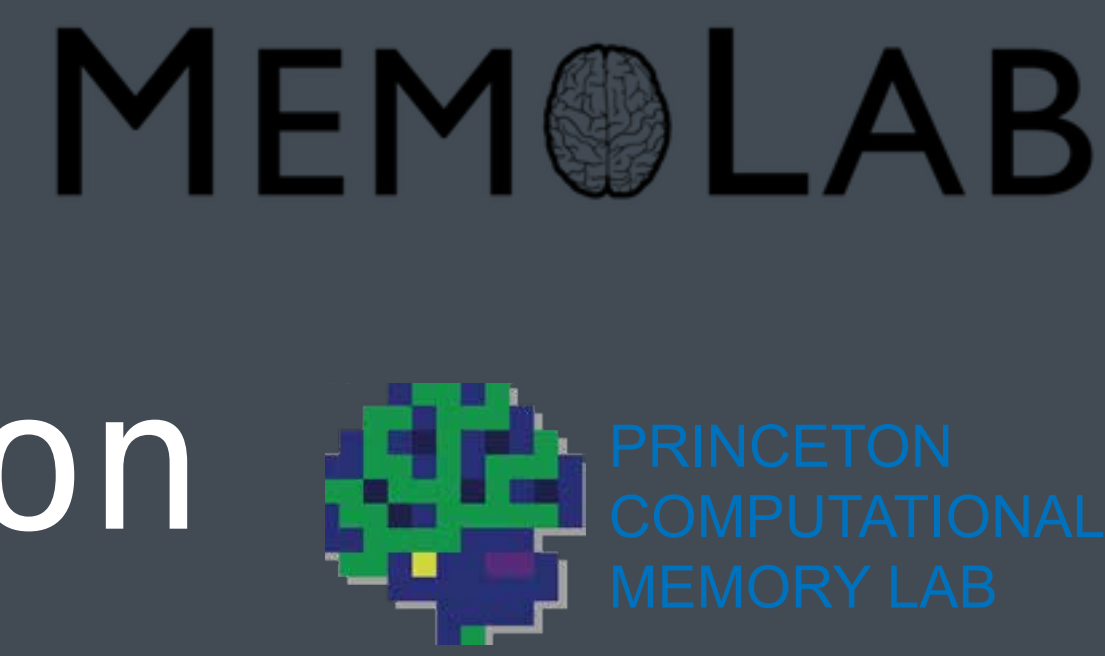




# Eye movements reveal the dynamics of memory reactivation supporting successful memory suppression



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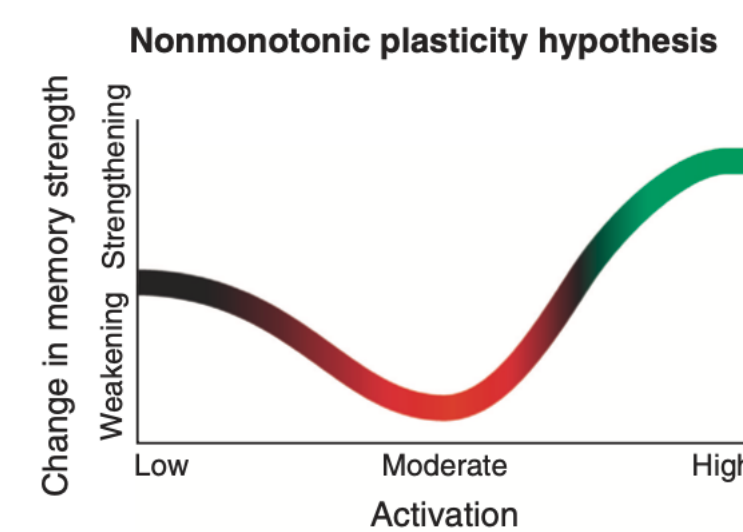
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## Introduction

The ability to control the retrieval of memories is adaptive and may be protective against psychiatric disorders.

Repeatedly engaging in retrieval suppression of a specific memory can lead to memory weakening (forgetting).

