Cognitive emotion regulation enhances aversive prediction error activity while reducing emotional responses.

Abstract:
Cognitive emotion regulation is a powerful way of modulating emotional responses. However, despite the vital role of emotions in learning, it is unknown whether the effect of cognitive emotion regulation also extends to the modulation of learning. Computational models indicate prediction error activity, typically observed in the striatum and ventral tegmental area, as a critical neural mechanism involved in associative learning. We used model-based fMRI during aversive conditioning with and without cognitive emotion regulation to test the hypothesis that emotion regulation would affect prediction error-related neural activity in the striatum and ventral tegmental area, reflecting an emotion regulation-related modulation of learning. Our results show that cognitive emotion regulation reduced emotion-related brain activity, but increased prediction error-related activity in a network involving ventral tegmental area, hippocampus, insula and ventral striatum. While the reduction of response activity was related to behavioral measures of emotion regulation success, the enhancement of prediction error-related neural activity was related to learning performance. Furthermore, functional connectivity between the ventral tegmental area and ventrolateral prefrontal cortex, an
area involved in regulation, was specifically increased during emotion regulation and likewise related to learning performance. Our data, therefore, provide first-time evidence that beyond reducing emotional responses, cognitive emotion regulation affects learning by enhancing prediction error-related activity, potentially via tegmental dopaminergic pathways.