



INHIBITING SCENE MEMORIES THROUGH CLOSED-LOOP MODULATION OF RETRIEVAL STRENGTH

ANNE C. MENNEN¹, JORDAN POPPENK², MEGAN T. DEBETTENCOURT³, KENNETH A. NORMAN¹

¹ Princeton Neuroscience Institute, Princeton University, ² Department of Psychology, Queen's University, ³ Institute for Mind and Biology, University of Chicago



Introduction

Moderately reactivating memories leads to weakening of those memories¹⁻⁴

Perceptual distraction (via Multiple Object Tracking, MOT) can control memory reactivation⁵

Closed-loop fMRI neurofeedback can be used to adjust task difficulty in real time⁶

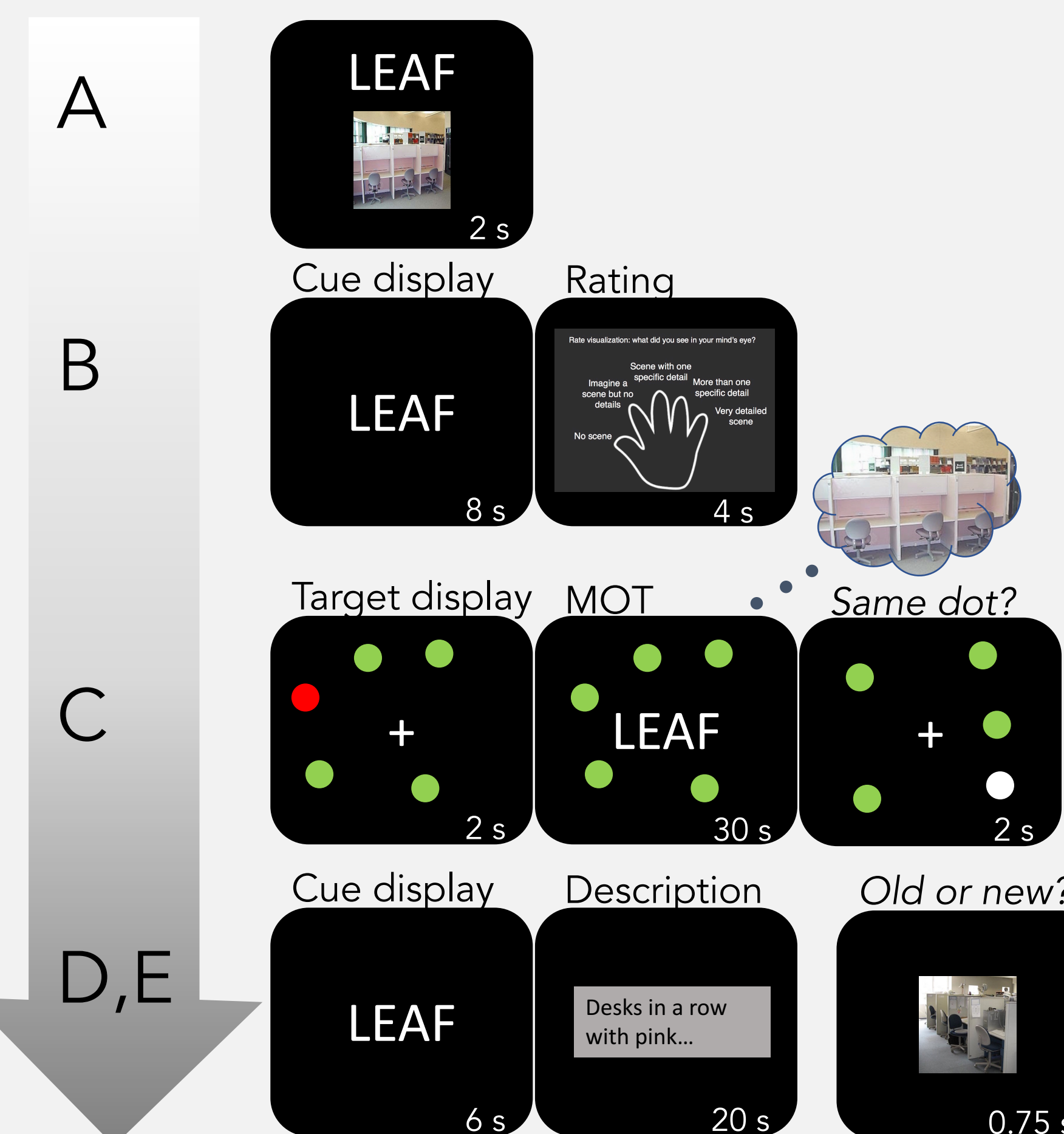
In a pilot version of this paradigm, we found that moderate levels of reactivation lead to memory weakening, as evidenced by decreased pattern similarity to the item's previous representation⁷

