

The neural basis of cognitive control in task-relevant memory retrieval

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Introduction

Semantic Memory

Pancakes

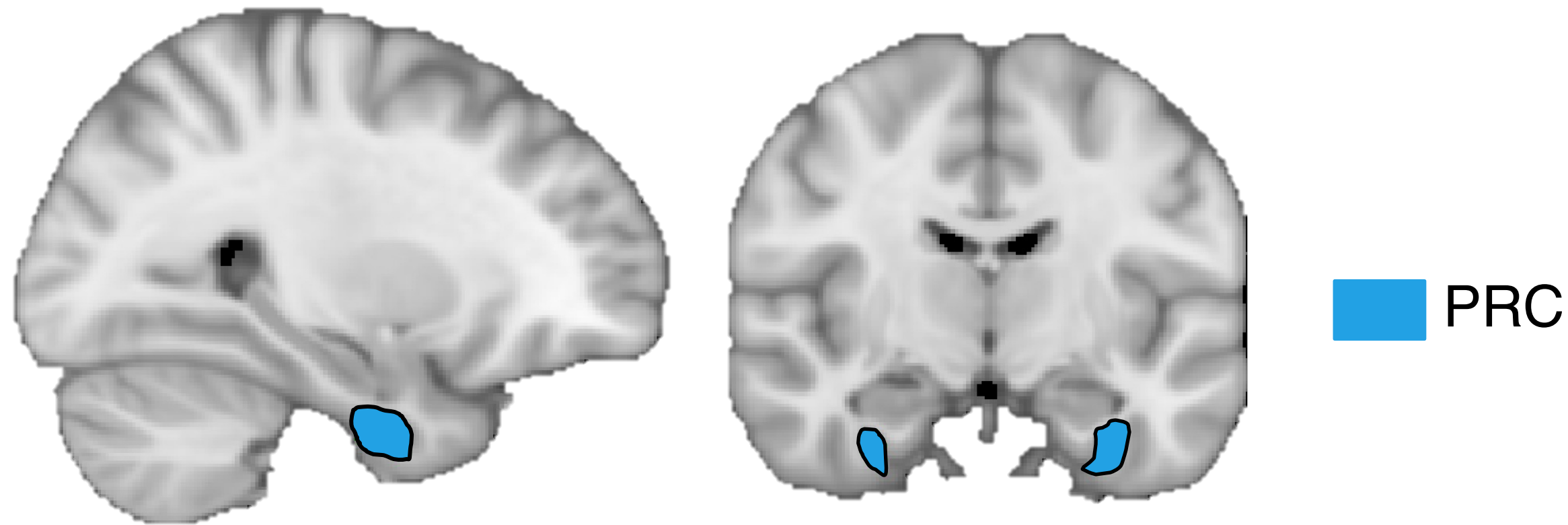
- edible
- breakfast food
- eaten with syrup
- tan colored

conceptual knowledge about the world that is acquired over a lifetime of experiences

Episodic Memory

recollection of specific spatiotemporal and event details of an experience in one's life