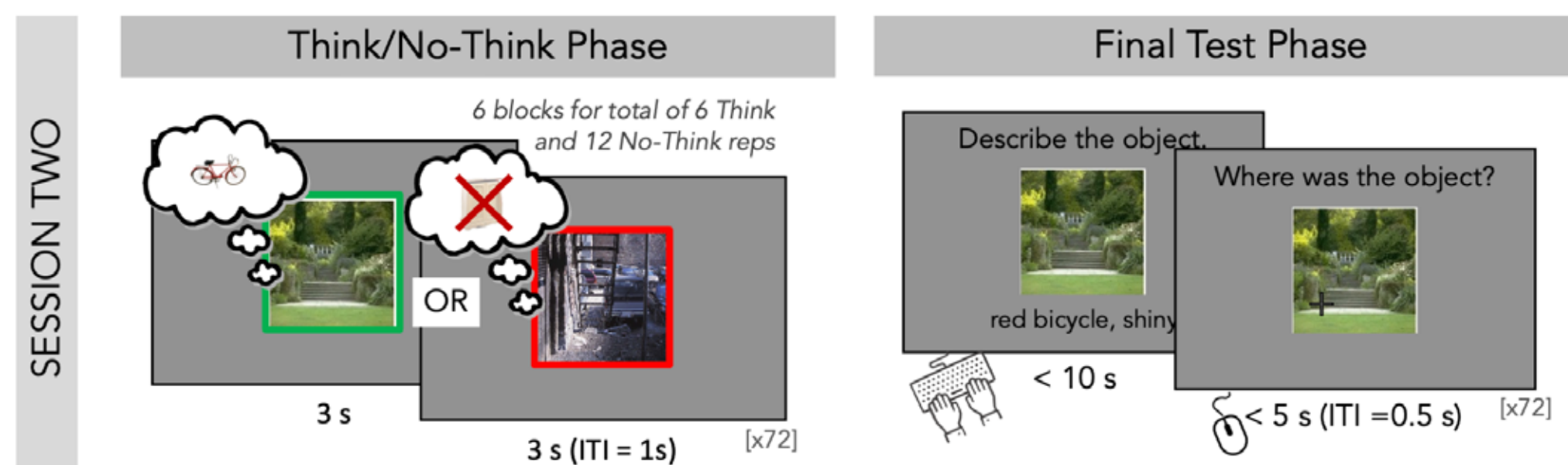
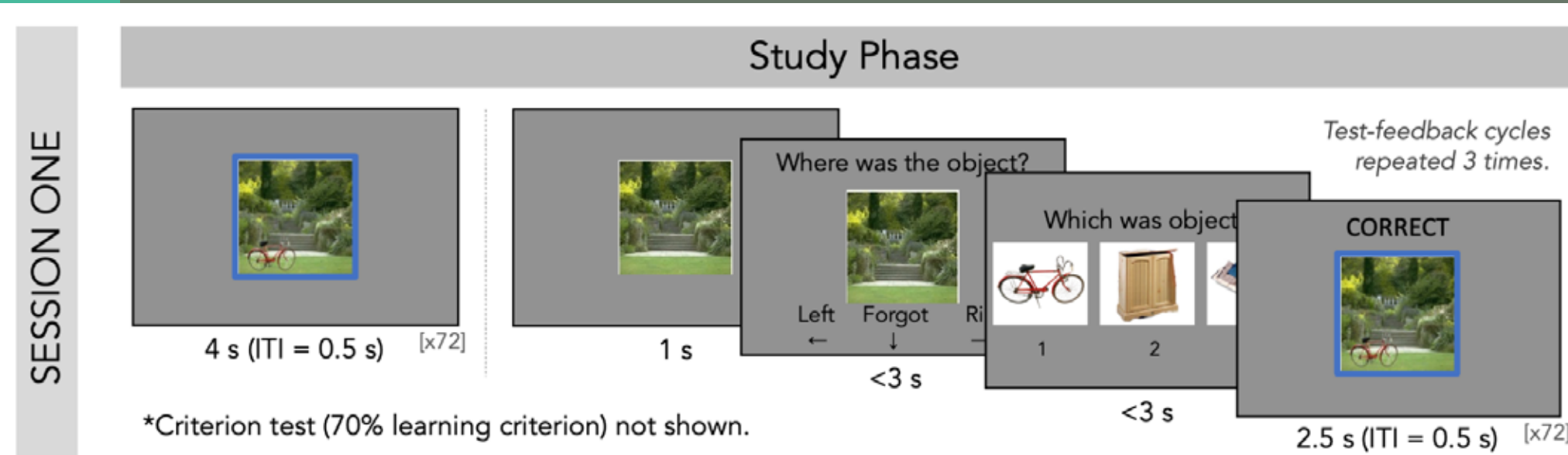
The NMPH predicts that during voluntary memory suppression, forgetting occurs when memories enter a moderate state of activation.



We used **eye-tracking** and a **think/no-think** task to covertly measure the strength of memory reactivation during retrieval suppression.

Across two experiments (N=21; 34), we tested if **gaze reinstatement** can distinguish the process of **retrieval vs. suppression**, as well as **successful vs. unsuccessful suppression**.

## Experimental design



Memoranda consisted of object-background "scenes" in which each object was presented either on the left or the right (72 total scenes). Half of the scenes were negatively valenced. Gaze reinstatement was assessed during think/no-think phase. Eye tracking was done via a Tobii Pro Spectrum with a 120hz sampling rate. Final memory test was free response, participants were shown the background image and prompted for both object identity and location.