Goal: Adjust perceptual distraction in real time to evoke moderate activation & (through this) memory weakening

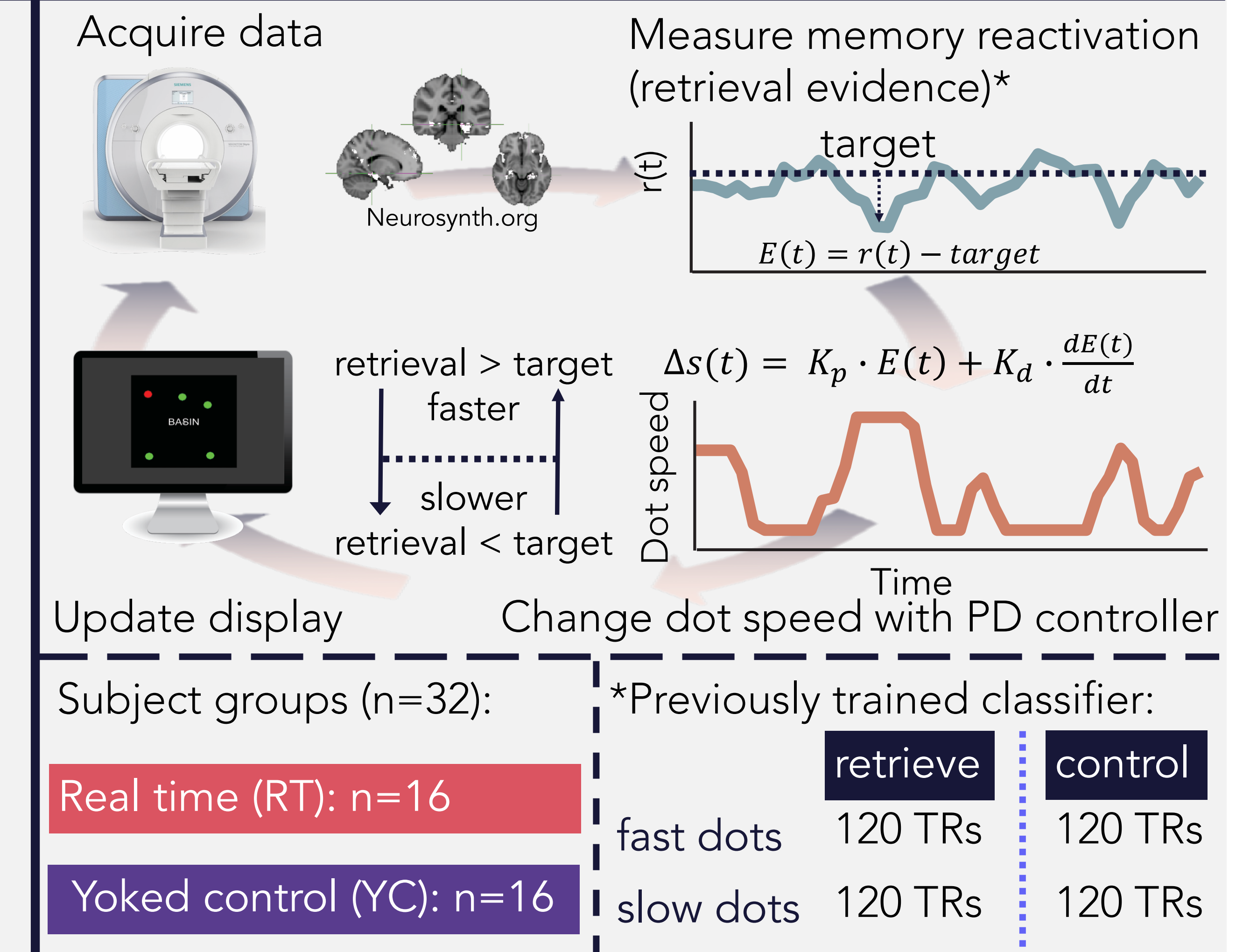
Design

| | Task | Stimuli |
|---|--------------------------|-------------------------------------|
| A | Learn word & scene pairs | 10 MOT 10 OMIT |
| B | Recall 1 | 10 MOT 10 OMIT |
