Differential engagement of dorsal and ventral medial prefrontal cortex in retrieval of recognition and semantic memory

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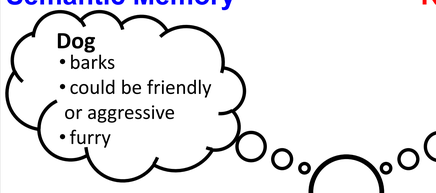
Introduction

- Cognitive neuroscience research studying how semantic and episodic memory are supported by the brain has traditionally focused on either one kind of memory or the other.

Semantic Memory

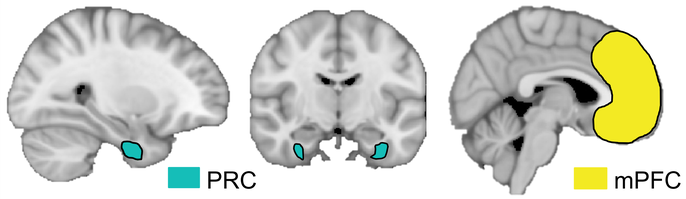


- Knowledge acquired over a lifetime of experience
- Generalizes across category exemplars

Recognition Memory

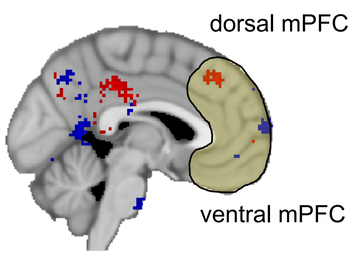
- Recognition of prior occurrence with a specific exemplar
- Does not generalize across exemplars

- Perirhinal cortex (PRC) represents objects and object concepts in a manner that enables item-based semantic memory decisions as well as item-based recognition memory decision [1].
- Prior research has also revealed an overlap in cognitive control mechanisms that support retrieval of both semantic and recognition memory [2].



- **How do we flexibly retrieve item-based semantic OR recognition memories?**

1. Examined the role of PRC in the retrieval of information from semantic and recognition memory by varying task demands across two retrieval contexts (semantic / recognition).
2. Examined whether retrieval of semantically-based and recognition-based item information engages different areas within mPFC.



Neurosynth Meta-analysis [3]
Red: "Recognition Memory"
Blue: "Semantic Memory"

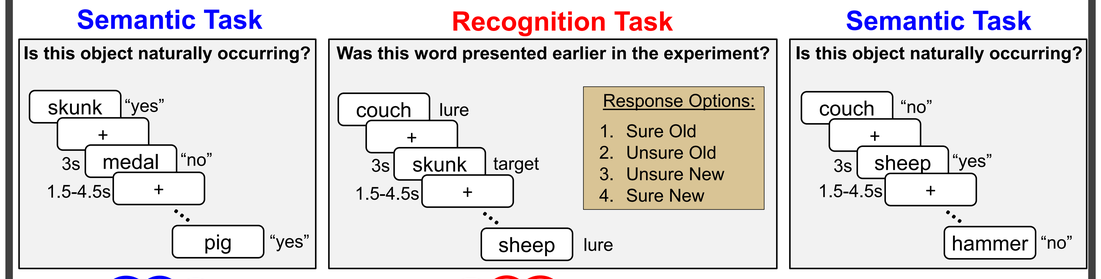
Hypotheses

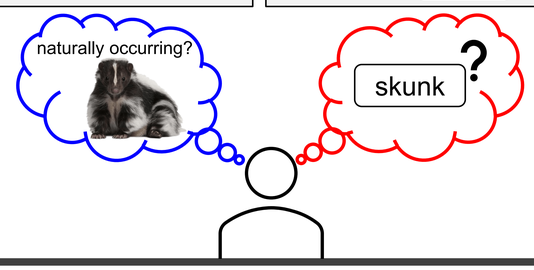
(i) PRC will support retrieval of information that enables semantic and recognition decisions.

(ii) Dorsal mPFC will be more engaged during recognition, Ventral mPFC during semantic.

fMRI Experimental Design

- Each participant (N = 27; M_{age} = 20.04 years, F = 19) completed a mixed block / event-related fMRI task that required either semantic or recognition memory judgements.
- There were eight blocks in total, the first two and last two blocks were completed using semantic retrieval demands, the middle four blocks were completed using recognition retrieval demands.

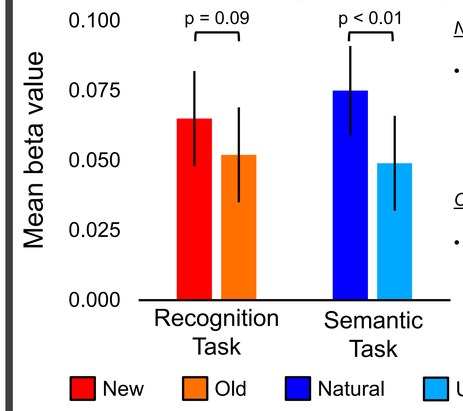




Making a recognition judgement about whether you previously encountered the word skunk does not require the retrieval of semantic information for skunks.

