Gist and Detailed Mnemonic Discrimination of Highly Similar Scenes Along the Hippocampal Longitudinal Axis

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BACKGROUND

Longitudinal axis of the hippocampus (HPC)

- Anteroposterior gradient (APG) in episodic memory processing
  - Connectivity patterns found among (Aggleton, 2012; Ranganath & Ritchey, 2012)
    > aHPC ~ anterior regions (e.g., vmPFC for schemas)
    > pHPC ~ posterior neocortex (e.g., perceptual regions)
  - A model of HPC-APG (Poppenk et al., 2013, Robin & Moscovitch, 2017)
    > aHPC ~ coarse, global representations
    > pHPC ~ fine-grained, local representations

Mnemonic Similarity Task (MST) (Stark & Stark, 2017)
  > Measures recognition and mnemonic discrimination of scene images
  > At retrieval, presents a dissimilar scene (*foil*) or one exemplar of a highly similar scene (*lure*) not identical to studied items (*targets*)

RESEARCH OBJECTIVES

- Adopt the MST and show *multiple exemplars* per scene category at encoding and retrieval to measure detailed and gist-like memory
- Evaluate the interpretation of the HPC APG via our MMST task (Fig.1) in fMRI (Fig.2)

Goal: Measure aHPC & pHPC activations for gist vs detailed recognition
Hypotheses: a. aHPC > retrieval of gist-like memory
                 > via accurate foil recognition & inaccurate lure recognition
             b. pHPC > retrieval of detailed memory
                 > via accurate recognition of targets & lures
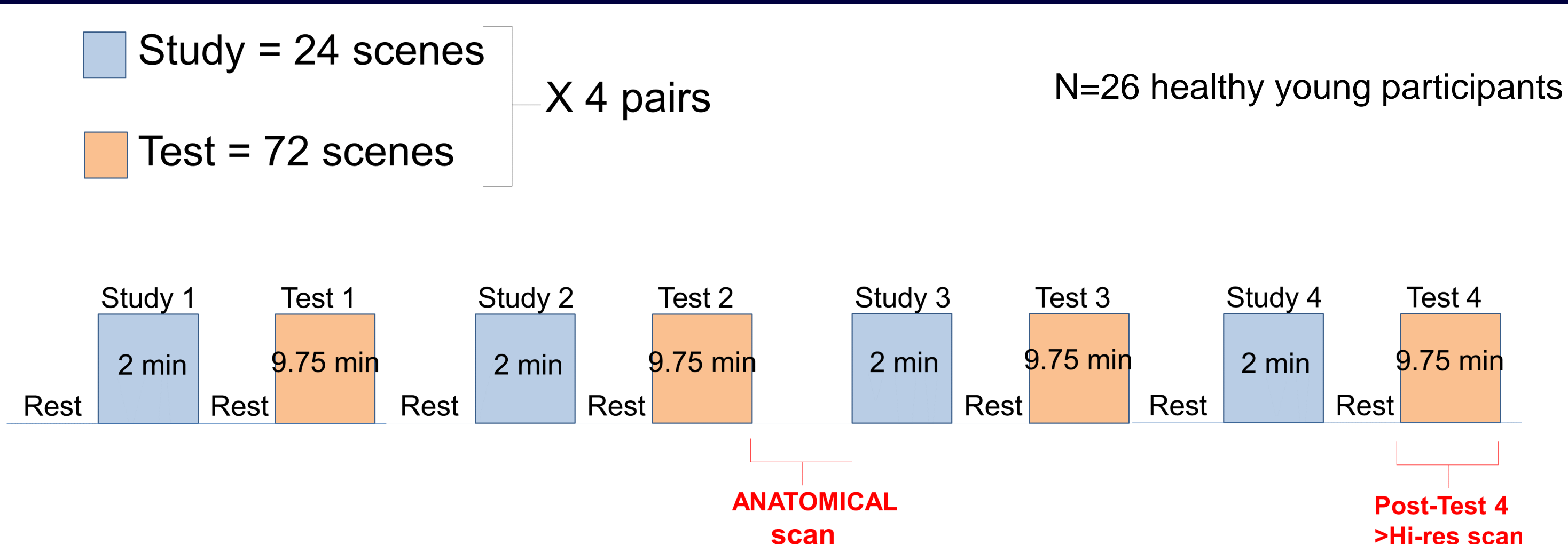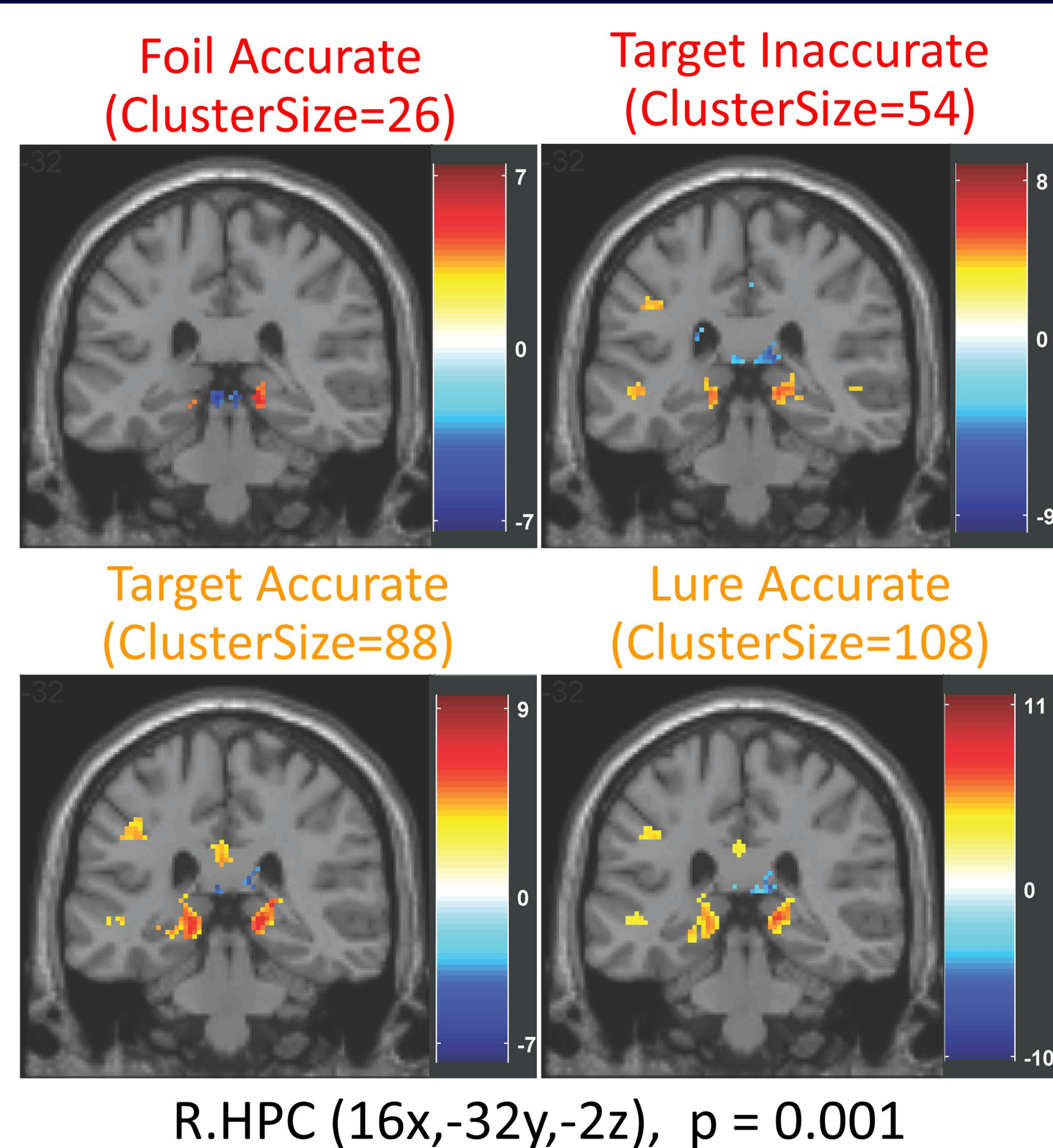
METHODS

