

Identity negative priming involves accessing semantic representations in the left anterior temporal cortex: A 4T fMRI study



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Purpose

Tipper (1985) introduced the classic negative priming (NP) paradigm by presenting participants with two superimposed pictures of familiar objects. A red printed picture denoted the target to be named, while a green printed picture denoted a distractor. Participants were required to name the target picture as quickly as possible while ignoring the accompanying distractor. When a target picture was identical to the distractor on a previous trial, naming responses were slowed compared to responses to novel targets. As the ignored distractor is subsequently presented as the target, the task is often referred to as identity NP.

It is unclear whether classic identity NP arises due to the involvement of abstract semantic representations that the ignored object accesses automatically. Contemporary connectionist models propose a key role for the anterior temporal cortex in the representation of abstract semantic knowledge (e.g., McClelland & Rogers, 2003), suggesting that this region should be involved during performance of the classic identity NP task if it involves semantic access. The present fMRI experiment addresses whether the classic identity NP task (Tipper, 1985) involves accessing semantic representations within the anterior temporal cortex.

Subjects

Thirteen healthy participants (10 males) with a mean age of 25.4 years (SD 6.2) performed the experiments. All were right-handed native English speakers.

Procedure

25 line drawings of common objects were used. The experimental block consisted of 50 trial pairs, repetition ignored (25 in which prime and probe were identical) and control (25 in which prime and probe were unrelated), presented in pseudorandom order such that targets on adjacent trials did not share the same picture name. Participants were first presented with a crosshair for 500 ms, followed by an identical blank period, then superimposed prime target/distractor pictures were presented for 500 ms eliciting a naming response. Next, a pattern mask was presented for 250 ms, followed by a blank interval of 1000 ms. Probe target/distractor pictures were then presented in the same manner. A blank interval of 11 s then ensued, in which a single image volume was acquired. Vocal response latencies were measured from the onset of each probe target/distractor presentation.

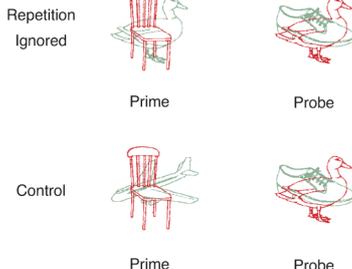


Figure 1. Example prime and probe stimuli from the two conditions of the negative priming task.

Imaging

Participants were imaged with a 4T Bruker Medspec system using a TEM head coil. A gradient echo EPI sequence optimised for both image quality and noise reduction (McMahon et al. 2004) was then used to acquire T2*-weighted images depicting BOLD contrast (64 x 64 matrix; 3.6 x 3.6 mm voxels). In a single session, 52 image volumes of 36 axial 3.5 mm slices (0.1 mm gap) were acquired (effective repetition time, 13.5 s; echo time, 30 ms; flip angle, 60°). The first two volumes were discarded. Behavioural trials were interleaved with image acquisition to capture the estimated peak BOLD signal response to task-related neural activity (Gracco et al., 2005). Image processing and analyses were conducted in SPM2 at both fixed and random effects levels using classical inference.

Results

Participants were slower to respond on trials in which a repeated object had been previously ignored compared to control trials (mean (SD): 862 (76) ms and 831 (74) ms, respectively; paired $t_{(12)} = 4.55$, $p = .001$). Error rates were comparable across conditions (repetition ignored 1.0% and control 1.15%). A comparison of conditions revealed significantly increased activation of the left middle temporal gyrus and temporal pole (peak x, y, z : -54, 0, -18; $Z = 4.4$, $p < .001$, uncorrected). Other peaks were found bilaterally in the supplementary motor area (SMA) corresponding to the supplementary eye fields (SEF) (peak x, y, z : 3, 18, 54; $Z = 3.4$, $p < .001$, uncorrected), and in the medial part of the left inferior parietal lobule (IPL) (peak x, y, z : -30, -51, 30; $Z = 4.3$, $p < .001$, uncorrected). See Figure 2. Bivariate correlation analysis was conducted with the mean percent BOLD signal responses extracted from each participant and the magnitude of their individual NP effect. This revealed a significant positive correlation with left anterior temporal cortex activity during the repetition ignored trials ($r = 0.49$, $p < .05$).

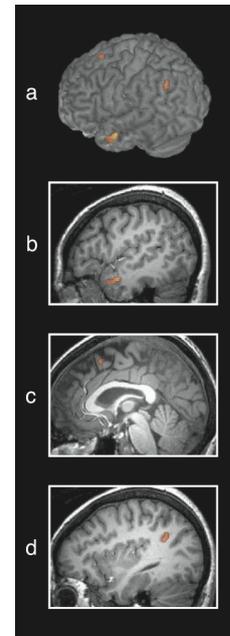


Figure 2. Differences in cortical activity between the repetition ignored and control conditions.

(a) 3D rendering of the increased activations;

Sagittal slices showing:

(b) increased activation in the left anterior temporal cortex

(c) increased activation in the right supplementary eye field (SEF)

(d) increased activation in the left inferior parietal lobule (IPL).

Activations are thresholded at $p = .001$, and shown on a single participant's T1-weighted MRI in atlas space.

Summary

We observed a significant BOLD signal increase in the left anterior temporal cortex that was directly associated with the relatively slowed naming responses during the probe trials in the repetition ignored condition. This result does appear to implicate semantic processing in identity NP. We also found increased responses in two other cerebral regions that have been implicated in object processing, namely the SEF and left IPL. Both regions contain cells that are known to mediate object-centred representations in attention and maintain them in memory. Consequently, our results might implicate both selective attention and episodic retrieval mechanisms in identity NP (Tipper, 2001). However, as we collected BOLD responses only during probe trials, our data cannot address the nature of the initial processes occurring during prime presentation.

References

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