| C | Real time MOT x 3 | 10 MOT |
| B | Recall 2 | 10 MOT 10 OMIT |
| D | Scene description | 10 MOT 10 OMIT |
| E | Recognition | 10 MOT; 10 LURE 10 OMIT; 10 LURE |

Stimuli



Closed-loop system

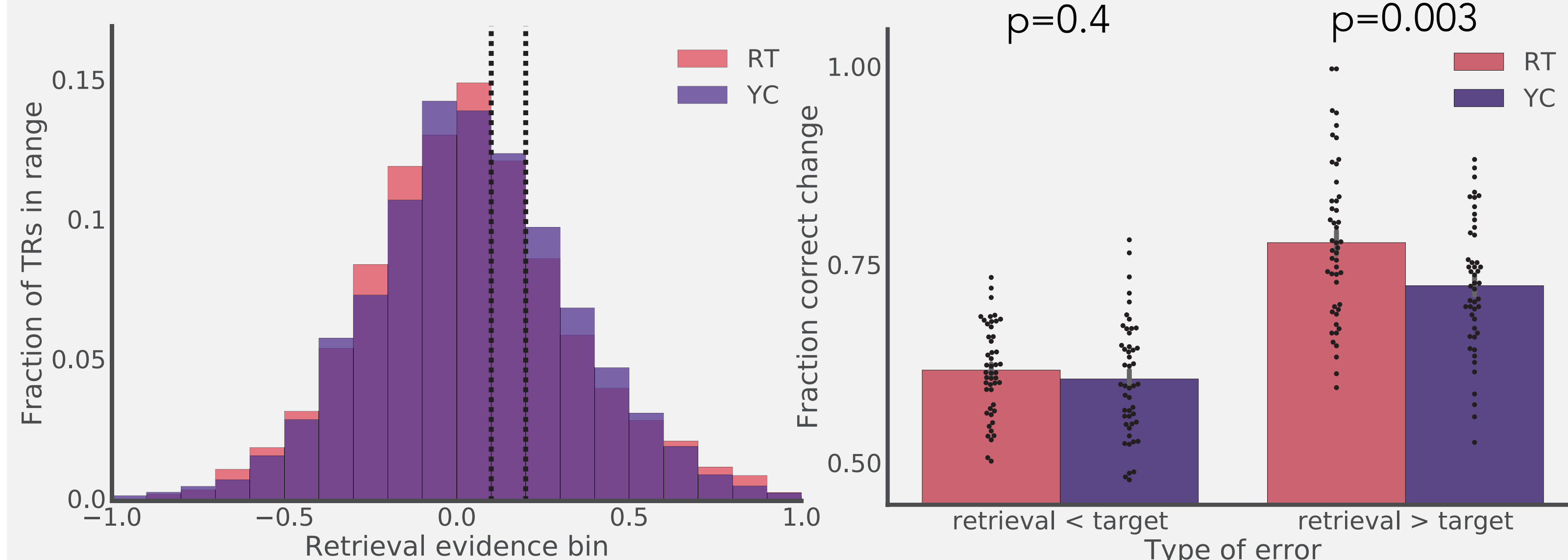


Comparing results across groups → Analyzing within group variance

How effective is real time at correcting retrieval?