## Approach & Results

### Gaze Reinstatement

Did the participant look at the same side of the screen where the object was encoded?

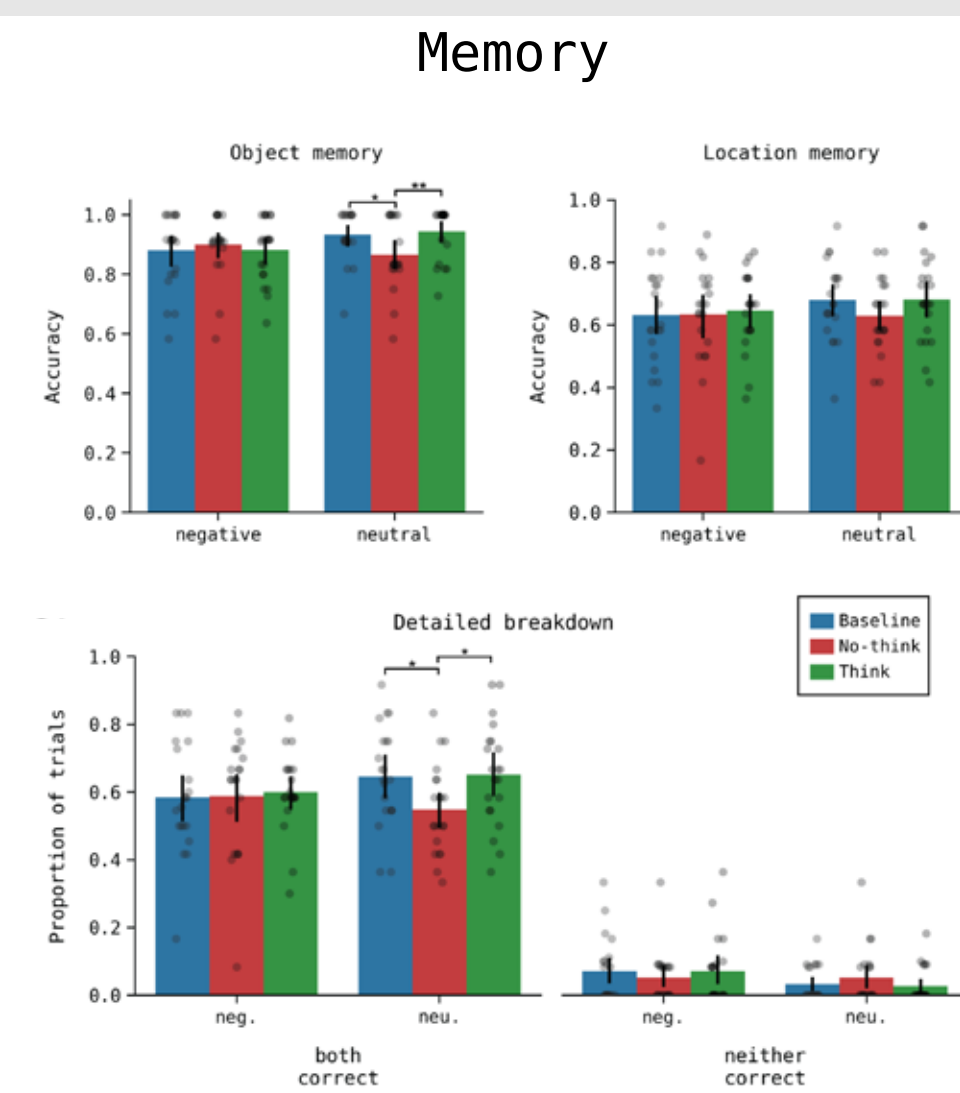
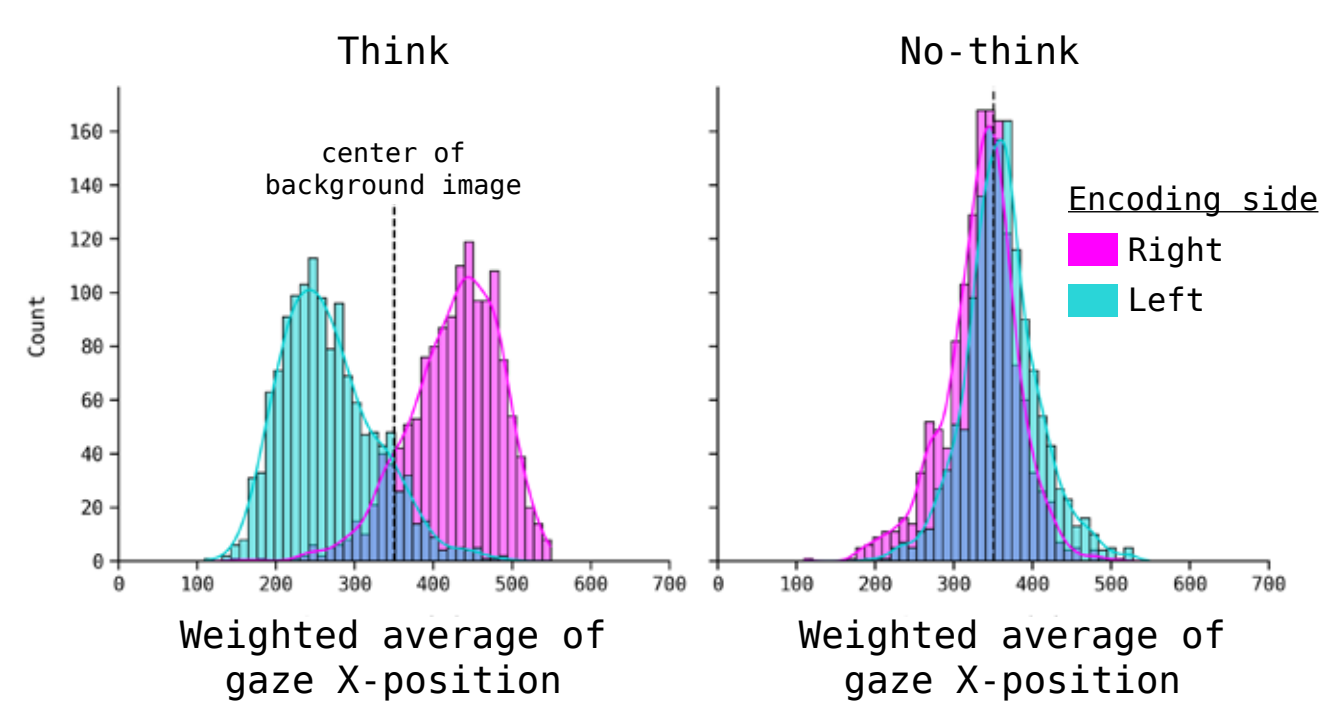