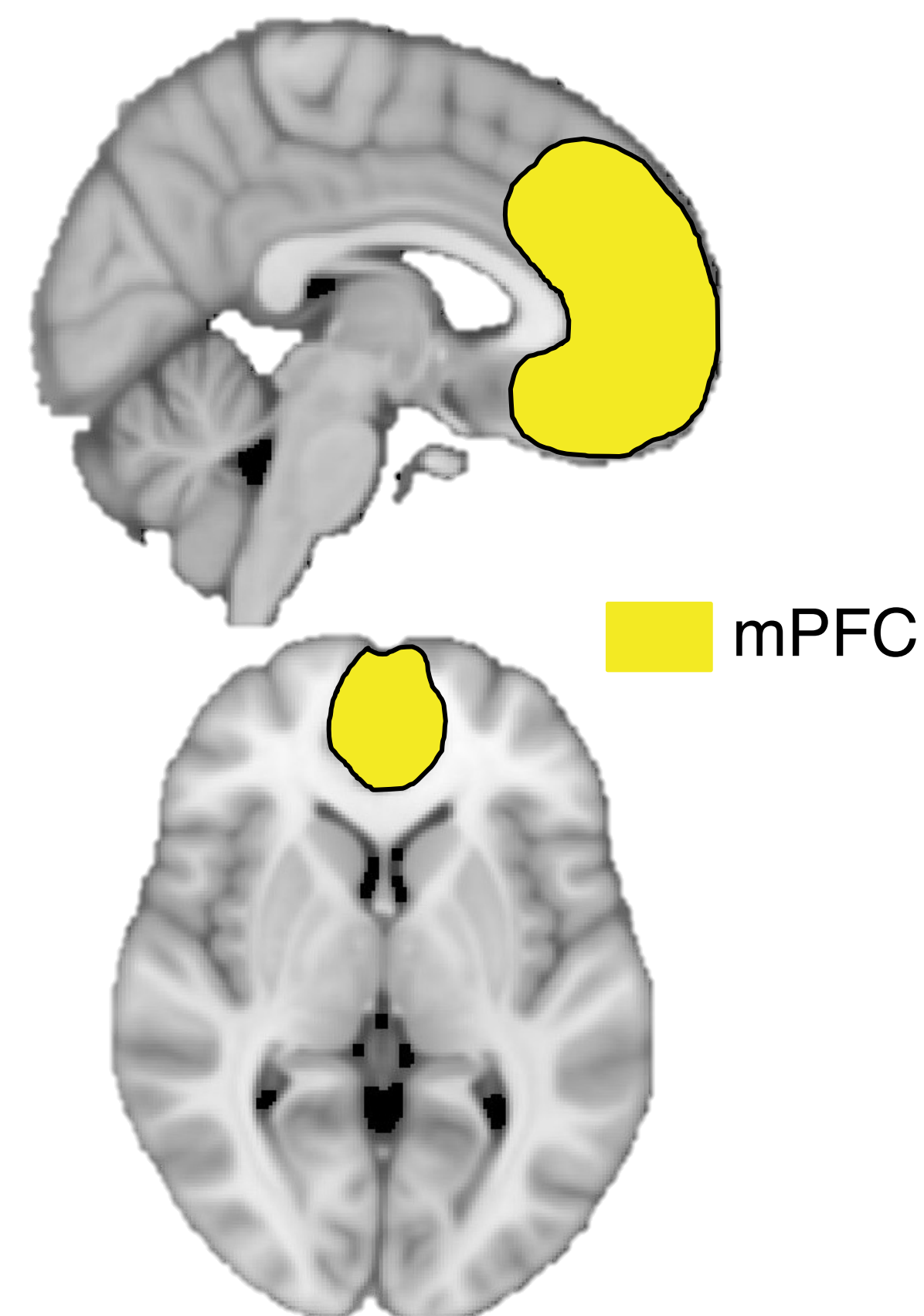
- Cognitive neuroscience research studying how semantic and episodic memory are supported by the brain has traditionally focused on either one system or the other.
- An emerging line of evidence suggests that the perirhinal cortex (PRC) contributes to both of these fundamentally different kinds of memory[1].



- Prior research has also revealed an overlap in cognitive control mechanisms that aid in the retrieval of both semantic and episodic memory[2].

Research Questions

- I. Does the PRC support the retrieval of semantic and episodic information?
- II. Are there shared cognitive control processes during the retrieval of semantic and episodic memory?