Study Phase   **Test Phase**

Multiple Mnemonic Similarity Task (MMST)

Indoor or Outdoor?   Old, Similar, or New?

> 3 exemplars per scene category (x8)

Exemplars of targets and lures can be tested for a given scene category

12 indoor
12 outdoor

> 3 exemplars per 8 targets/ 8 lures/ 8 foils

3.0 sec per stimulus
3.0 sec response time

3.0 sec per stimulus
3.0 sec response time

24 targets(old)
24 lures(similar)
24 foils(new)

Figure 1. The MMST protocol

fMRI STUDY DESIGN

Study = 24 scenes
Test = 72 scenes   X 4 pairs   N=26 healthy young participants

Rest | Study 1 2 min | Rest | Test 1 9.75 min | Rest | Study 2 2 min | Rest | Test 2 9.75 min | Rest | Study 3 2 min | Rest | Test 3 9.75 min | Rest | Study 4 2 min | Rest | Test 4 9.75 min

ANATOMICAL scan

Post-Test 4 >Hi-res scan

Figure 2 – Event related design using T3 fMRI scanner

WHOLE BRAIN ANALYSIS: HPC ACTIVATION

Foil Accurate (ClusterSize=26)

Target Inaccurate (ClusterSize=54)

Target Accurate (ClusterSize=88)

Lure Accurate (ClusterSize=108)