fixation density map

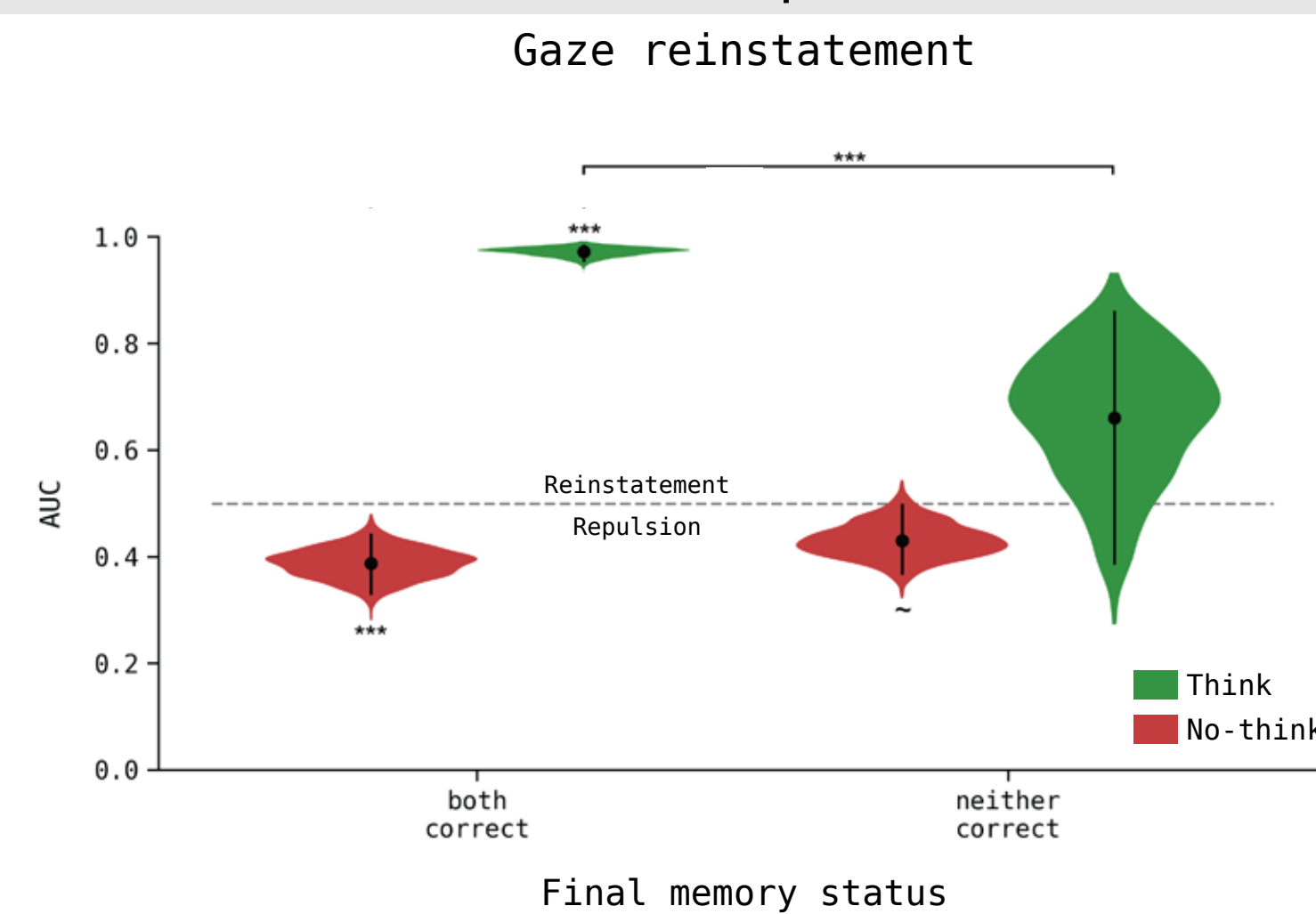
Gaze reinstatement is measured by computing the AUC of trials on which the object was encoded on the left vs. the right.