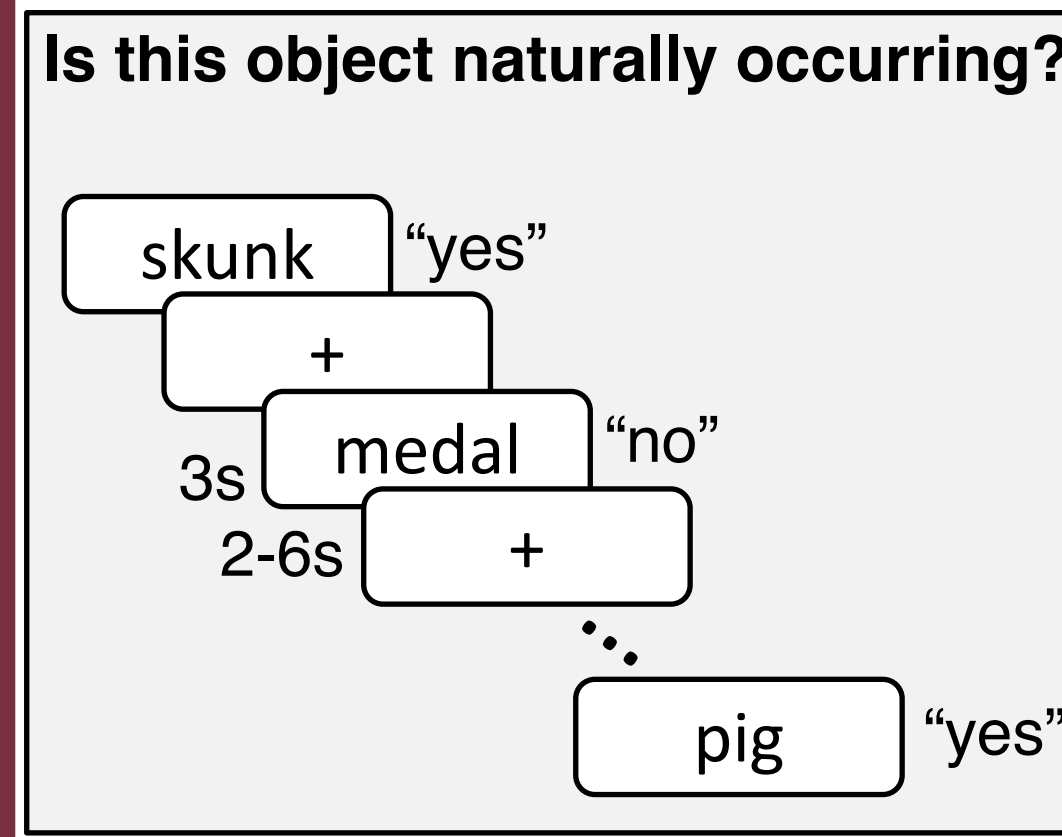
Hypotheses

Information in PRC will be dynamically reshaped to reflect ongoing retrieval demands and these transient changes will be driven by the establishment of an alliance with the medial prefrontal cortex (mPFC).

