Paying Attention When it Counts: The Effect of Motivation on fMRI Activity During Attentional Control

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Introduction

Attentional control is the goal-driven allocation of attention to task-appropriate stimuli and responses, and away from distractions. Motivation is the ability to anticipate and appreciate the consequences of behavior, such as rewards or punishments. We examined interactions between neurobiological systems underlying motivation and attentional control using a Rewarded Counting Stoop task during an fMRI scan.

Experimental Design

Subjects made a button press response indicating the number of lines of text presented. The content of the text could be neutral, number words congruent with the number of lines of text, or number words incongruent with the number of lines of text. Stimulus duration was 200msec, with and interstimulus interval randomly jittered from 2-5 seconds. Subjects were notified at each block start that performance would (Reward Condition) or would not (No Reward Condition) be rewarded (25 cents per correct response within 500msec, indicated at the end of each Reward block).

fMRI Methods

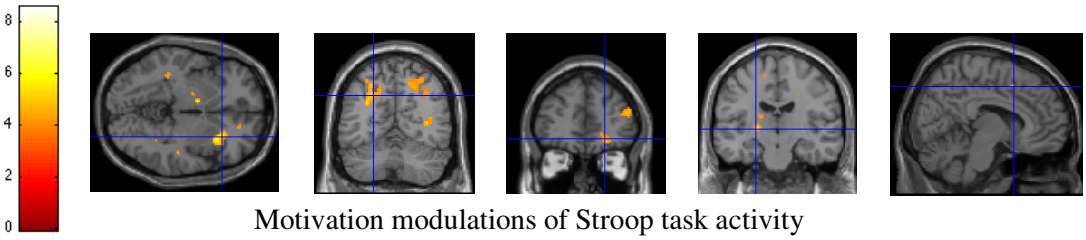
Fourteen subjects participated in this study. All were right handed, neurologically normal, aged 18-40, with normal or corrected-to-normal vision. BOLD fMRI activity was recorded with a 3T Siemens Tims Trio Scanner using an Echo-Planer (EPI) sequence (TR=2270ms, TE=30ms, flip angle=90, matrix=64x64, 33 slices, 3mm thickness). The stimuli were presented with E Prime software on an MR-compatible LCD display at the rear of the scanner. Subjects made finger-press responses using a fiber-optic button pad.

Statistical Analysis

Data processing and analysis were preformed using Statistical Parametric Mapping (SPM5) software. Data were submitted to realignment (to correct for movement errors), slice timing adjustment, non-linear spatial normalization, and spatial smoothing (isotropic Gaussian kernal, FWHM = 8mm). Each stimulus event in each condition was convolved with a reference hemodynamic response function, and these covariates were entered into a general linear model (GLM).

Results

Relative to the No Reward condition, Stroop task performance in the Reward condition was associated with greater activation of striatum, thalamus, insula, orbitofrontal cortex, right dorsolateral prefrontal cortex and the intraparietal sulcus area. During Incongruent trials, greater activity occurred in anterior cingulate cortex and orbitofrontal cortex in the Reward than the No Reward condition. During Congruent trials, there was greater activity in the pre-supplementary motor area in the Reward than the No Reward condition.



Motivation modulations of Stroop task activity

Conclusion

These results suggest that motivation modulates attentional control via increased activity in orbitofrontal and anterior cingulate cortex, as well as increasing arousal and sustained attention by increasing activity in thalamus and right dorsolateral prefrontal cortex.