AUC values greater than 0.50 indicate significant **gaze reinstatement**, while AUC values less than 0.50 indicate significant **gaze repulsion**.

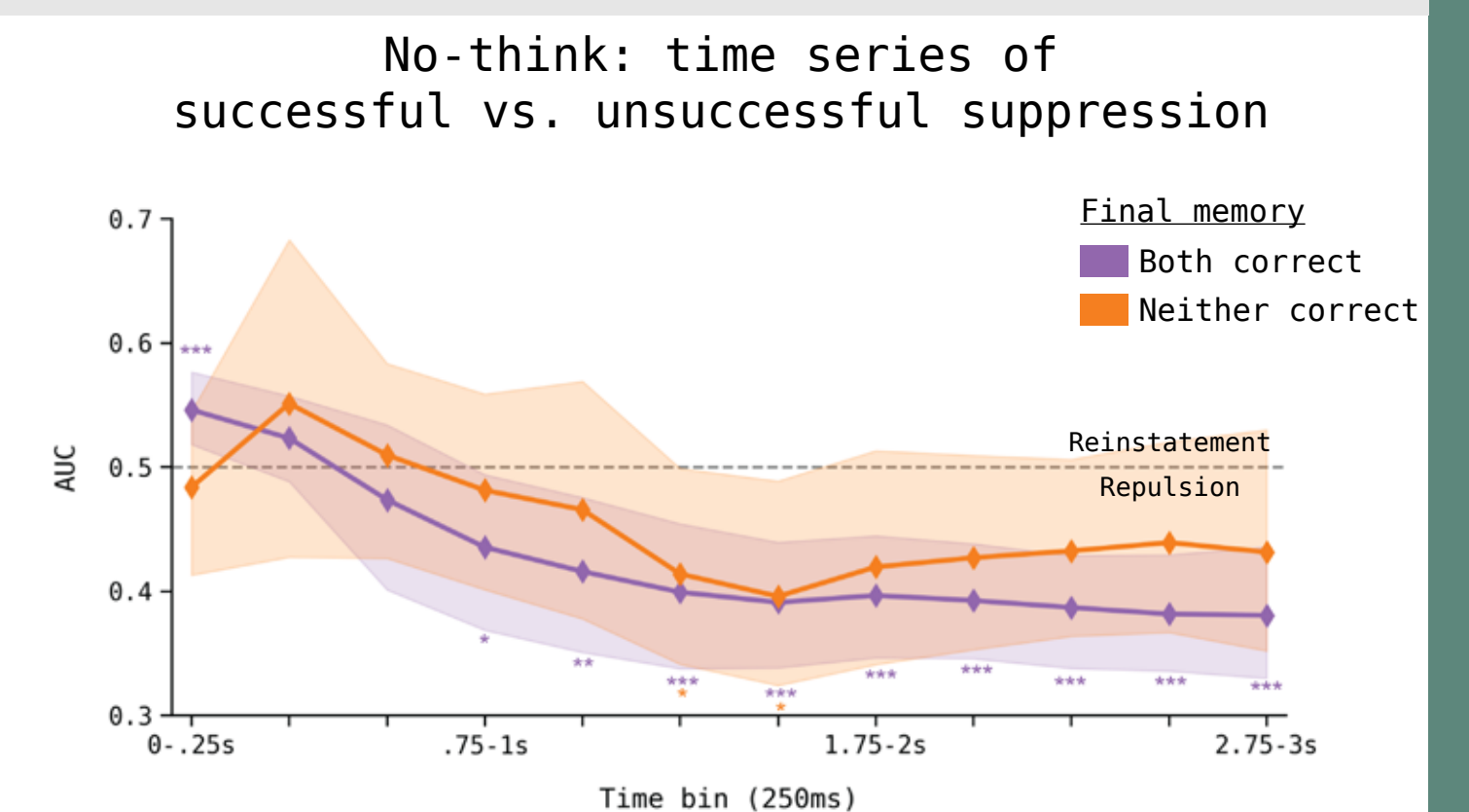
Significance was assessed via fixed effects bootstrapping (whole subject).