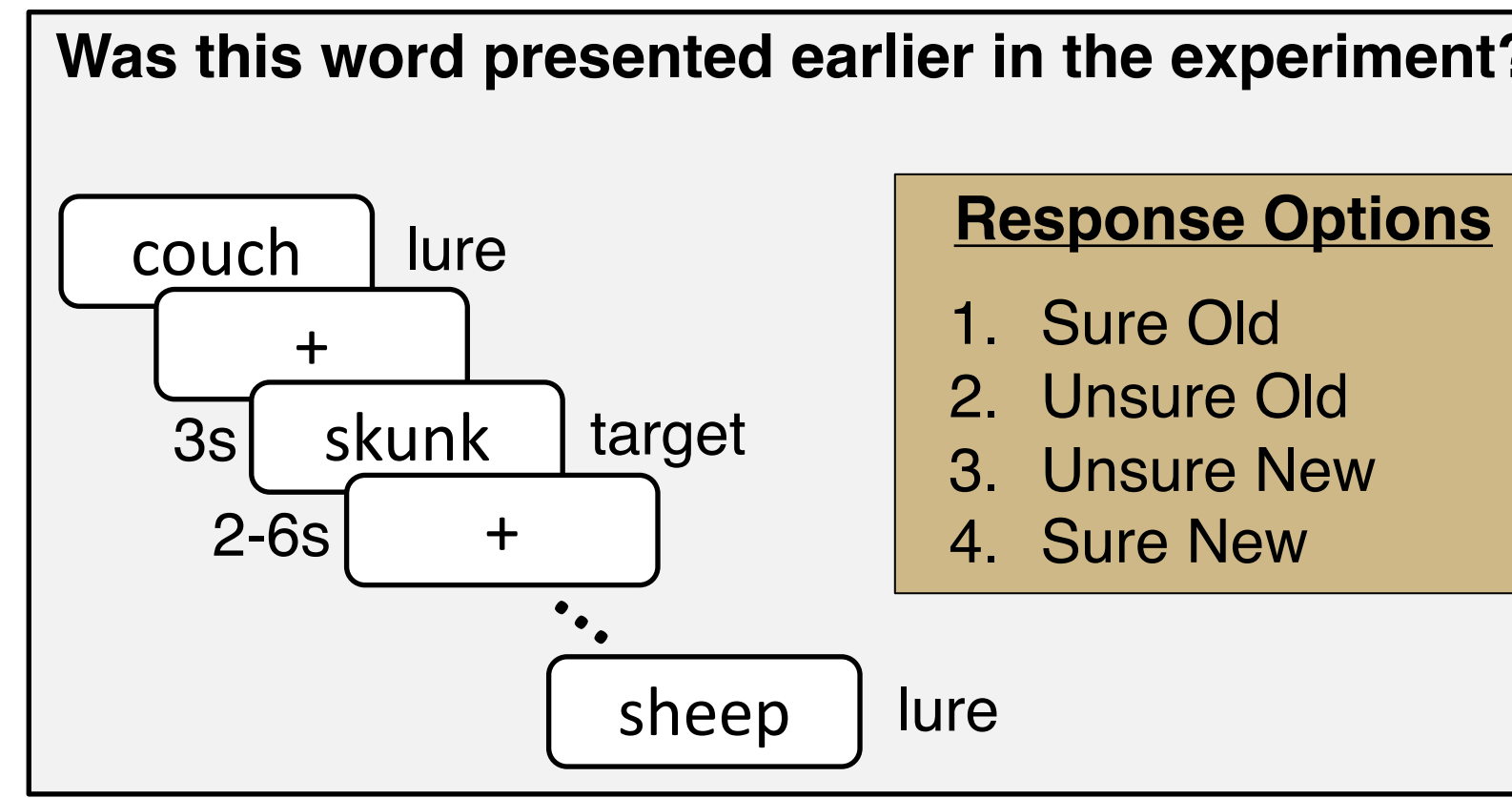
fMRI Experimental Design

- 30 cognitively healthy graduate and undergraduate students at Florida State University
- Mixed block / event-related functional Magnetic Resonance Imaging (fMRI) experiment that required retrieval of either semantic or episodic information from memory

