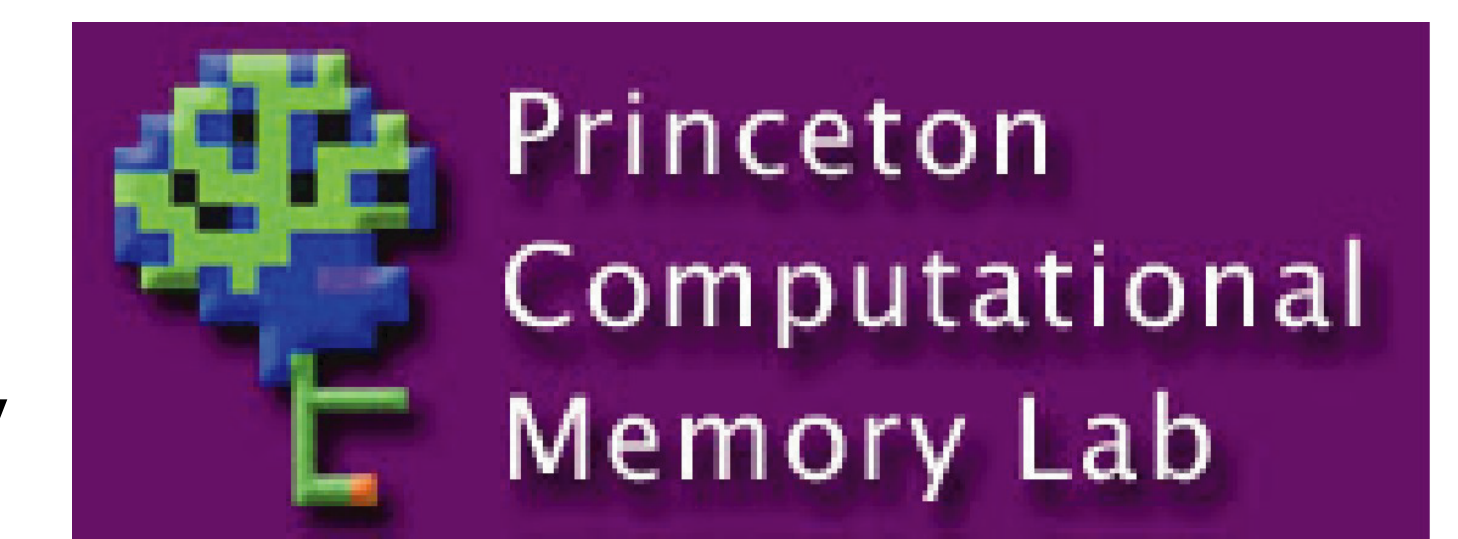




Using fMRI pattern classification of recollection and familiarity to predict false alarms in recognition memory



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Introduction

There is general agreement that recognition memory can be based on general assessments of stimulus familiarity, or on the recollection of specific details. However, there is still significant debate over when the processes are used and what decision rules people use to combine them. Behavioral measures of recollection and familiarity have been very useful, but make controversial assumptions. Additionally, the process of measurement itself may affect how people normally perform the task.

Our goal is to address some of these issues using pattern classification of fMRI data to more covertly examine people's time-varying utilization of recollection and familiarity in a recognition task