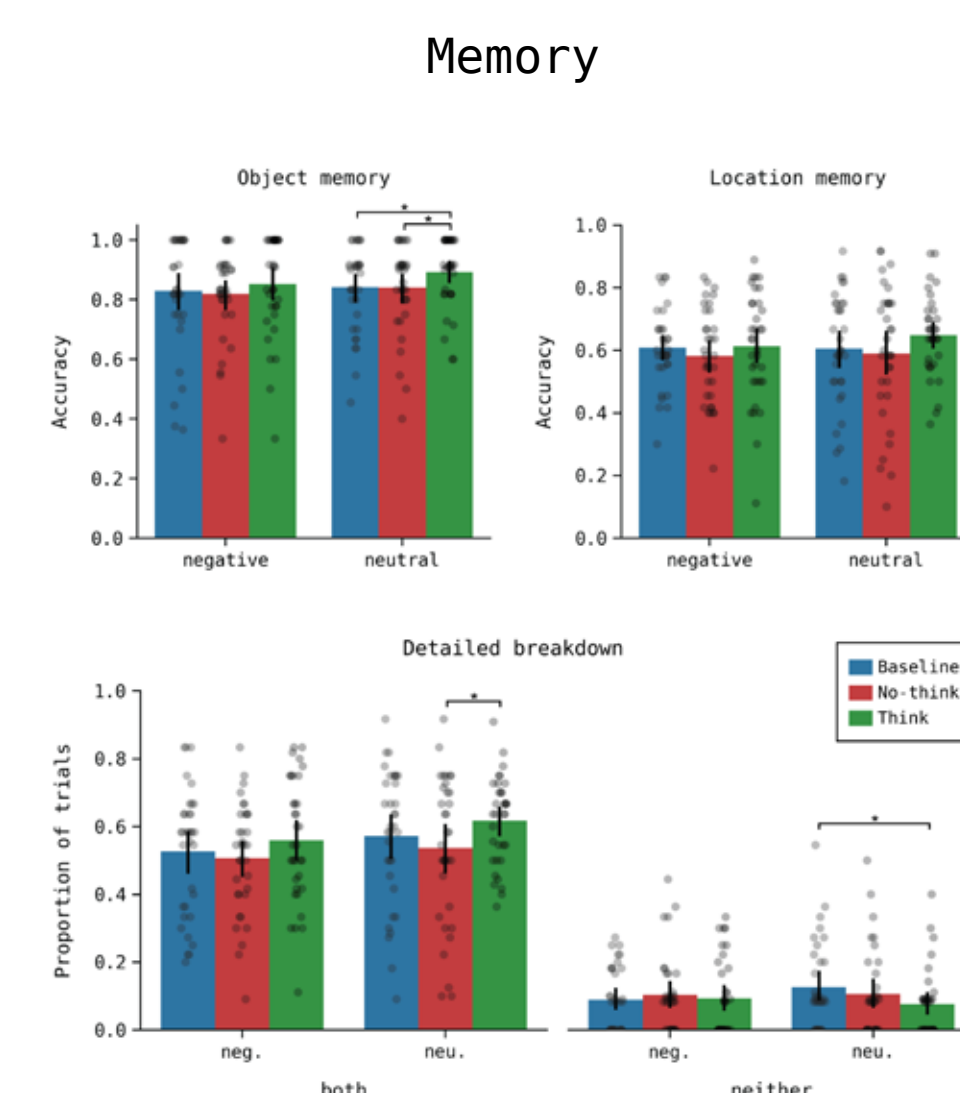
We observed a full suppression effect for neutral scenes. This was driven mainly by memory for object identity.