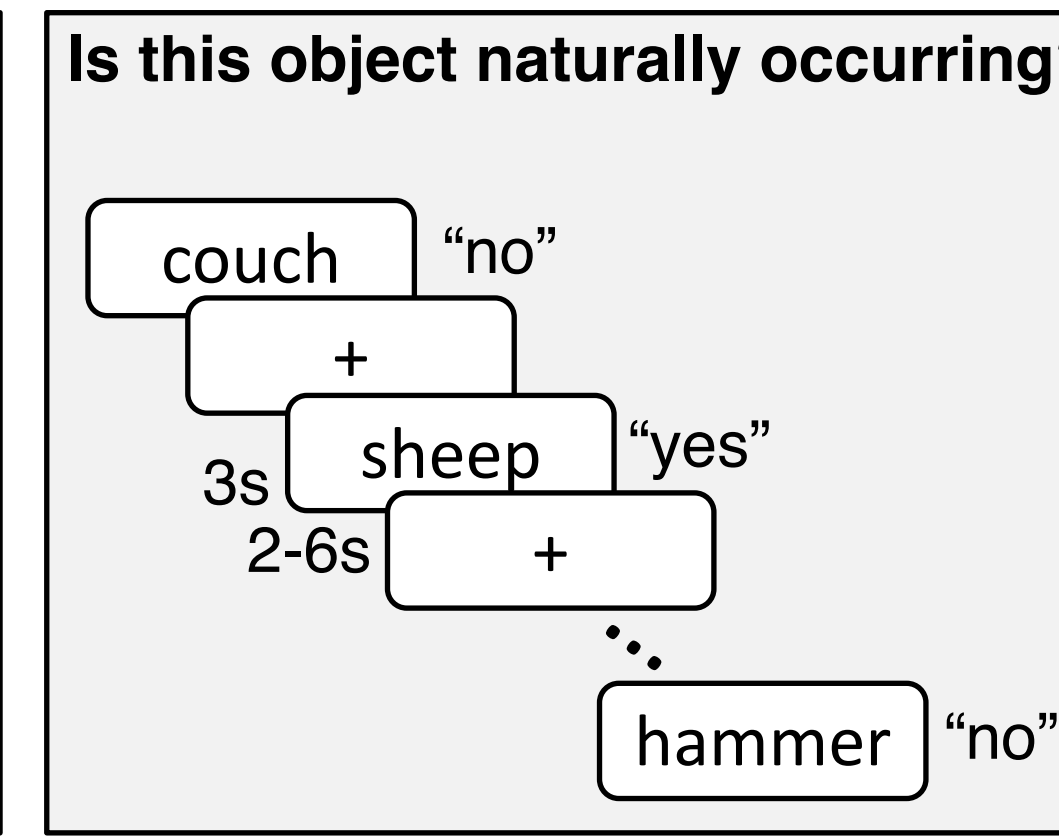
Semantic Task



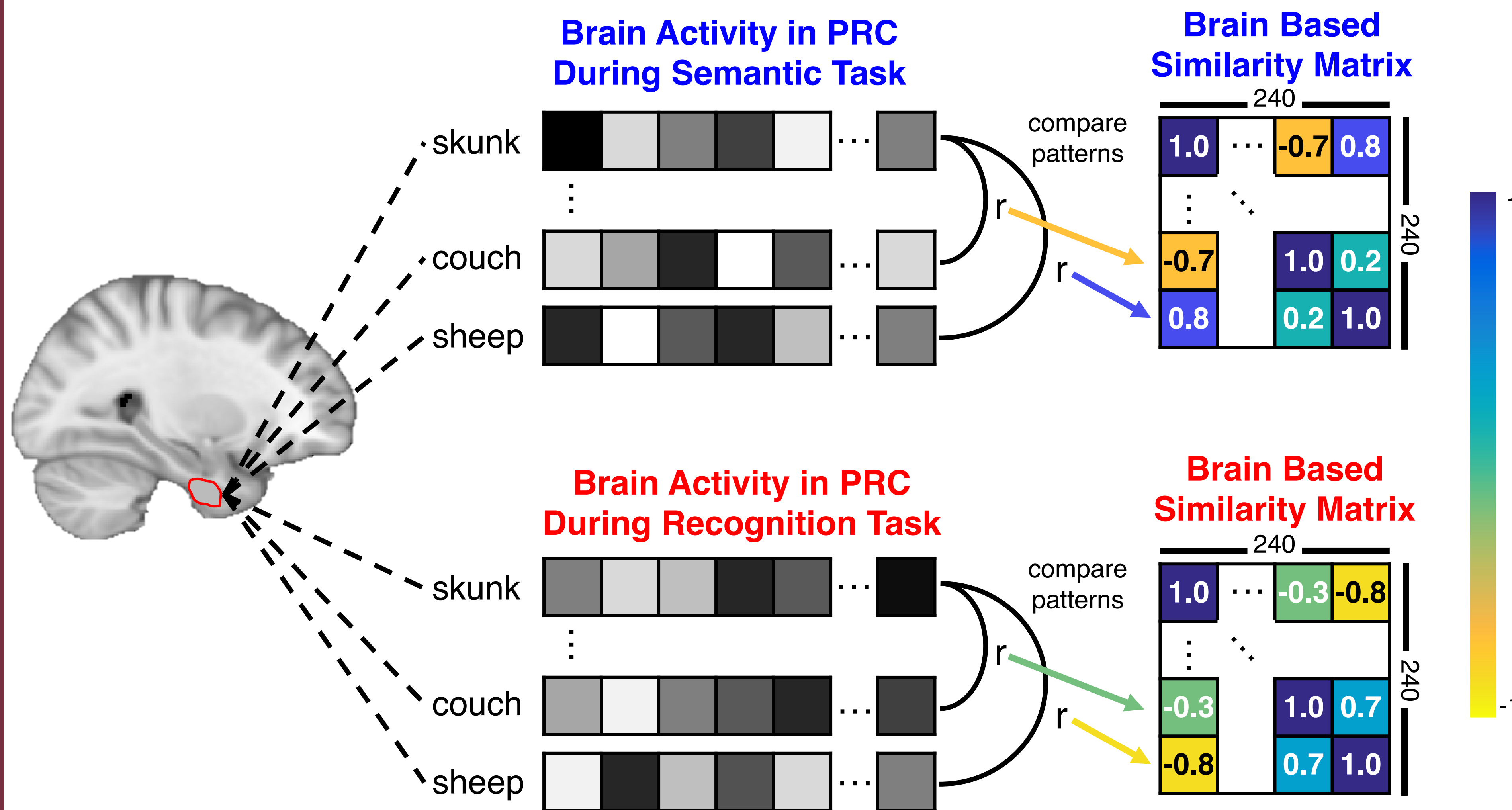
Recognition Task