R.HPC (16x,-32y,-2z), p = 0.001

REGION OF INTEREST (ROI) ANALYSIS AND DISCUSSION

p=.031   p<.001   p<.000

Con values

Foil   Target   Lure

Probe Type

Anterior
Posterior
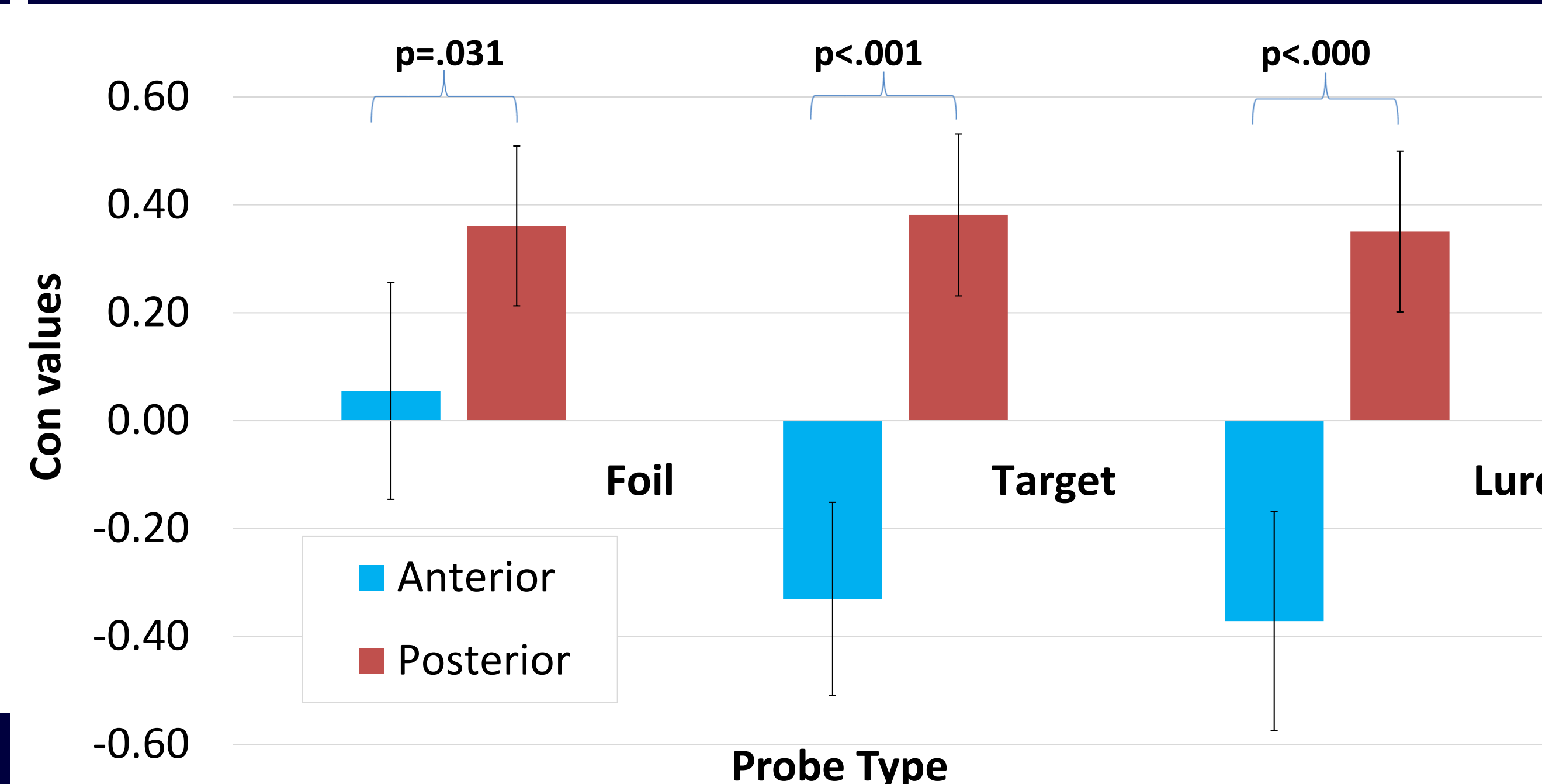
Figure 3. Accurate probe recognition across HPC APC