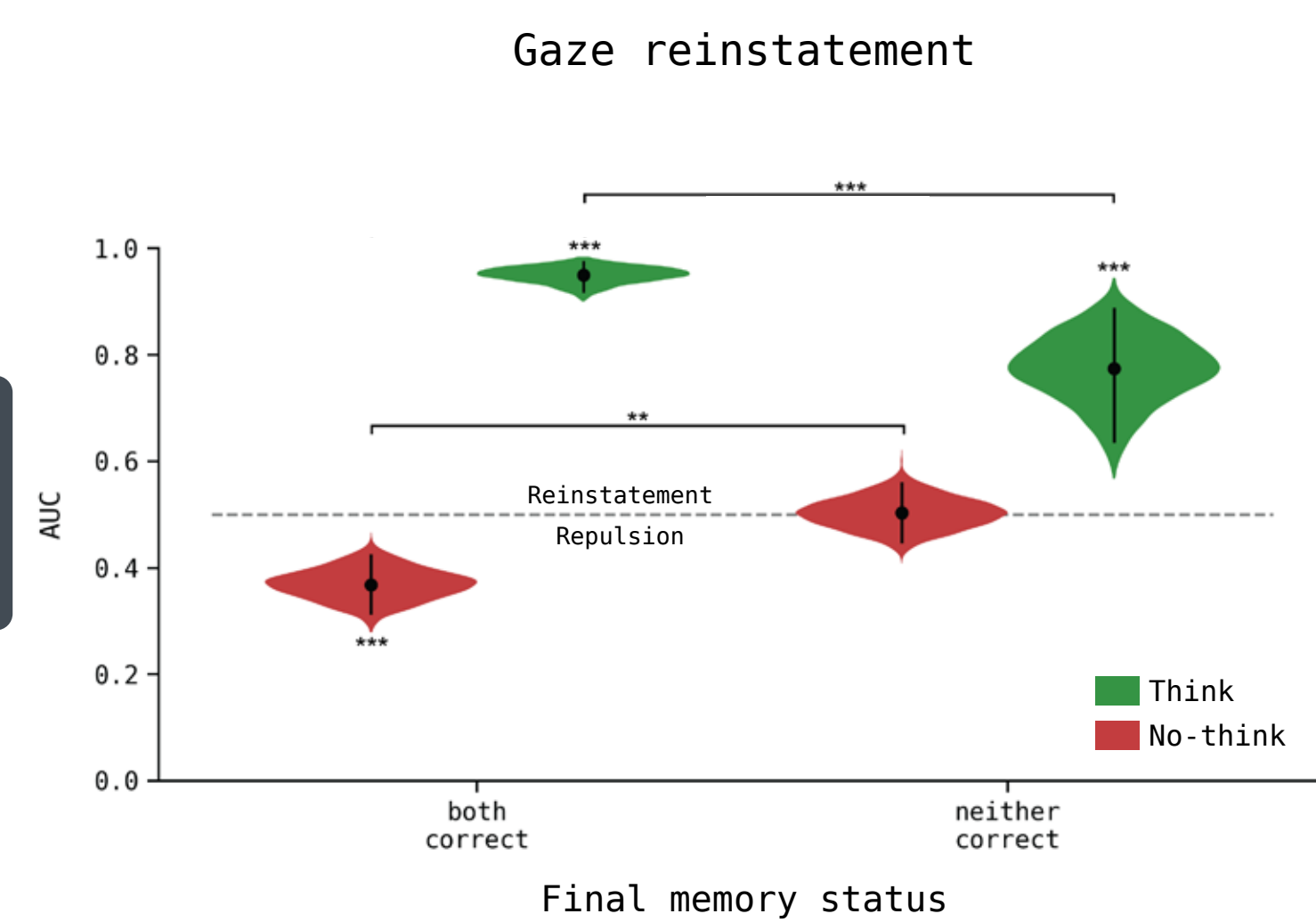
There was significant gaze reinstatement on think trials, as well as significant gaze repulsion on no-think trials. Successful suppression (neither correct at final memory test) was associated with only marginal gaze repulsion.