Semantic Task

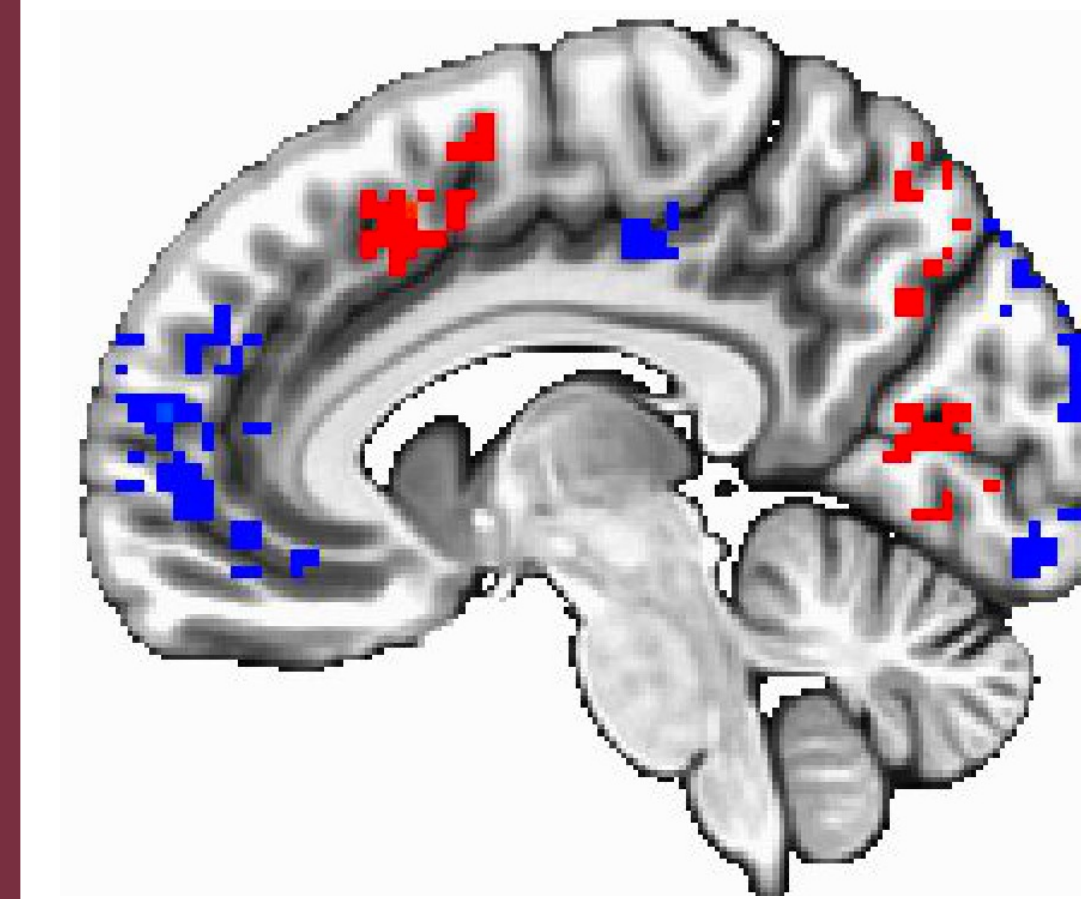


Brain-Based Pattern Similarity Analysis



Task-Based fMRI Contrast