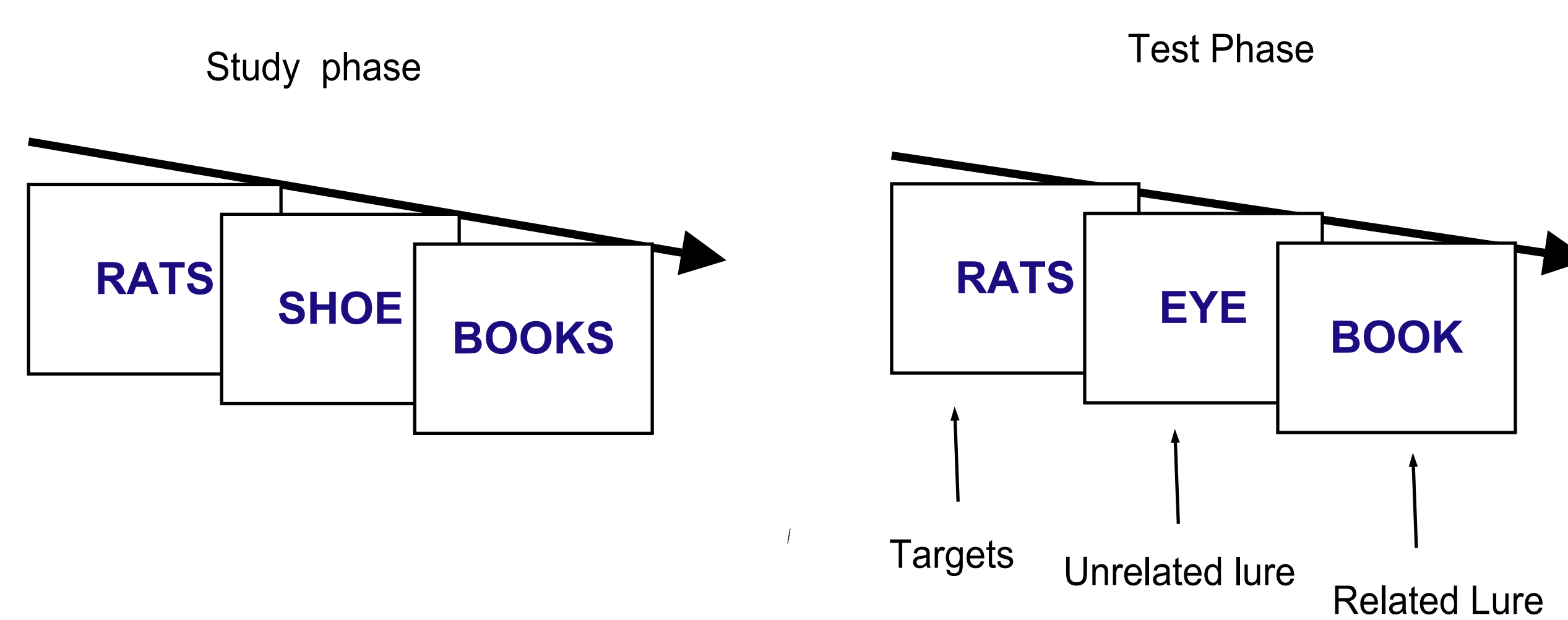
□ □ □ □ □ Pattern Classification in fMRI

Pattern classification in fMRI involves training an algorithm to distinguish the distributed patterns of brain activity associated with specific cognitive states (Kamitani & Tong, 2005; Polyn et al., 2005)

OUR BASIC APPROACH: treat recollection and familiarity as differentiable retrieval states with different neural signatures

1. Use a pattern classification algorithm to extract a neural measure of recollection and familiarity task sets from fMRI data
2. Use the classification measure to predict behavior on a different task.

Plurals Paradigm (Hintzman, Curran, & Oppy, 1992)



In a plurals paradigm, some lures are closely related to studied words and differ only in that their plurality has been switched.

Subjects' uses of recollection and familiarity in this task have unambiguous consequences for switched-plurality related lures: related lures are familiar, but can be rejected if recollected. Thus, related lure false alarms should be reduced with greater use of recollection.

A Two-Phase Experiment

10 subjects were scanned.

