Abstract

The role of prefrontal cortex and the anterior cingulate in resolving conflict has been a topic of great current interest. In order to understand the time course of these activations we used a version of the flanker task in a high-density ERP study. We found that activity of a generator in the medial frontal (ACC) areas, which was active in our previous fMRI study, responded differently to incongruent compared to congruent trials at about 250-450 ms after input. Analysis of differences between correct and error trials suggested that there is an error-related negativity which peaks very close to the response. The midline electrodes. Dipole analysis suggested that lateral and medial areas worked together to monitor conflict.

Methods

Participants

Eight right-handed normal adults (mean age = 30.3 years, SD = 6.7, range 20-36 years; 5 female, 3 male) participated this study. They were scanned in either an 1.5T or an 3.0T MRI scanner in a previous study while they carried out the flanker task.

Flanker task

Stimuli consisted of a row of 5 visually presented horizontal black lines, with arrowheads pointing leftward or rightward, against a grey background. The target was a leftward or rightward arrowhead at the center. This target was flanked on either side by two arrow heads in the same direction (congruent condition), or in the opposite direction (incongruent condition). Participants were instructed to respond with the left button if the central arrow pointed left and the right button if the central arrow pointed right.

Acquisition of EEG data

The EEG was recorded from 128 scalp sites using the 128 channel Geodesic Sensor Net (Tucker, 1995). All recordings were referenced to Cz. EEG was recorded using a 0.1 - 100 Hz bandpass. The data were re-referenced to an average of all channels and grand average ERP for all 8 subjects was computed.

ERP Results

Figure 4-5 show the stimulus-locked ERP for the four categories: congruent, congruent error, incongruent error, and the difference between correct incongruent and congruent. Figure 6-7 show the response-locked ERP and ERN.

Discussion

We examined midline electrodes to determine the earliest time when the incongruent area responded differently to the incongruent and congruent trials. We found that the congruent responded differently to incongruent compared to congruent trials at about 250-450 ms after input and showed a peak difference at about 380 ms or about 70-120 ms prior to the response. Dipole analysis was consistent with the activation found in the fMRI study.

In a recent article Van Veen and Carter (in press) used a different flanker task to examine ACC activation during conflict and the error related negativity. They also found that incongruent and congruent trials diverged over midline electrode sites at about 380 ms. In their experiment this was during a negative wave (N2). Our localization and time course is similar but in our results the departures come during a positive deflection.

In our data analysis of differences between correct and error trials suggested that there is an error-related negativity which peaks very close to the response in the midline electrodes. Dipole analysis suggested that the generator was similar to that found active in comparison of incongruent and congruent trials. These effects were also quite similar to those reported by Van Veen & Carter.

Overall our results show a single generator in the ACC, but provide only weak support for any independent generator in the lateral frontal cortex. If there is a single lateral frontal cortex, as was found in our previous fMRI result, we cannot reject the hypothesis that its time course is the same as the ACC.

In our previous work (Fan, submitted) we reasoned that if the two brain areas found active in relation to conflict were involved in suppressing conflict we would expect that the need to suppress two different sources of conflict in the same task would cause considerable interference. However based on previous results in perceptual studies (Duncan, 1980) we reasoned that if the areas were only monitoring conflict there would be little specific interference between different computations performed by this network, and thus we tentatively suggested that the network as a whole (both lateral and medial areas) serves to monitor conflict. The inhibitory operations that suppress conflict may then be in a different area specific for each conflict task.

References


Neurophysiology, 87

Supported by NSF grant BCS 9907831, NIMH grant P50 HD25802-13, and by a DeWitt Wallace-Reader’s Digest Research Fellowship in Psychiatry. The authors would like to thank members of Sackler Institute for their help.

Acknowledgement

Prepared by TFP (joint ICS-KMC). JMC (joint AHRQ, UCLA, EMDF) and a Sackler-Walker-Reader’s (Opiate Research Fellowship in Psychiatry). The authors would like to thank members of Sackler Institute for their help.

Poster request: Please leave your email address here or email to Jin Fan: jf2014@med.cornell.edu.