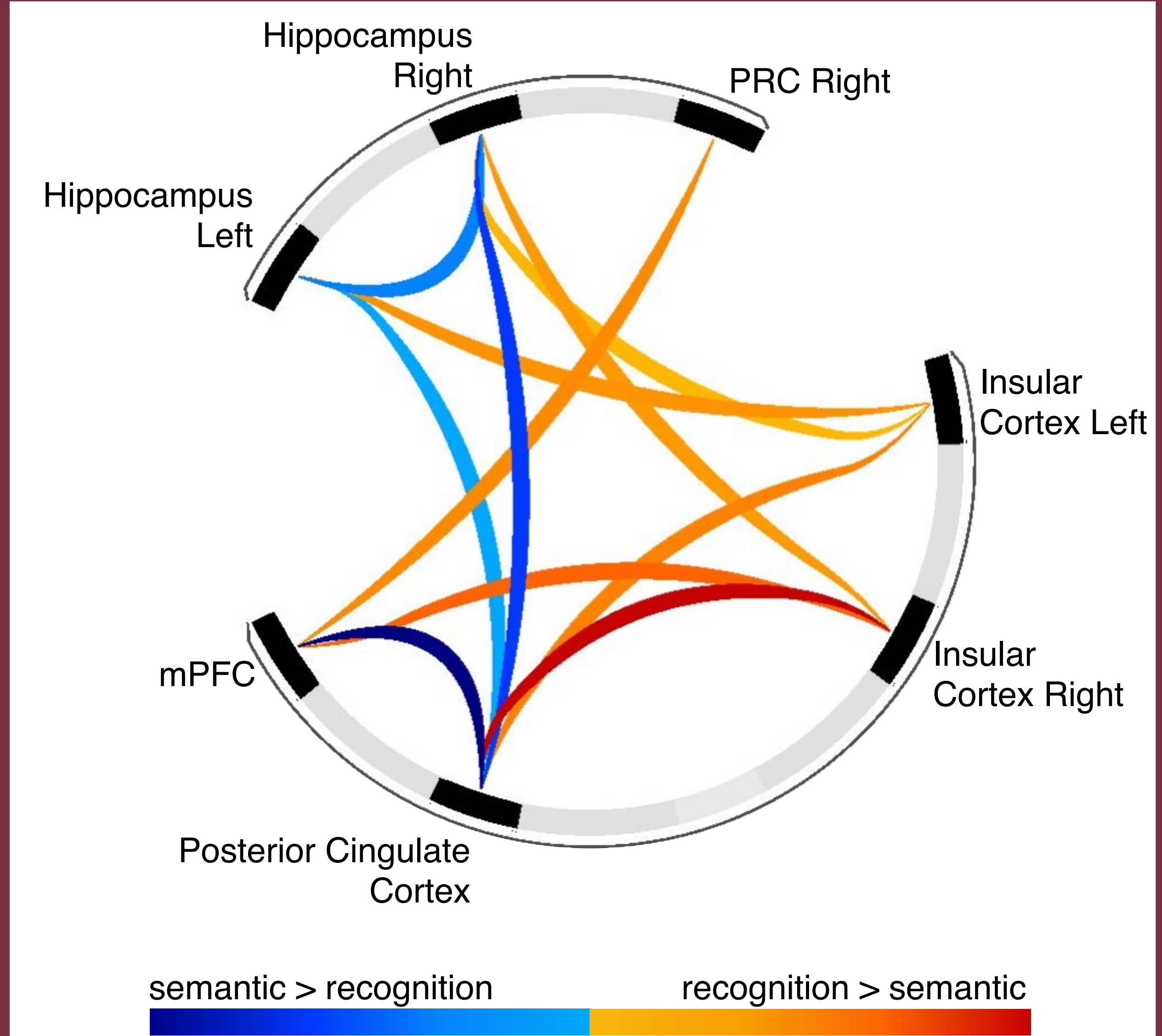
Task-Based Contrast Reveals a Posterior-to-Anterior Gradient of Activity in mPFC