PHASE 1: Classifier training with constrained tests

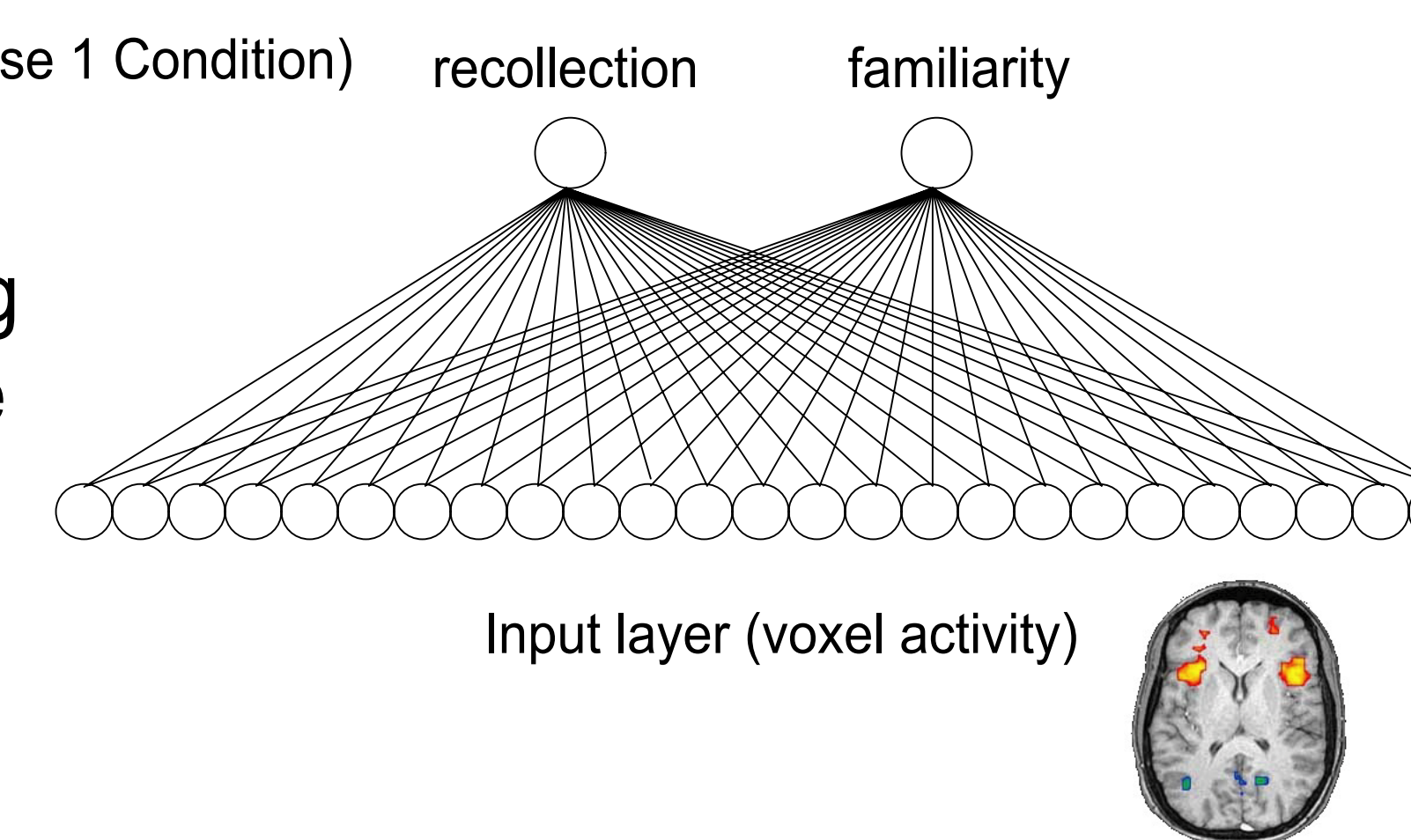
- Study list of words; old/new recognition test for studied items (RATS) and unrelated lures (SHOE)
- Two types of blocks, each appearing 8 times across 4 runs: □
 - - Instruct subjects to judge whether they recollect something specific about the item.
 - - Instruct subjects to judge quickly whether the item is familiar.
- Train the classifier to distinguish brain patterns associated with recollection and familiarity tasks

Phase 2: Classifier testing with a unconstrained test:

- Subjects are free to use whatever strategy they would like
- Full plurals task – mixed list of targets, unrelated lures, and switched-plurality lures.

Simple Neural Network Classifier

The network learns a mapping between voxel activity and the presence of one condition or another.

