



Left Ventrolateral Prefrontal Cortex Contributions To A Language-based, Object Use Generation Task

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Background & Objectives

- One of the most unique aspects of human cognition is the ability to employ one's knowledge flexibly and rapidly for optimal goal achievement. Such ability for advanced goal-directed behavior has been traditionally linked to the frontal lobes (Heilman et al., 2003).
- The left ventrolateral prefrontal cortex (VLPFC; BA 44/45) has been identified as a region with particular importance regarding the task-relevant activation of semantic memory (Thompson-Schill et al., 2005) and may be recruited in different functional domains, both linguistic and non-linguistic (e.g., Hirshorn & Thompson-Schill, 2006; Kan & Thompson-Schill, 2004).
- Previous research has shown that patients with frontotemporal dementia (FTD) may exhibit decreased creativity/novelty of responses in artistic generation tasks (Hart & Wade, 2006; Finney & Heilman, 2007). In contrast, transcranial magnetic stimulation (TMS) pulses over the left frontotemporal lobe may promote perceptual accuracy in artistic reproduction tasks in healthy subjects (Snyder et al., 2003).
- The present study used a randomized fMRI paradigm to examine the involvement of this PFC region in the generation of usual and unusual goal-oriented categorizations of common objects (e.g., use a shoe as footwear or as a doorstop).

Design & Methods

Participants

- Twenty-four (N = 24) right-handed, native English speakers (mean age = 23.04, 10 males) participated in the fMRI study.

Materials

- A set of 72 black-and-white photographs of everyday objects were used as experimental stimuli and a set of 72 abstract black-and-white images were used as baseline stimuli. Examples of representative stimuli and their presentation duration are presented in Figure 1.

Procedure

- Participants were randomly assigned in one of two conditions. They produced common or uncommon uses for objects (speaking into a fiber optic microphone) while undergoing fMRI in a 3-T scanner (see Figure 1).

Condition 1: Common Uses (n = 12) Condition 2: Uncommon Uses (n = 12)

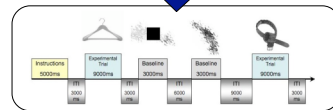
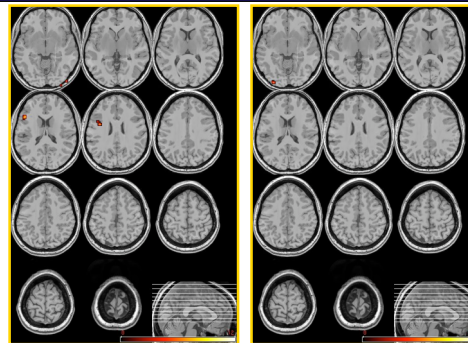


Figure 1. Examples of stimuli and task type by condition

fMRI Results



Common Use > Baseline (n = 12, permuted t > 8.18, p < .05)

Uncommon Use > Baseline (n = 12, permuted t > 8.03, p < .05)

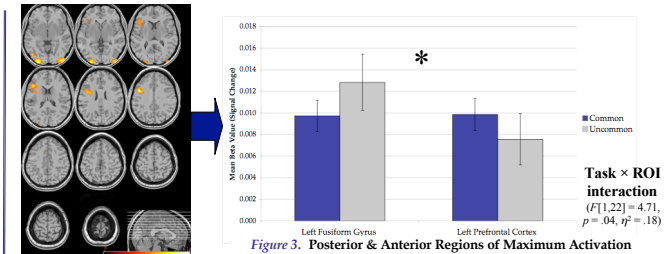


Figure 3. Posterior & Anterior Regions of Maximum Activation

Both Tasks > Baseline (n = 24, permuted t > 5.53, p < .05)

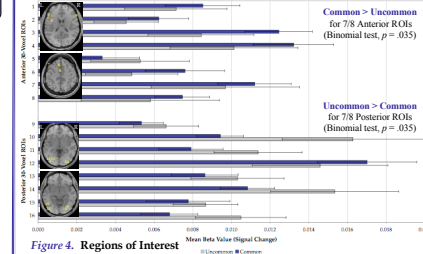
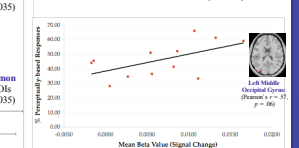


Figure 4. Regions of Interest

Figure 5. Qualitative Analysis of Responses Uncommon Use Task (n = 12)



Correlation with Median score on qualitative measure: Pearson's r = .65, p = .02 *

Summary & Conclusion

- These results suggest that: (1) when searching for an uncommon use for a visually-depicted object, posterior cortical areas involved in high-level visual processes are recruited; and (2) generating an uncommon use for an object does not necessarily recruit PFC systems associated with performance on close-ended tasks.
- These dissociable brain patterns reveal a tradeoff between regions involved in rule-based processing (i.e., prefrontal cortex) and regions involved in object processing (i.e., lateral occipital complex). The results are in favor of a flexible distributed conceptual network that selectively focuses on different aspects of knowledge based on task demands.

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