- recognition > semantic
- semantic > recognition

- Greater activity in anterior mPFC during retrieval of semantic memory supports the idea that anterior regions in the frontal lobe guide more abstract cognitive control processing [3].

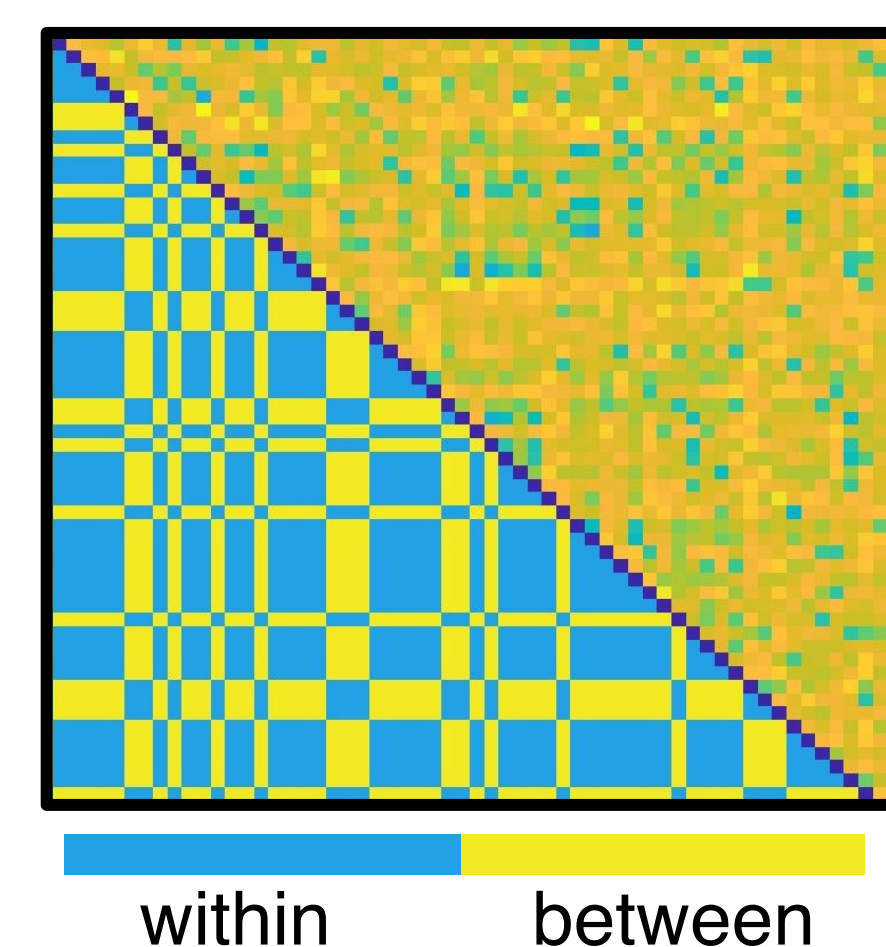
Functional Connectivity Analysis



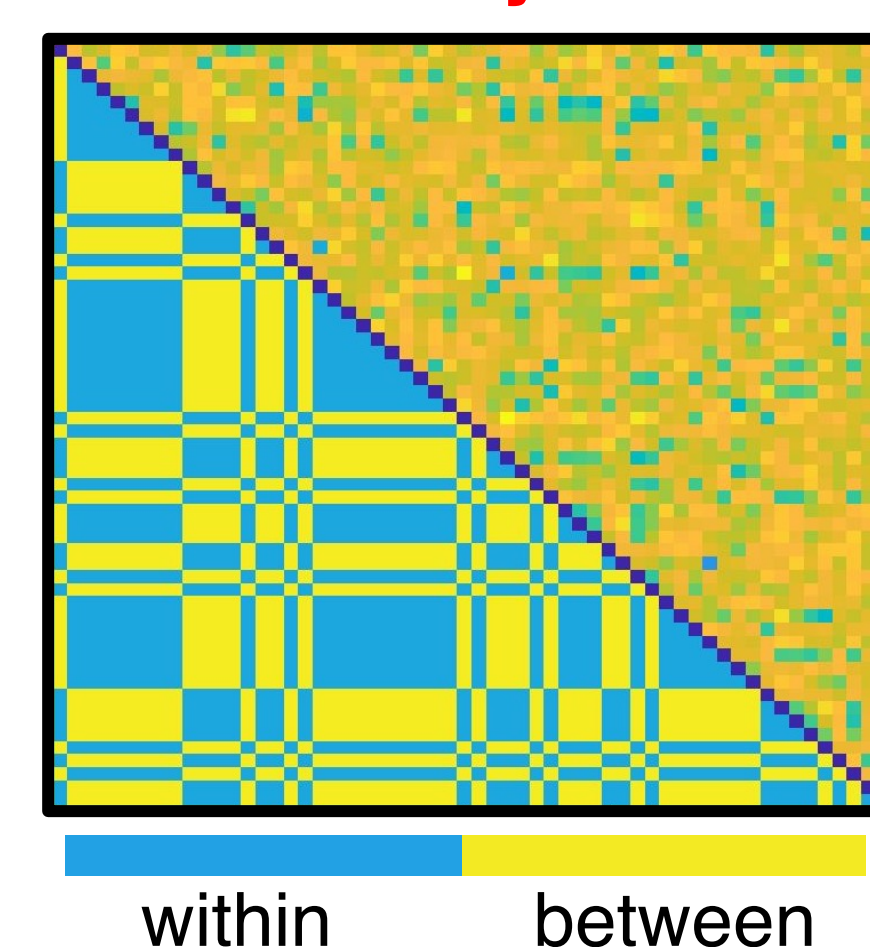
Generalized Psycho-Physiological Interactions (gPPIs) reveal whether the functional connectivity between pairs of brain regions depends on the task context

Neural Similarity Within and Between Categories

Semantic Similarity Matrix



Recognition Similarity Matrix



Average Within Categories

$$\frac{\sum r_{within}}{N_{within}}$$

$$\text{Within Semantic} = \frac{r_{natural\&natural} + r_{unnatural\&unnatural}}{N_{within}}$$

$$\text{Within Recognition} = \frac{r_{new\&new} + r_{old\&old}}{N_{within}}$$

Average Between Categories

$$\frac{\sum r_{between}}{N_{between}}$$

$$\text{Between Semantic} = \frac{r_{natural\&unnatural} + r_{unnatural\&natural}}{N_{between}}$$

$$\text{Between Recognition} = \frac{r_{new\&old} + r_{old\&new}}{N_{between}}$$

Z-scored similarity scores

Region	Semantic		Recognition - High Confidence Old		Recognition - Low Confidence Old	
	Within	Between	Within	Between	Within	Between
PRC	0.0342	0.0319	0.0293	0.0348	0.034	0.0576
Hipp	0.0353	0.0326	0.0338	0.0381	0.0339	0.0559

Summary

- Comparing the similarity of neural patterns within and between categories reveals a trend towards differential activity in being coded in PRC for both semantic and episodic memory.
- The anterior extent of mPFC demonstrated greater activity during retrieval of semantic memory, whereas posterior MPFC demonstrated greater activity during retrieval of episodic memory, providing evidence for a shared cognitive control process during the retrieval of semantic and episodic memory in the mPFC.
- Further analyses are needed to reveal the role of the posterior-to-anterior gradient of activity in mPFC in the retrieval of semantic and episodic memory.