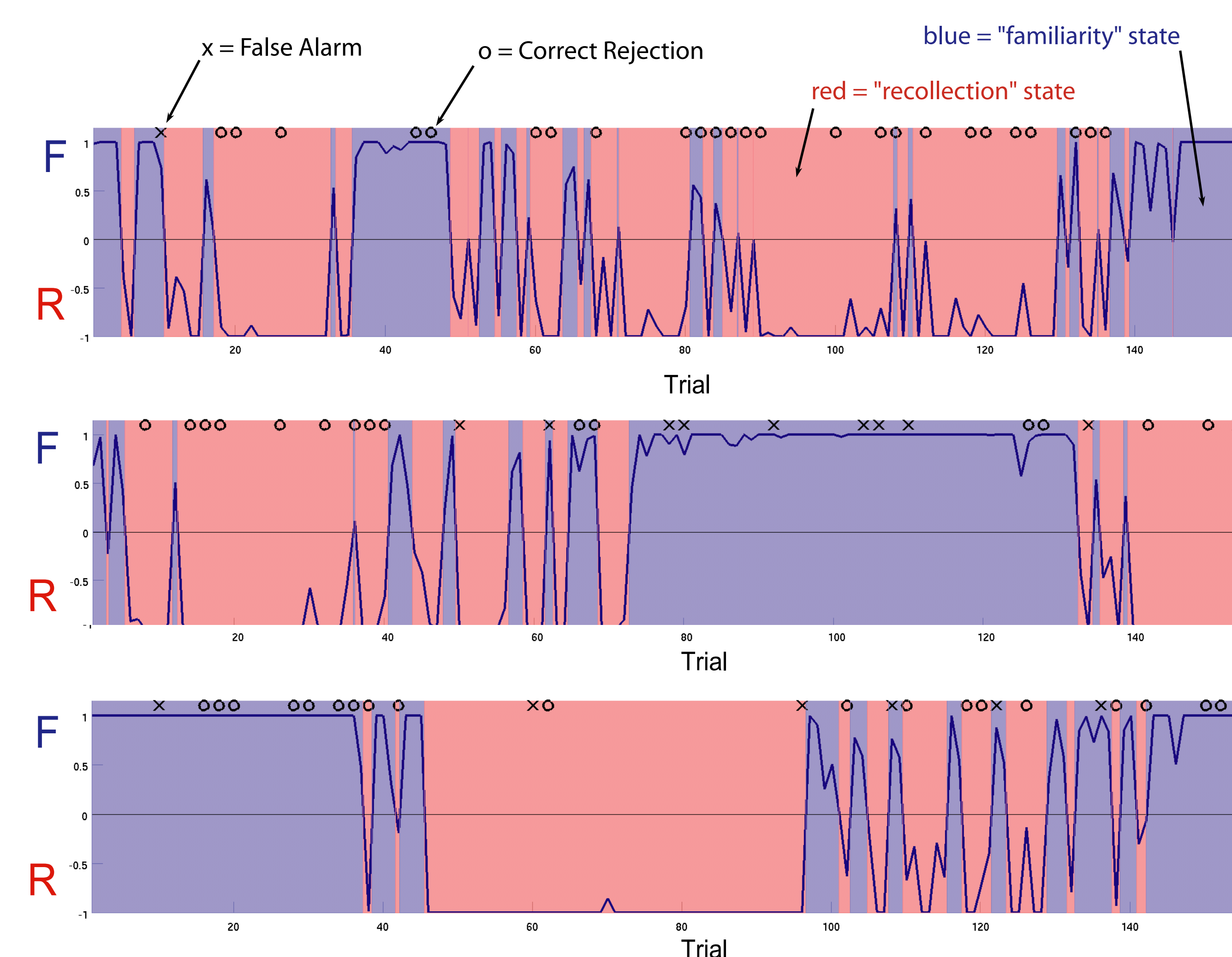


Phase 1: Classification of recollection and familiarity

- First, we tested the reliability of classification.
- N-1 Cross-validation: Exclude 1 of the 4 runs; train on remaining 3, Test on excluded run.
- 6 of 10 subjects show cross-run generalization above 60% for recollection and familiarity (63%-73%).
- Generalization performance can be used as exclusion criteria: If generalization is at chance (50%), the classifier is not learning anything reliable about the conditions; Thus, no prediction can be made for related lure trials
- 4 subjects at chance were removed at this point; For the remaining 6, we then trained the classifier on all Phase 1 data and tested on Phase 2 data...