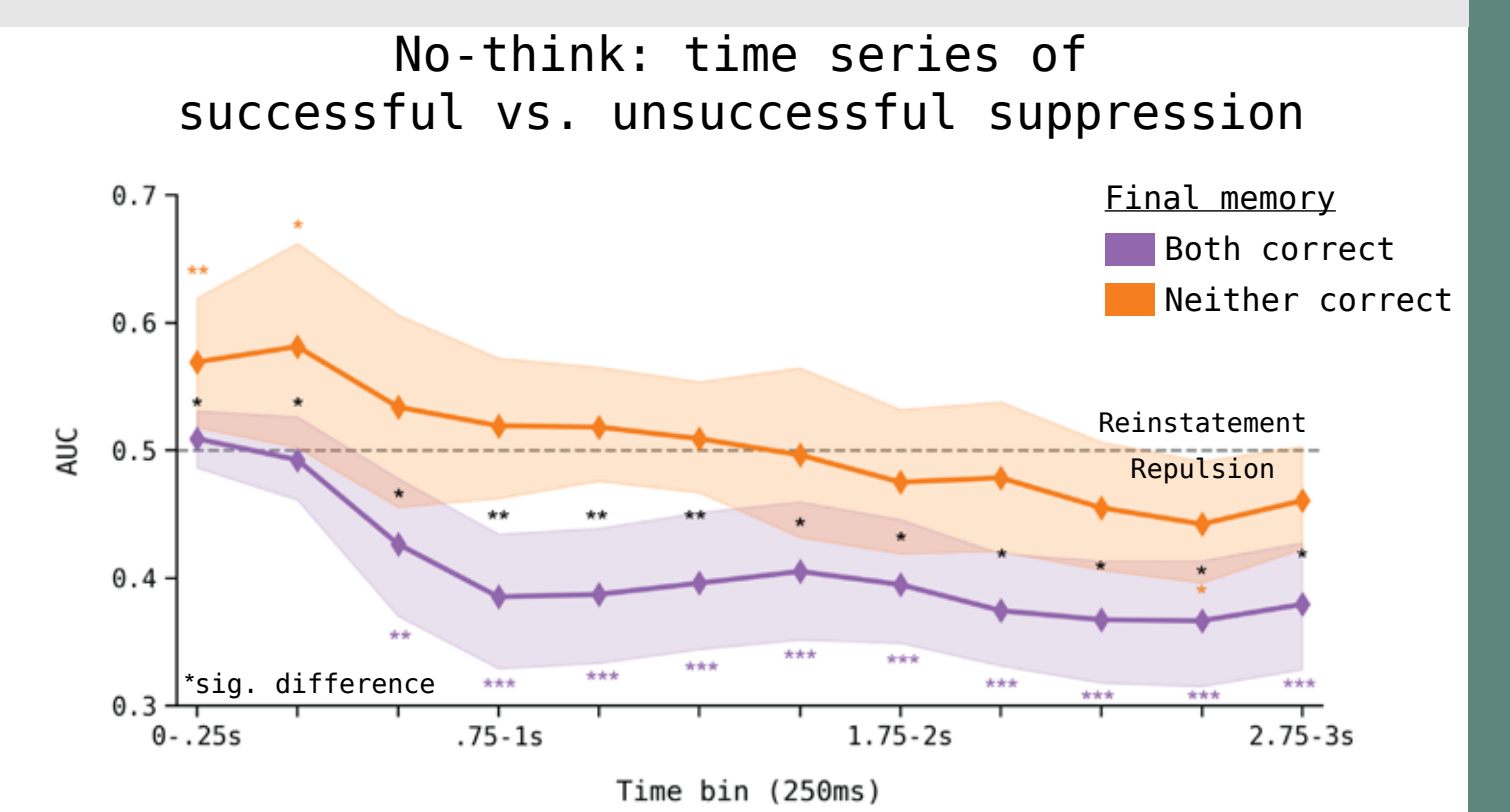
We observed a trend (n.s.) of initial reinstatement followed by subsequent repulsion for successful suppression (neither correct). There were no differences between successful vs. unsuccessful suppression.



There was only a mild suppression effect for neutral scenes. This was again driven mainly by memory for object identity.



Replication of our main findings: Think = gaze reinstatement No-think = gaze repulsion. Successful suppression (neither correct) was associated with neither reinstatement nor repulsion. Gaze repulsion was stronger for unsuccessful suppression (both correct) compared to successful suppression.



We observed significant initial reinstatement followed by significant repulsion for successful suppression (neither correct). We interpret this as a state of moderate activation supporting memory modification (NMPH). Successful vs. unsuccessful suppression were significantly different at every time point (FDR corrected).

## Conclusions

By combining a novel experimental design with eye-tracking, we show that the cognitive operations of retrieval and retrieval suppression are associated with distinct patterns of eye gaze.

When participants engaged in memory retrieval (think) there was significant gaze reinstatement to the side on which the memory was encoded. In contrast, when participants engaged in retrieval suppression (no-think) there was significant gaze repulsion away from the encoding side.

In our replication experiment, we observed distinct patterns of gaze reinstatement/repulsion for successful vs. unsuccessful retrieval suppression. Successful suppression (forgetting) was associated with an initial reinstatement to the encoding side followed by subsequent repulsion.

Through the lens of the non-monotonic plasticity hypothesis, this initial gaze reinstatement might represent a moderate state of memory reactivation needed for memory weakening.