Using dense-sampling to reveal distributed representations of familiarity and decisional processes in recognition memory

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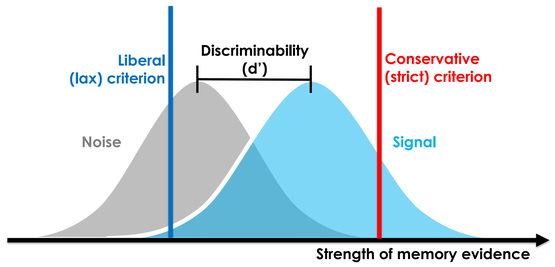
Introduction

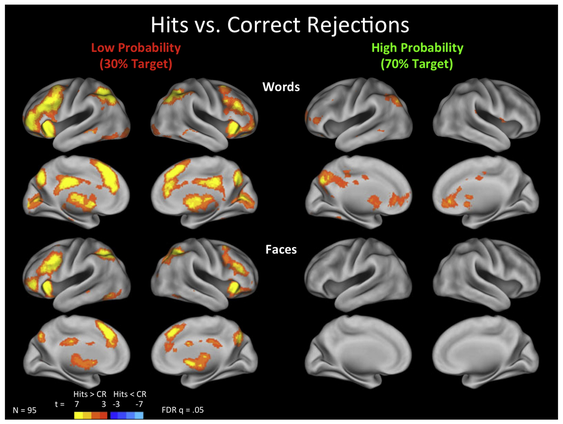
Memory as decision-making

When faced with uncertain memory evidence, one must weigh the available information against a *decision criterion*. **Signal detection theory** offers a framework for quantifying both: 1) the ability to discriminate between old and new information (*d'*), and 2) the extent to which one is monitoring the decision evidence (*C*).



Individuals differ greatly in their willingness/ability to strategically shift their decision criterion under situations of varying uncertainty (Aminoff et al., 2012). Recent work from our lab suggests that **the propensity to modulate one's decision strategy is a uniquely- individualized cognitive trait**, stable both over time and across decision domains (Layher et al., 2020).

While fMRI studies of recognition memory have consistently identified a robust frontoparietal network recruited during memory judgments, we have shown that this pattern of activity is driven by *conservative* criterion placement (Aminoff et al., 2015)—that is, when one is cautiously monitoring the evidence.



The Current Study

Neuroimaging studies of recognition memory often neglect important decisional factors when individuals make recognition judgments.

Even when manipulated, it is difficult to disentangle whether (or to what extent) various components of the observed signal arise from memory itself vs. more epiphenomenal decision processes.

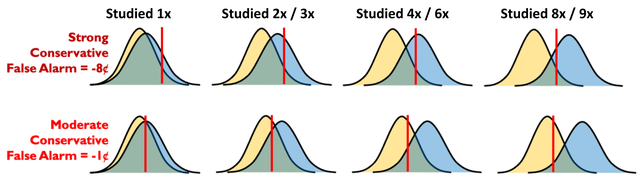
Our goal is to use dense-sampling methods alongside MVPA to derive a more nuanced spatial account of how these processes are represented in the brain.

Dense-Sampling Paradigm

STUDY 1—RECOGNITION MEMORY FOR FACES
(16 SESSIONS | 4 STUDY/TEST PER SESS | 64 UNIQUE PER STUDY)

STUDY 2—RECOGNITION MEMORY FOR SCENES
(31 SESSIONS | 4 STUDY/TEST PER SESS | 80 UNIQUE PER STUDY)

4 X 4 DESIGN—MANIPULATE FAMILIARITY VIA REPEATED PRESENTATIONS DURING ENCODING, MANIPULATE CRITERION WITH MONETARY PENALTIES FOR CRITICAL LURES

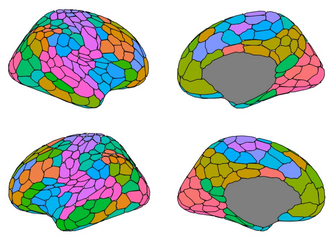


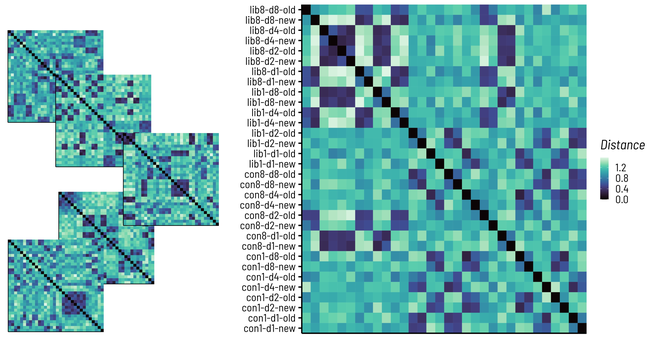
Representational Similarity Analysis

1) **Parcellate brain into 400 cortical regions.**

2) **For each brain region and each scanning session, compute 32x32 representational (dis-) similarity matrices, capturing all possible criterion, familiarity strength, and item (old/new) pairs.**