Phase 2: Generalization to the Plurals task

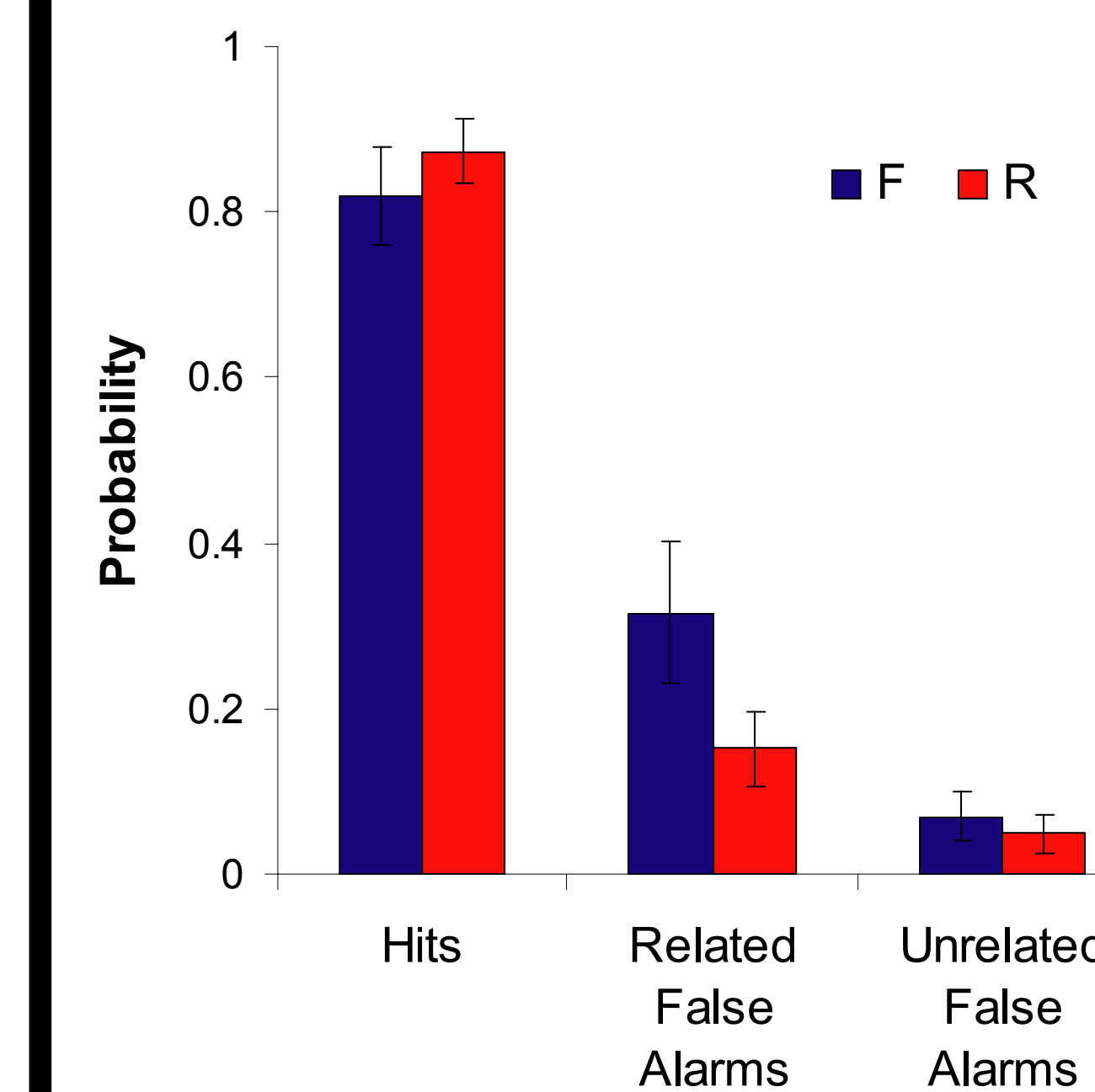
Time-varying fluctuations in classifier's "best guess" as to whether activity more closely-matched recollection or familiarity (data from 1 subject):



References

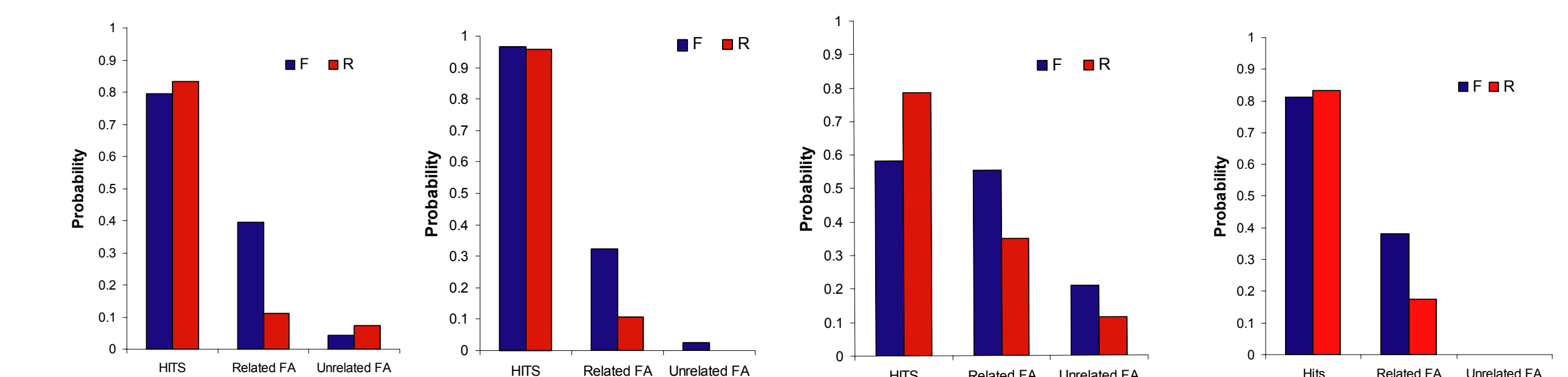
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Predicting False Alarms



