NeuroImage 11, Number 5, 2000, Part 2 of 2 Parts IDEAL®

LANGUAGE

Cortical activation during a semantic priming lexical decision task as revealed by event-related fMRI

W. Caroline West*, Anders M. Dale†, Doug Greve†, Gina Kuperberg*, Gloria Waters‡, David Caplan*

**Neuropsychology Lab, Department of Neurology, Massachusetts General Hospital*

†Massachusetts General Hospital-NMR Center

‡Department of Communication Disorders, Boston University

Previous studies using event-related brain potentials (ERPs) have shown an increase in the amplitude of the N400 component in response to words or pseudowords preceded by unrelated prime words than to words preceded by semantically related prime words (e.g., Holcomb, 1988). We report here an fMRI study aimed at identifying the cortical regions underlying this effect. More generally, the goal of this study was to localize the neuroanatomical substrates of semantic information processing.

Methods

Echo-planar functional images (24 slices, 3.125 mm in-plane resolution, 4 mm thickness, skip 1 mm) were collected on a GE 3T scanner using a T2*-weighted gradient echo sequence (TE = 30 ms, TR = 3s, flip angle = 90) while 6 subjects performed a semantic priming lexical-decision task. Subjects saw 120 related prime-target pairs (e.g., *chair-table*), 120 unrelated pairs (e.g., *chair-nurse*), 120 pseudoword pairs (e.g., *chair-flark*), and 120 fixation trials. The prime was always a legal English word. Related and unrelated word pairs were counterbalanced across subjects. Trials in the four conditions were presented over 6 runs and in pseudorandom order. Each prime-target trial began with a fixation cross presented at the center of the screen for 250 ms. After 50 ms, the prime appeared at the same location for a duration of 500 ms. Then after a 300 ms blank screen (800 ms SOA), the target word appeared for a duration of 500 ms. After the target, there was a blank screen for 1400 ms until the start of the next trial. Subjects read both the prime and target of each pair and decided if the target was a real English word or not. They were told to respond as quickly and as accurately as they could by pressing buttons on a response box with their left hand. The finger used for each response was counterbalanced across subjects. For each subject, the selectively averaged hemodynamic activity was mapped onto the cortical surface, which was reconstructed from high-resolution T1-weighted SPGR scans and inflated using the procedures described by Dale, Fischl, and Sereno (1999). Inter-subject averaging was accomplished using the spherical surface-based coordinate system and morphing procedures developed by Fischl, Sereno, and Dale (1999).

Results

Greater activation was found for unrelated pairs compared to related pairs primarily in regions of the left inferior frontal gyrus, including Broca's area. Pseudoword pairs were also associated with greater activation than related pairs. However, the localization of this activation had a more posterior focus than that of unrelated pairs, with less activation in ventral inferior frontal regions and more activation in premotor cortex. Pseudowords were also associated with greater right hemisphere activity.

Conclusions

This study demonstrates a decrease in fMRI BOLD signal, primarily in the inferior frontal gyrus, with semantic priming. It also suggests a different pattern of cortical regions involved in the processing of pseudowords (or unknown words) than that involved in processing known words. These data also provide evidence that the scalp-recorded N400 may have several cortical generators.

References

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Supported by NRSA, NIH