RT group did not spend more time in target region

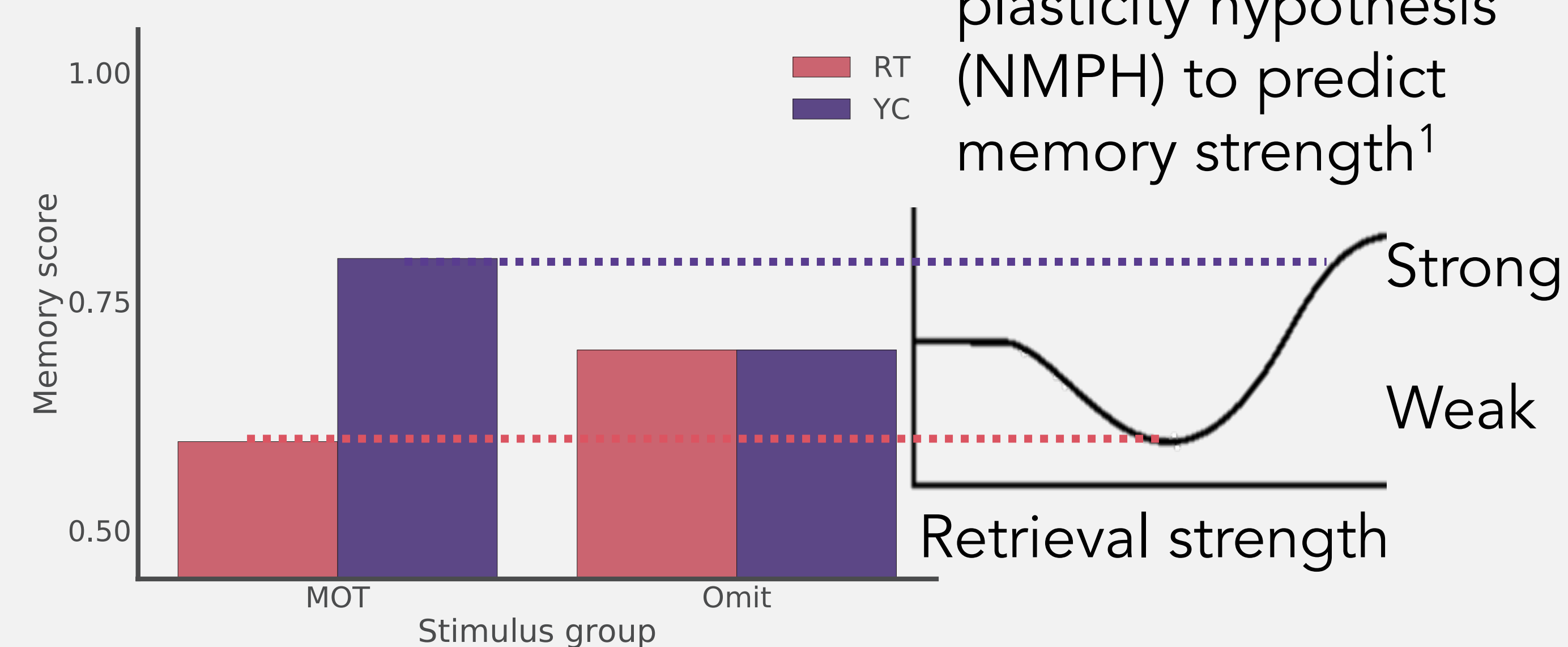
RT group is better at correcting overly strong activation



