, OFC and amygdala (Fig. 2A, 2B).

② Self-distancing enhanced learning-related functional connectivity in the critical areas (Fig. 2C).

③ Sources of CER were identified in the DLPFC, DMPFC and VLPFC (Fig. 2C).

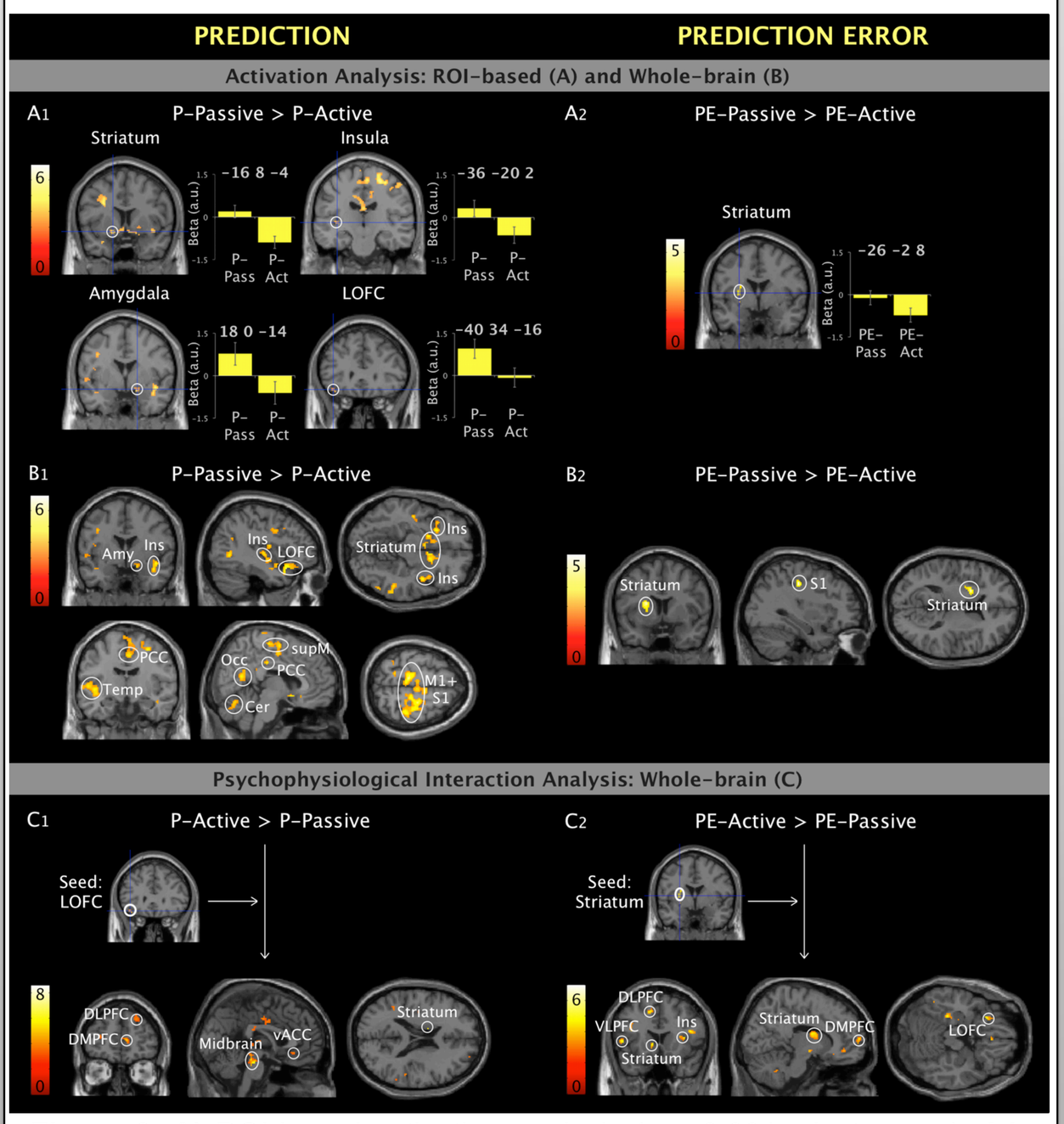

Figure 2: A) ROI-based activation analysis ($p < 0.001$, cluster corr). **A1:** CER reduced P-related activity in the striatum, insula, amygdala and OFC. **A2:** CER reduced PE-related activity in the striatum. **B)** Whole-brain activation analysis ($p < 0.001$, cluster corr). **B1**: Reduction of P-related activity due to CER was wide-spread, additionally including S1, M1, PCC and cerebellum. **B2:** Reduction of PE-related activity due to CER occurred in the striatum and S1. **C)** gPPI analysis ($p < 0.005$, uncorr.). **C1:** CER enhanced covariance in P-related activity between left LOFC (seed region) and DMPFC, DLPFC, ventral ACC, dorsal striatum, and midbrain. **C2:** CER enhanced covariance in PE-related activity between left striatum (seed) and DMPFC, DLPFC, VLPFC, LOFC, insula and dorsal striatum.

Conclusion:

The findings suggest that cognitive emotion regulation reduces the adaptive effects of negative emotions on the brain, or in other words enables a person to remain unchanged by aversive events.

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