SUPPRESSION OF IRRELEVANT MEANINGS OF HOMOGRAPHS

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Purpose

Identify the neural regions activated in suppressing irrelevant meanings of homographs using event-related fMRI.

Background

• Behavioral evidence suggests that multiple meanings of homographs are often initially activated, even when the homographs appear in sentences that strongly imply only one meaning (e.g., *He dug with the spade*).
• Gernsbacher (1997) suggests that successful comprehension involves suppressing inappropriate meanings.

Behavioral Task

• Participants read sentences that ended in homographs.
• A test word appeared after each sentence at a short (100ms) or long (3100 ms) test interval.
• Participants manually indicated whether test word was related to the meaning of the sentence.

Experimental Stimuli

INAPPROPRIATE Test word related to the inappropriate meaning of the sentence-final homograph:
He dug with the spade. ACE
UNRELATED: Test word unrelated to sentence:
He dug with the shovel. ACE
(Correct answer is "no" to both types of sentences.)

Filler Stimuli

Test word related to the sentence:
He erased the board. CHALK
Test word ambiguously related to the sentence:
He approached the board. CHALK
(Correct answer is "yes" to both types of sentences.)

Previous Findings

• Behaviorally, interference is observed at short test intervals when the test word is inappropriately related to the meaning of the homograph compared to when the test word is unrelated to the homograph. With longer test intervals, this interference dissipates, suggesting suppression of the inappropriate meanings (Gernsbacher, 1997).
• More-skilled comprehenders benefit more from the long test delay; less-skilled comprehenders benefit less because they have been shown to be less skilled at suppression (Gernsbacher & Robertson, 1995).
• Other populations also suffer from this inability: Schizophrenics, children with ADD/ADHD & Alzheimer's patients.

Experimental Design

• 240 sentences, divided equally between 2 types of "no" items and 2 types of "yes" items.
• Experimental items counter-balanced so that across participants each experimental test word served as an immediate-inappropriate, immediate-unrelated, delayed-inappropriate, and delayed-unrelated experimental item.
• Word-by-word presentation at fixed rate based on length.
• Test word appeared for 2500 ms at the end of the sentence after either a short (100 ms) or long (3100 ms) delay.
• 16 right-handed graduate students; 2 males and 2 females assigned to each of the four material sets.

Behavioral Data Results

	Short Interval	Long Interval
Inappropriate	1048 ms - 8 % error	1004 ms - 6 % error
Unrelated	963 ms - 2 % error	980 ms - 3 % error

85 ms interference (p < .001)   interference not significant (F ~ 1.0)

• Scanning Parameters

• Event-related design, variable onset: 3 sec (X) + 1 sec.
• GE 1.5T functional EPI images.
• 23 coronal slices, interleaved acquisition, slice/gap = 7/1mm, TR=3sec, TE = 50 ms, 90º flip, matrix: 64 x 64, FOV 24 cm.
• 196 images for each of 5 scans, first 5 images removed.
• T1-weighted 3D SPGR(256 x 256 x 124).

fMRI Data Analysis

• Post-processing and statistical analysis done with SPM99.
• Data sets slice-timed, motion corrected, coregistered, normalized, and smoothed (FWHM = 8 x 16 x 8mm).
• Fixed-effect statistical analysis (T=3.11, p = .001 uncorrected, k=0) for each subject used in random-effect group analysis (T=3.73, p = .001 uncorrected, k=0).

Comparisons of Interest

fMRI analyses based on cognitive subtraction:

Short Comparison: Inappropriate Test Word at Short Delay - Unrelated Test Word at the Short Delay
Long Comparison: Inappropriate Test Word at Long Delay - Unrelated Test Word at the Long Delay

Short Test Delay
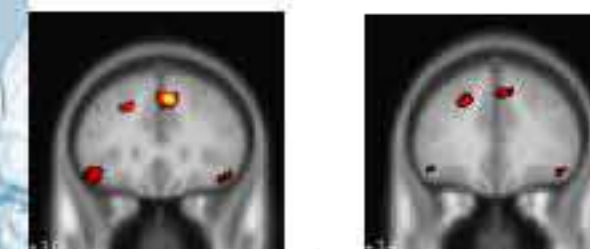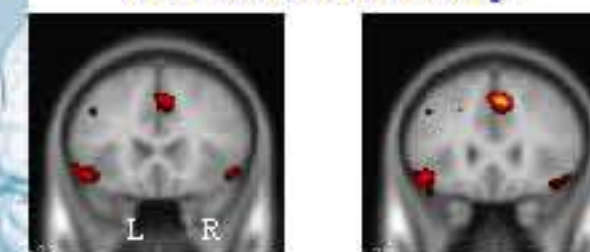
Significant activation shown in the frontal limbic region *(above)*. Significant activation shown in the left supramarginal gyrus *(below)*.

Long Test Delay

Significant activation shown in the right supramarginal gyrus in addition to that shown in the left at the short test delay *(below)*.
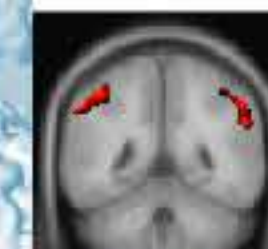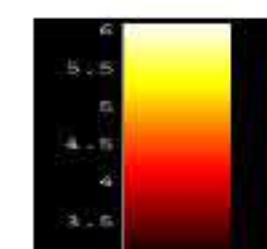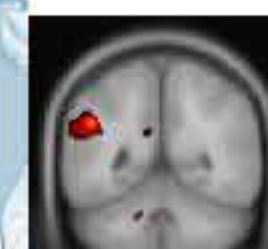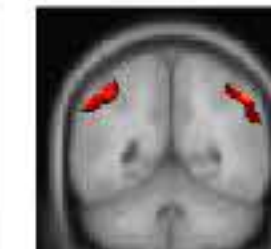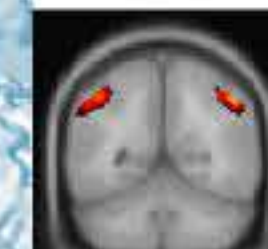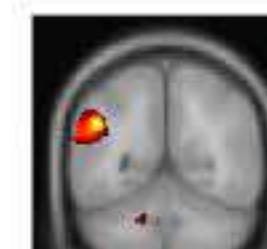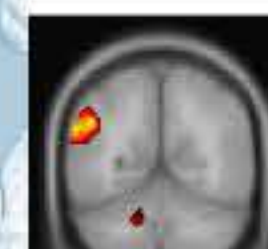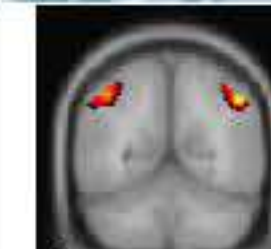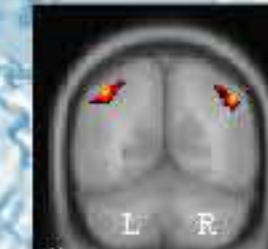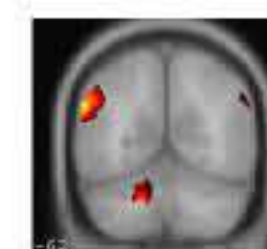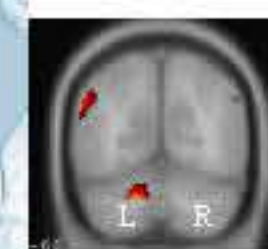
Thresholds greater than T = 3.73 are significant at the p uncorrected cluster level .001