COGNITION (OTHER)

Anterior cingulate activation is sensitive to response probability but not response inhibition

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Introduction:

In previous work, we have suggested that the anterior cingulate cortex (ACC) plays a critical role in cognitive control, by monitoring for the presence of conflict between mutually exclusive responses or overlapping processing pathways [1]. This hypothesis has been supported by a number of different neuroimaging findings [2,3,4]. In the current study, we examine ACC activity during performance of a go/no-go response inhibition task. Two factors were manipulated: 1) the probability of go vs. no-go trials; and 2) the type of response made on no-go trials (suppress response vs. alternate response). Rapid event-related imaging methods were used to separately examine ACC activation on go vs. no-go trials. We predicted that the ACC response would be strongest on no-go trials when these occurred with low probability, as this condition should be associated with the highest degree of response conflict.

Methods:

Fourteen subjects performed variants of a go/no-go task that was found to elicit ACC activity in a previous study [5]. Participants monitored visual single letters presented sequentially at a rapid rate (250 msec duration; 1000 ms ISI). The letter "X" served as the no-go stimulus. A factorial design was used with 3 levels of no-go trial (vs. go trial) probability (low=17%; med = 50%; high = 83%) and two levels of no-go response (suppress vs. alternate). For all go trials, subjects pressed a button with the index finger of their right hand. Responses were to be withheld on no-go trials in the suppress condition, as is standard in go/no-go tasks. However, for no-go trials in the alternate condition, subjects pressed a different button with the middle finger of their right hand. Each task condition was performed in a scanning run consisting of 150 task trials, and began and ended with subjects fixating a central cross-hair for 35 sec (total run duration = 4.3 min). Two runs of each condition were performed (300 trials/condition total).

Images were acquired with a 1.5T Siemens Vision whole body scanner. Functional images were acquired using an asymmetric spin-echo echo-planar sequence (TR=2500 ms, TE= 50 ms, flip = 90°). During each scanning run 103 sets of 16 contiguous, 8 mm thick axial images were acquired parallel to the anterior-posterior commissure plane (3.75 x 3.75 mm in-plane resolution). The functional imaging data were movement corrected, normalized, smoothed (using an 8mm FWHM Gaussian filter), and transformed into Tailarach atlas space. A region-of-interest in the ACC was identified by pooling all task conditions together and comparing against fixation using a between-subjects t-test. Rapid event-related methods were then applied to selectively average activity in this region on go vs. no-go trials, to yield 17.5 sec (8 scan) estimates of the event-related hemodynamic response. Following selective averaging, a 4-factor random effects ANOVA was conducted on the ACC activation, with trial type (go vs. no-go), probability (low, med, high), response type (suppress vs. alternate), and scan (1-7) as factors.

Results:

A 3-way interaction between trial type, probability, and scan was observed in the ACC region. This interaction was due to the fact that ACC activity on go vs. no-go trials showed a strong sensitivity to the no-go probability (see Figure 1). In the low probability no-go condition, an ACC response was observed to no-go trials but not to go trials. However, in the high probability no-go condition, the pattern was reversed, with a stronger ACC response occurring to go trials (which were low probability) compared to no-go trials. This pattern was present in the alternate condition as well as the suppress condition, suggesting that the ACC response is not solely influenced by the response inhibition requirements of the go/no-go task. This pattern of results is fully consistent with the predictions of conflict monitoring theory [1], in that the ACC response is strongest on trials associated with high conflict regardless of trial type (go vs. no-go) or response requirements (suppress vs. alternate response).

References

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