Hypothetical memory results

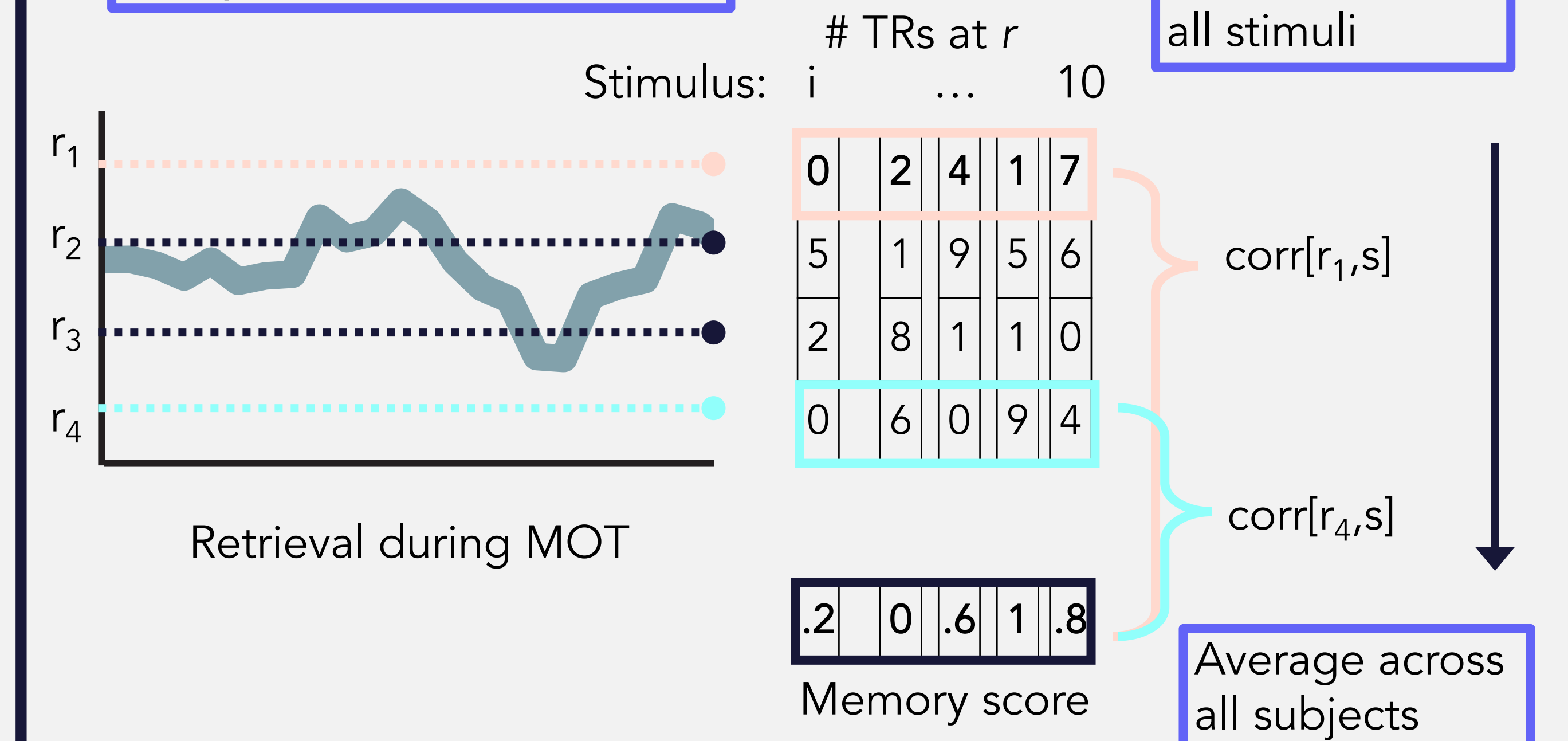
Expected results if RT group activation is moderate