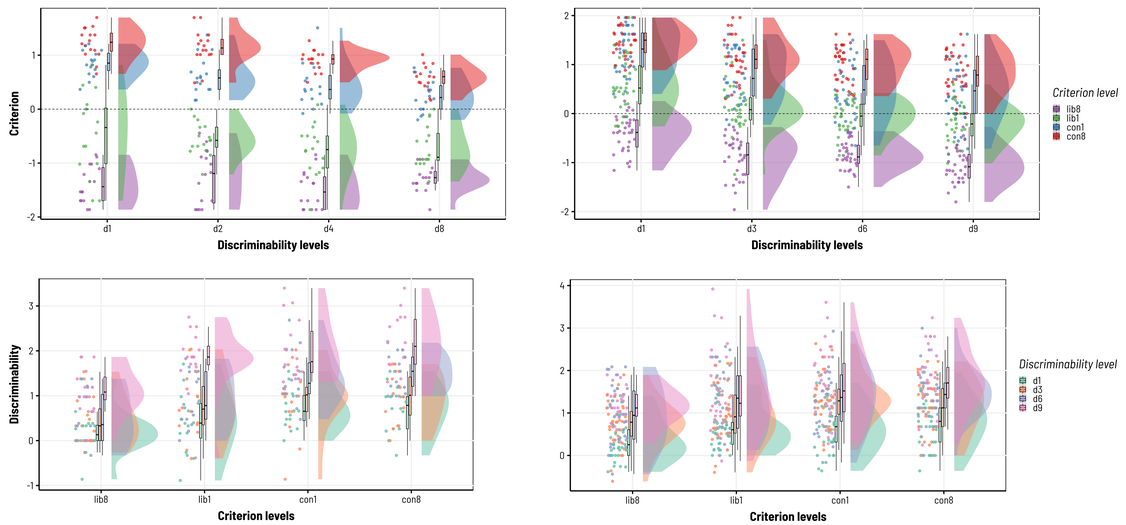
3) **Combine in hierarchical model and test against conceptual RDMs + behavior.**



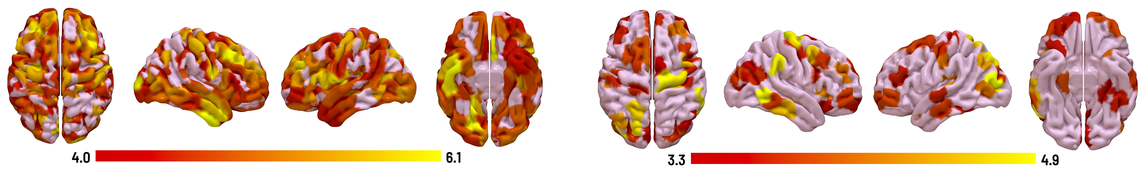


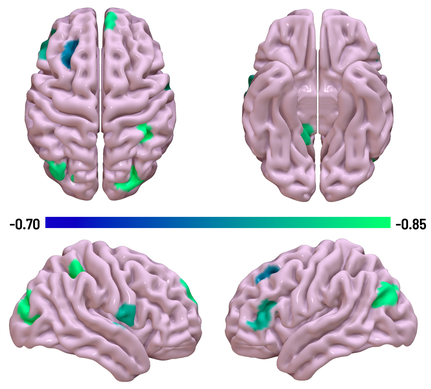
Results

BEHAVIORAL PERFORMANCE—STUDY 1 (*LEFT*) & STUDY 2 (*RIGHT*)

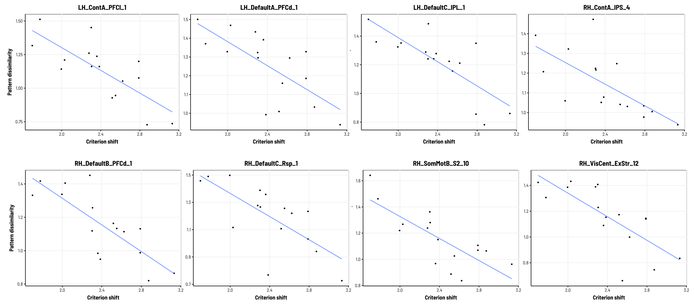


IN BOTH STUDIES, A NUMBER OF REGIONS RELIABLY DISCRIMINATE BETWEEN DECISION CRITERIA





IN STUDY 1, REGIONS THAT *DID NOT* RELIABLY DISTINGUISH BETWEEN OLD/NEW ITEMS WERE ASSOCIATED WITH MORE CRITERION SHIFTING



Summary

The search for memory continues. Consistent with our previous work, we observed wide swaths of the brain differentially responding to *criterion* manipulations—but none that seemed to specifically tease apart factors related to *memory evidence* itself (either the old/new status of items or the strength of familiarity). Representational similarity between old/new images was behaviorally-relevant—but also only with respect to shifting behavior. Additional analyses with more fine-grained model RDMs may be helpful in the future.

References

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