Univariate ROI Analysis

Right PRC Supports Semantic and Recognition Judgements



Natural vs. Unnatural

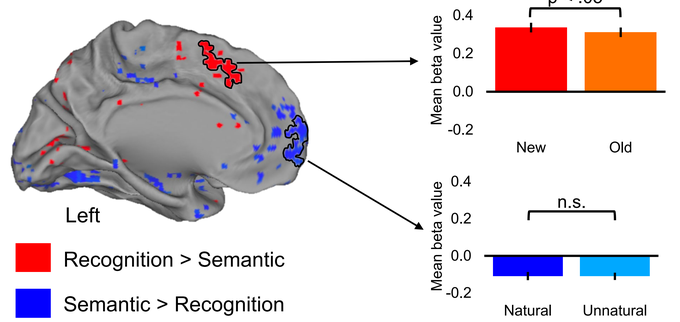
- Mean activity levels in right PRC differentiate between natural and unnatural judgements in the semantic task context.

Objective Old vs. New

- Mean activity levels in right PRC trend toward differentiation of old and new judgements in the recognition task context.

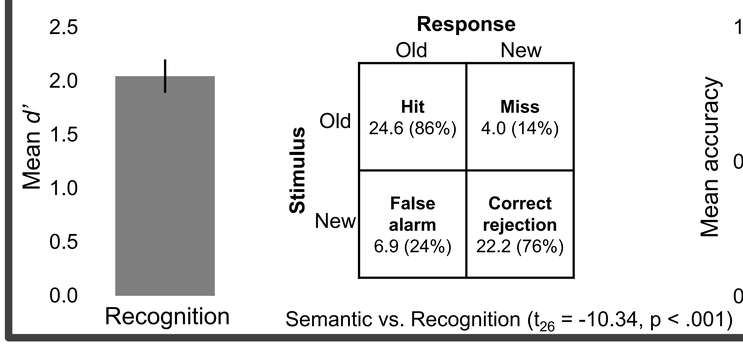
Task-Based fMRI Contrast

Task-Based Contrast Reveals a Ventral-to-Dorsal Division of Activity in mPFC

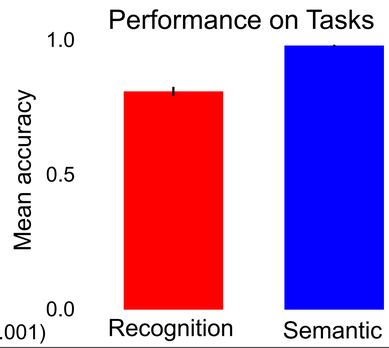


Greater activity in ventral mPFC during retrieval of semantic memory supports the idea that anterior regions in the frontal lobe guide more abstract cognitive control processing [4].

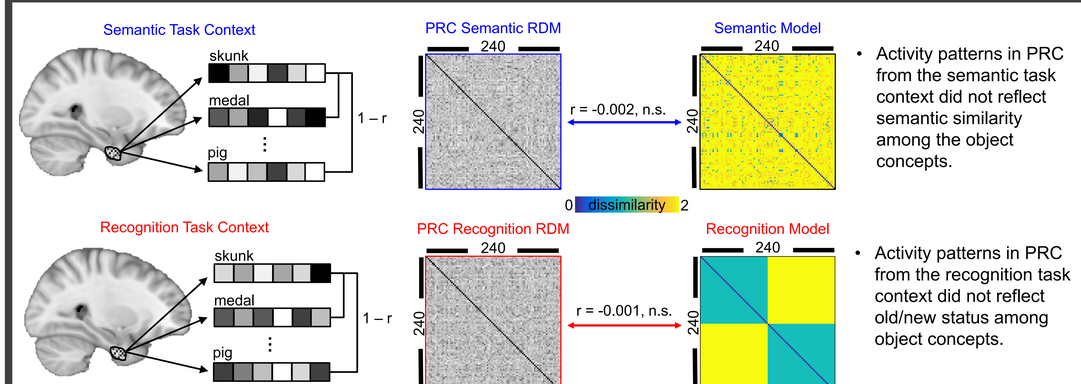
Behavioral Results



Semantic vs. Recognition (t_{26} = -10.34, p < .001)



Representational Similarity Analysis



- Activity patterns in PRC from the semantic task context did not reflect semantic similarity among the object concepts.
- Activity patterns in PRC from the recognition task context did not reflect old/new status among object concepts.

Conclusions

- Recognition memory and semantic memory judgements involve retrieval of fundamentally different kinds of information
- In line with previous research, activity in PRC was related to both semantic and recognition judgements
- We revealed a dorsal-ventral distinction in mPFC, such that dorsal areas were more active during a recognition task and ventral areas were more active during a semantic task
- Functional distinction in mPFC consistent with previous fMRI research that probed *either* recognition or semantic memory
- These data suggest that task-relevant retrieval of object-oriented memory reflects an interaction between systems of representation (PRC) and systems of control (mPFC)

References: 1. Bowles B, et al. 2007. Impaired familiarity with preserved recollection after anterior temporal-lobe resection that spares the hippocampus. *Proc Natl Acad Sci U S A.* 104(41): 16382-16387 **2.** Vatansever, D., Smallwood, J., & Jefferies, E. 2021. Varying demands for cognitive control reveals shared neural processes supporting semantic and episodic memory retrieval. *Nat. Commun*, 12(1), 2134. **3.** Yarkoni, T., et al. 2011. Large-scale automated synthesis of human functional neuroimaging data. *Nat. Methods* 8, 665–670. **4.** Badre, D., & Nee, D. E. (2018). Frontal Cortex and the Hierarchical Control of Behavior. *TiCS*, 22(2), 170–188.