Use the nonmonotonic plasticity hypothesis (NMPH) to predict memory strength¹



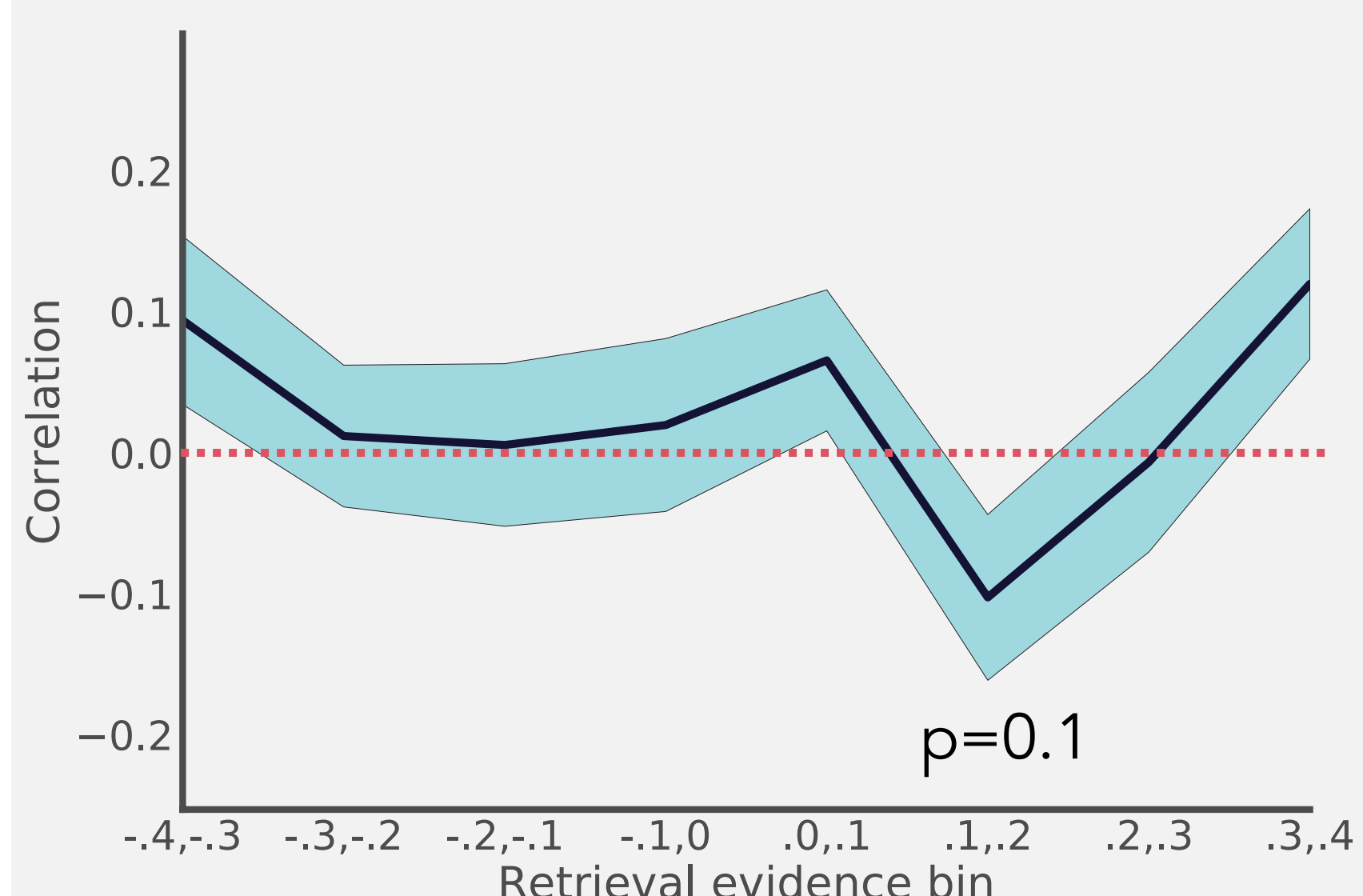
Using retrieval evidence to predict memory

Compute for each subject s:

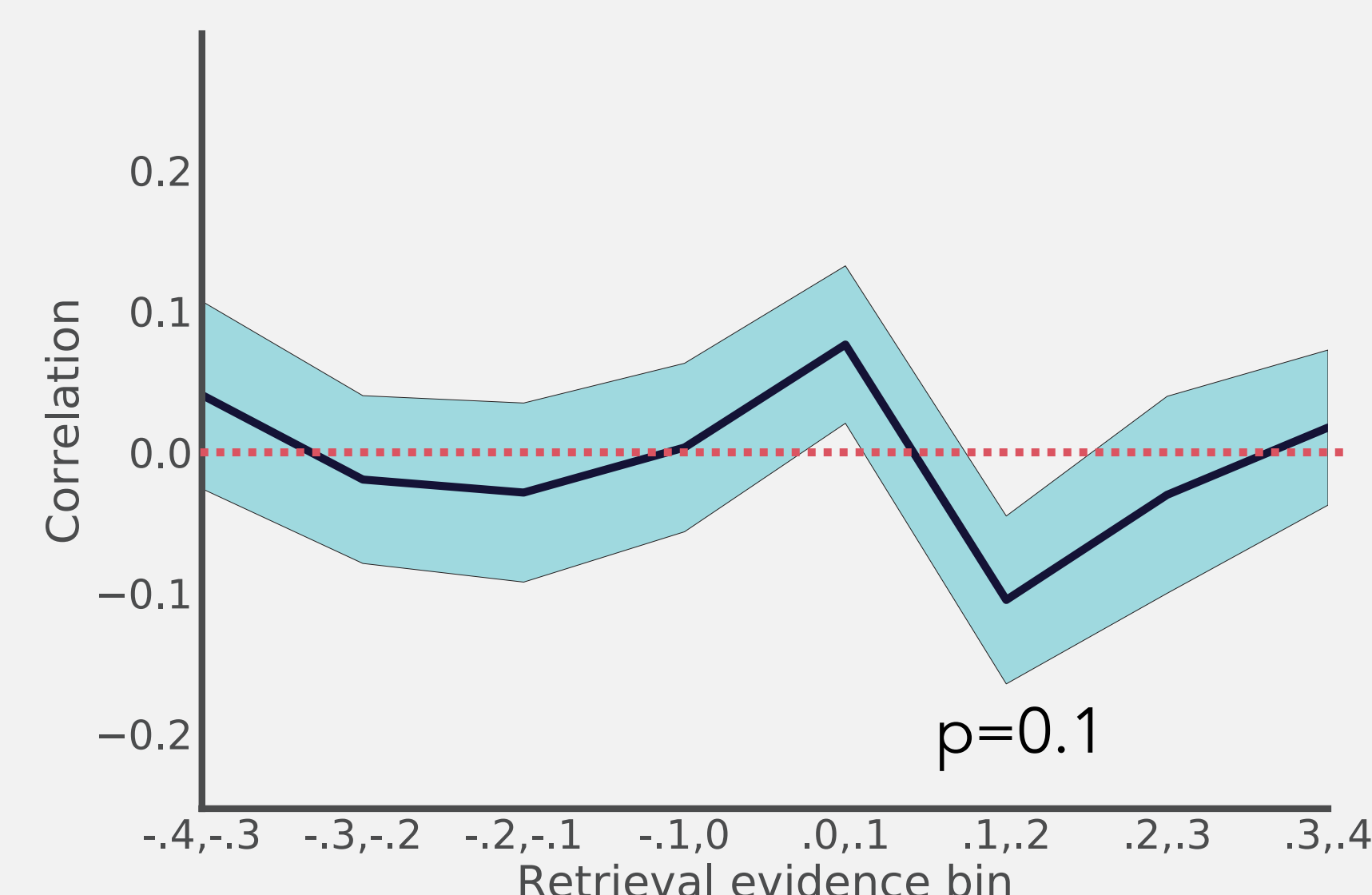


Preliminary correlations with memory activation

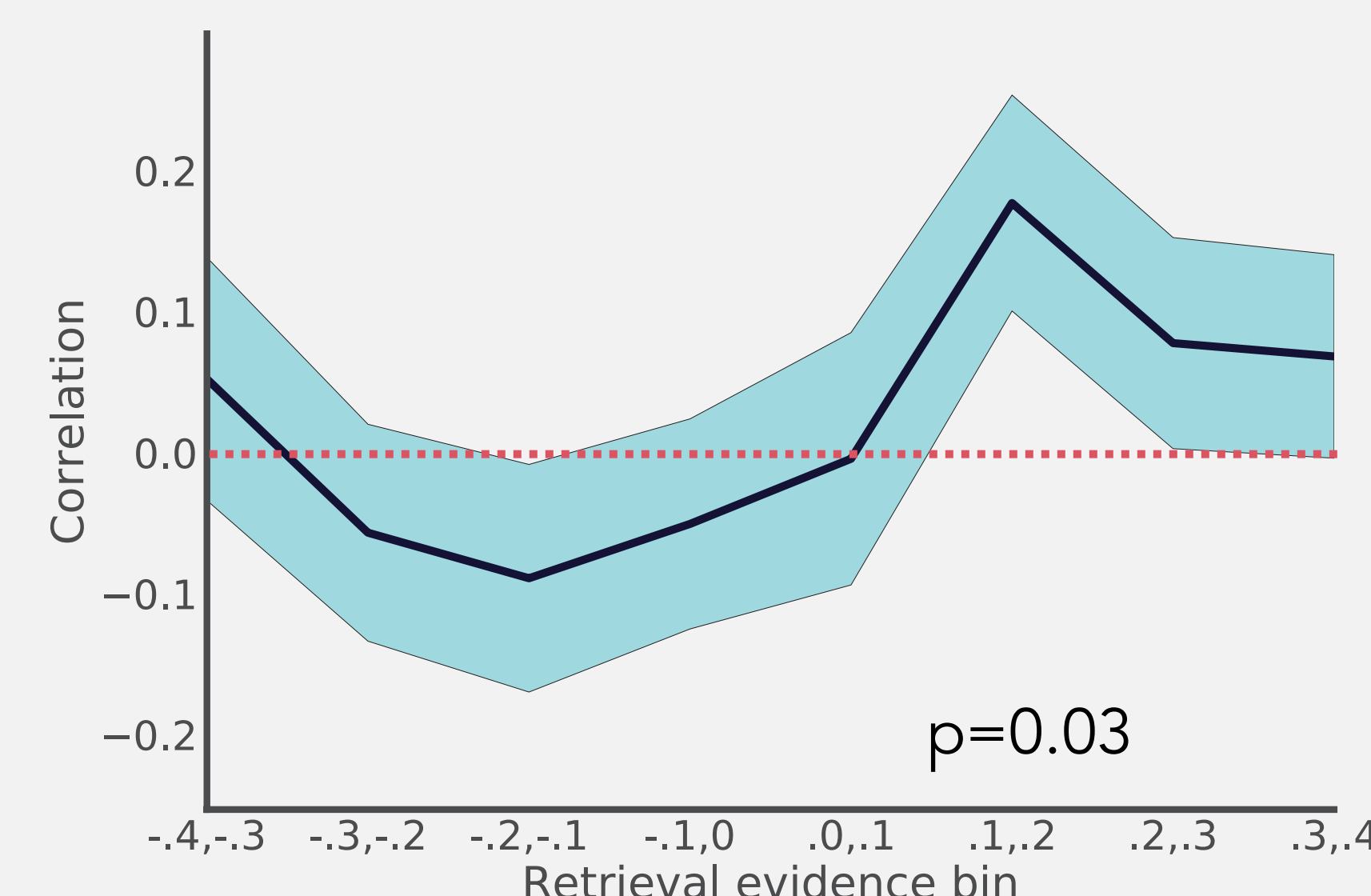
Post - Pre MOT pattern similarity



Post - Pre MOT detail ratings



Recognition RT to lure image



Discussion

We did not accomplish our goal of promoting moderate activation in the real time group. The MOT task was effective at reducing high memory activation, but not at increasing low memory activation.

However, results of preliminary analyses relating retrieval evidence and subsequent memory support the NMPH, with moderate retrieval evidence levels around 0.15 being associated with worse memory performance.

Follow-up analyses will use PCIT² to generate continuous estimations of the relationship between retrieval strength and subsequent memory.

References: [1] Newman & Norman (2010). *Cerebral Cortex*. [2] Detre et al. (2013). *Neuropsychologia*. [3] Kim et al. (2014). *PNAS*. [4] Lewis-Peacock & Norman (2014). *Nat. Commun.* [5] Poppenk & Norman (2017). *J. Cogn. Neurosci.* [6] deBettencourt et al., (2015). *Nat. Neurosci.* [7] Poppenk & Norman (2014). *J. Neurosci.*

Reprints: amennen@princeton.edu

Supported by NIH Training Grant T32MH065214 and Intel Corporation