p<.001   p<.000   p<.000   p=.192

Con values

Target_Accurate   Lure_Accurate   Target_Inaccurate   Lure_Inaccurate
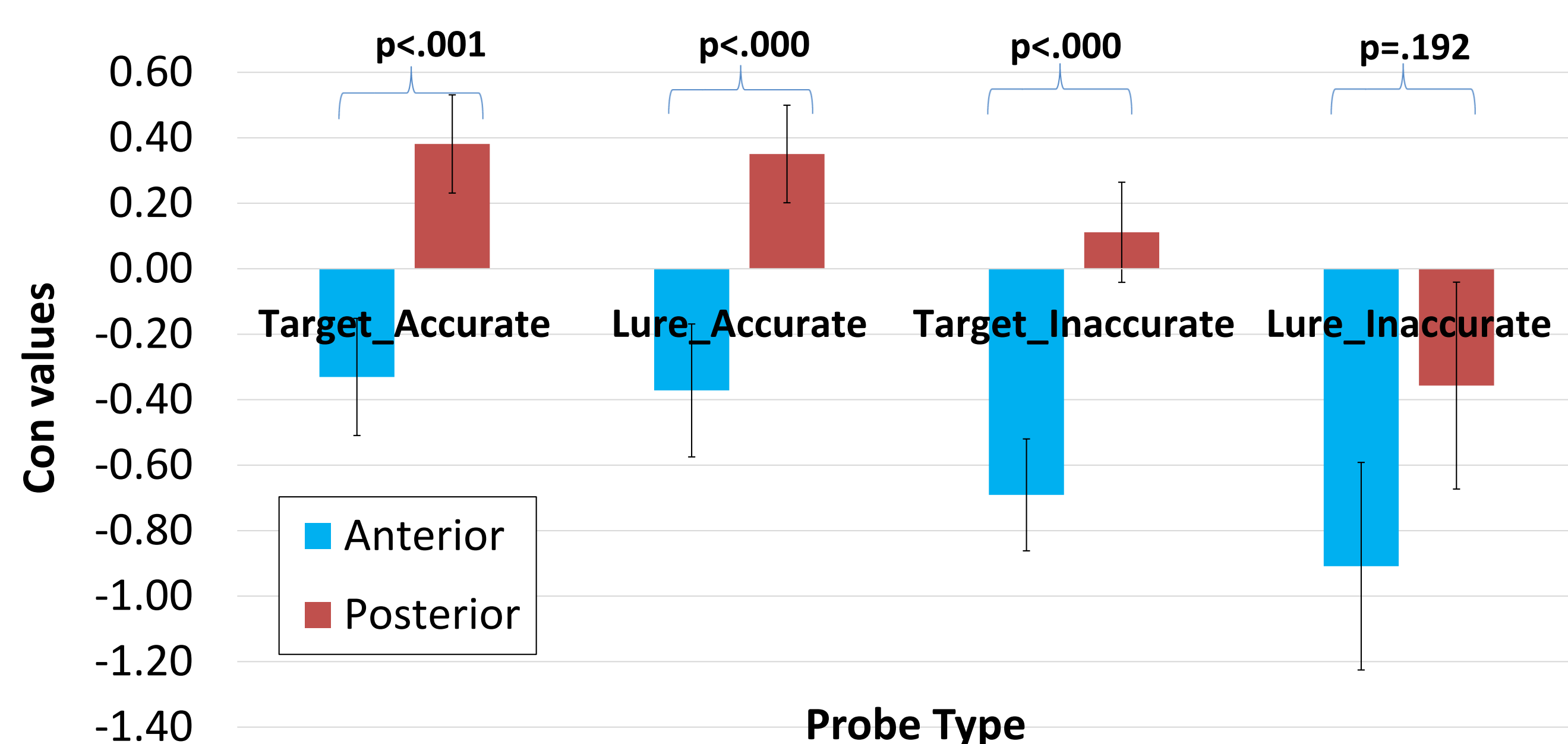
Probe Type

Anterior
Posterior

Figure 4. Inaccurate and accurate probe recognition across HPC APC

Take Home Message

1. **The MMST reliably measured detailed memory via participants' percent correct responses to targets and lures identification (above chance level of 33%)**
   > Increasing multiple exemplars at both encoding and retrieval was shown to enhance similarity detection!

2. **The MMST also reliably measured gist-like memory via participants' poor accuracy (hits – false alarms) for lure discrimination**
   > Lure accuracy was significantly lower than target (p<0.01) & foil (p<0.01) accuracy

3. **In all accurate trials, ROI activations showed significantly greater activations in the: pHPC > aHPC (p<0.01)**
   > this was modulated by stimulus type

4. **Relative to accurate target and lure recognition, the APG difference was smallest for accurate foils, which preferentially activated the aHPC (Fig.3)**
   > supports role of aHPC for gist-like memory

5. **For targets and lures, their accurate recognition showed greater pHPC activations than their inaccurate recognition (Fig.4)**
   > supports role of pHPC for detailed memory

REFERENCES: Aggleton, J.P. (2012). *Neurosci Biobehav Rev, 36*, 1579-1596. Poppenk, J., Evensmoen, H.R., Moscovitch, M., & Nadel, L. (2013). *Trends Cogn Sci, 17*, 230-240. Ranganath, C. & Ritchey, M. (2012). *Nat Rev Neurosci, 13*, 713-726. Robin, J. & Moscovitch, M. (2017). *Learn Mem Cogn, 40*, 459-475. Stark, S.M., & Stark, C.E. (2017). *Behav Brain Res, 333*, 109-117.