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Neural Substrates of the Interaction Between Negative Emotion and Motor Inhibition: an fMRI Emotional Go/No-Go Study

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Emotion & Motivation

Abstract

Neural substrates of motor inhibition have been probed in a variety of animal, neurobehavioral (1), neurophysiological, and functional neuroimaging studies (2), most of which have emphasized the role of prefrontal circuits. Likewise, the neurocircuitry of emotion has been investigated from a variety of perspectives (3). Only recently have investigators begun to study the interaction between emotion and behavior/cognition with neuropsychological probes (4, 5, 6). We developed a linguistic emotional Go/No-Go fMRI task to investigate the neurocircuitry underlying the interaction between emotion and motor inhibition. We hypothesized changes in the activity of anterior limbic and frontal regions reflecting the modulation, and possible impairment, of inhibition under conditions of negative emotion.

Fifteen normal healthy volunteers were studied with a block design linguistic emotional Go/No-Go task in conjunction with fMRI. The task incorporated matched sets of visually-presented negative, neutral, and positive valenced words requiring a button-press or its inhibition (i.e. Go or No-Go; 37.5% No-Go trials within No-Go blocks) in response to orthographically-based cues. Image acquisition was performed using GE 3T gradient EPI BOLD fMRI (TE 30ms, TR 1.2ms, 15 5mm slices). Image processing and analysis (linear mixed effects model) were performed with SPM99. Behavioral (e.g. response time, accuracy) and cognitive (e.g. memory) assays also were performed. Recognition data were analyzed with Wilcoxon rank-sum (one-tail) testing.

Behavioral results indicated successful induction of inhibitory tone during no-go blocks, greater recognition rates for emotional words, and high accuracy rates across all conditions.

Interaction of the effect of negative versus neutral valence upon response (NoGovGo) demonstrated activations in bilateral amygdala, left primary sensorimotor, bilateral primary visual cortex ($p<0.01$), left>right visual association areas (lateral occipital, inferior temporal, fusiform), left striatum, and left ventral anterior cingulate ($p<0.05$). Another interaction analysis comparing negative with neutral+positive valence revealed similar regions of activation.

The effect of negative versus neutral valence in the context of inhibition (NegNoGovNeuNoGo) demonstrated activations in left amygdala, left primary sensorimotor, and left>right OFC ($p>0.01$).

The effect of inhibition in the context of negative valence (NegNoGovNegGo) revealed activations in right amygdala, bilateral primary visual cortex, left>right visual association areas (lateral occipital, inferior temporal, fusiform), left ventral anterior cingulate, left medial OFC, bilateral DLPFC, right striatum, left premotor, and left primary sensorimotor ($p<0.01$).

These preliminary findings of increased limbic and motor activity in the context of inhibition and negative emotion support the hypothesized interaction between negative emotion and inhibitory control. Despite activations in inhibitory prefrontal regions, there is a relative failure of inhibition (i.e. increased primary motor activity) under negative emotional conditions. More amygdalar activity is seen in the combined setting of negative valence and inhibition than in either the negative valence or inhibition conditions alone. The increased activity of visual cortices in this interaction state may reflect an enhanced response by perceptual systems for processing such salient stimuli under these conditions.

References

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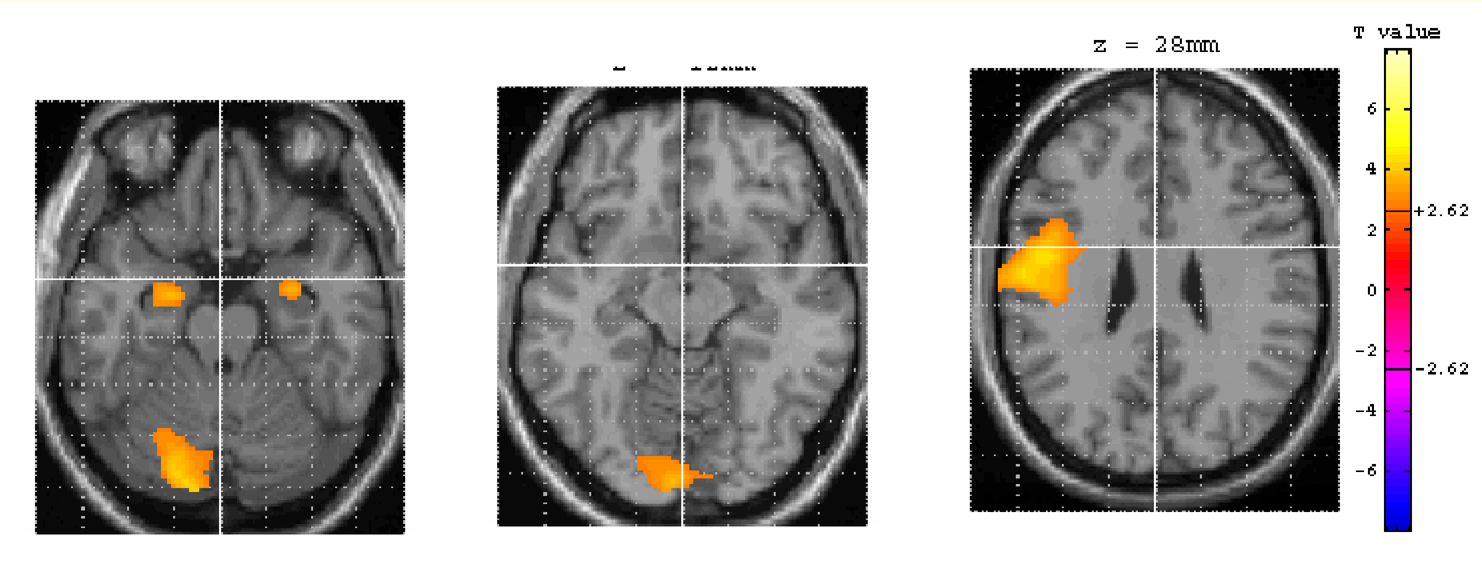

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