As predicted, we found a selective reduction of related lure false alarms when the classifier guessed "recollection state" compared to when it guessed "familiarity state".

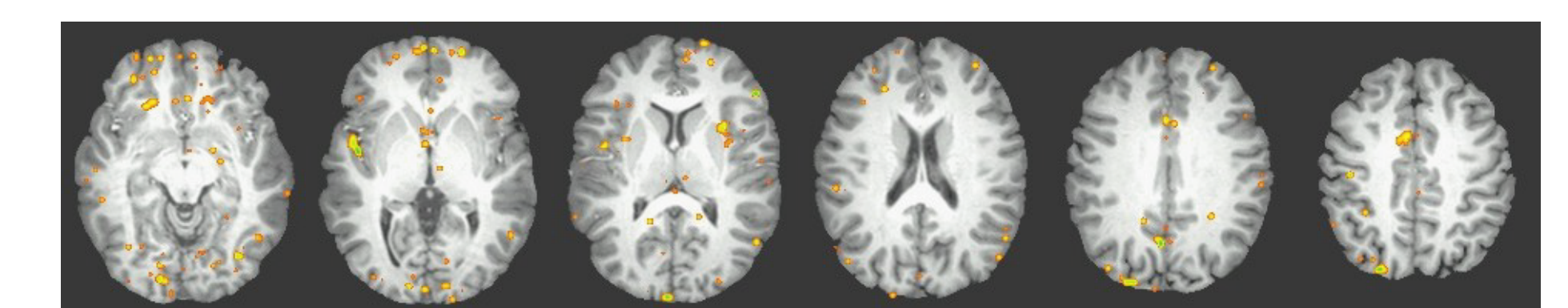
4 of the 6 subjects showed individually reliable effects as measured by a non-parametric bootstrapping procedure



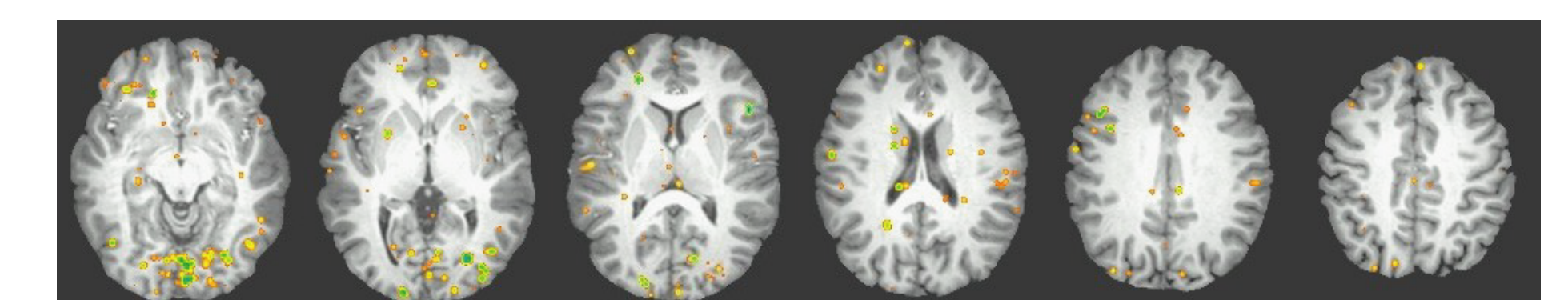
Voxel Importance Maps

Classifier weights reveal voxels to which the classifier is paying attention:

Familiarity weights > .2



Recollection weights > .2



The most consistent difference was greater importance of visual areas in recollection; may reflect retrieval of mental images of items formed at study.

Discussion

Pattern classification can measure and distinguish states elicited by relatively greater presence of recollection and familiarity

Classifier measures show fluctuations across time in presence of recollection and familiarity during unconstrained testing that predict related-lure false alarms

High potential for using neural classification measures to inform psychological theories of recognition