Repetition-related memory signals in parietal cortex integrate information about stimulus content

Yufei Zhao[1], Emily J. Allen[2], Yihan Wu[2], Thomas Naselaris[2], Kendrick Kay[2], Brice A. Kuhl[1], J. Benjamin Hutchinson[1]

1. University of Oregon 2. University of Minnesota

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Contact: yzhao17@uoregon.edu / http://zhaoyufei.rbind.io

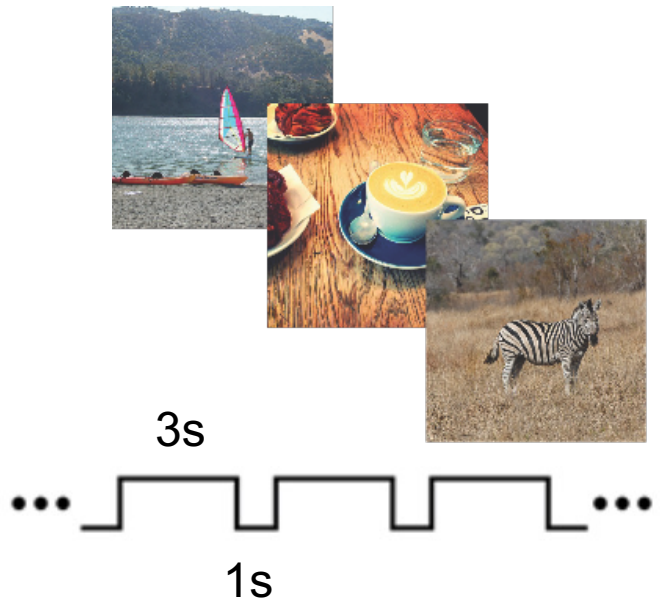
Introduction

- Successful recognition of previously-encountered stimuli is associated with increased activation in parietal cortex.
  - *Content-general effect of stimulus repetition*
- However, pattern-based fMRI studies have found that information about the content of stimuli is also reflected in activity patterns in parietal cortex.
- How do pattern-based content representations in parietal cortex relate to univariate effects of recognition memory?

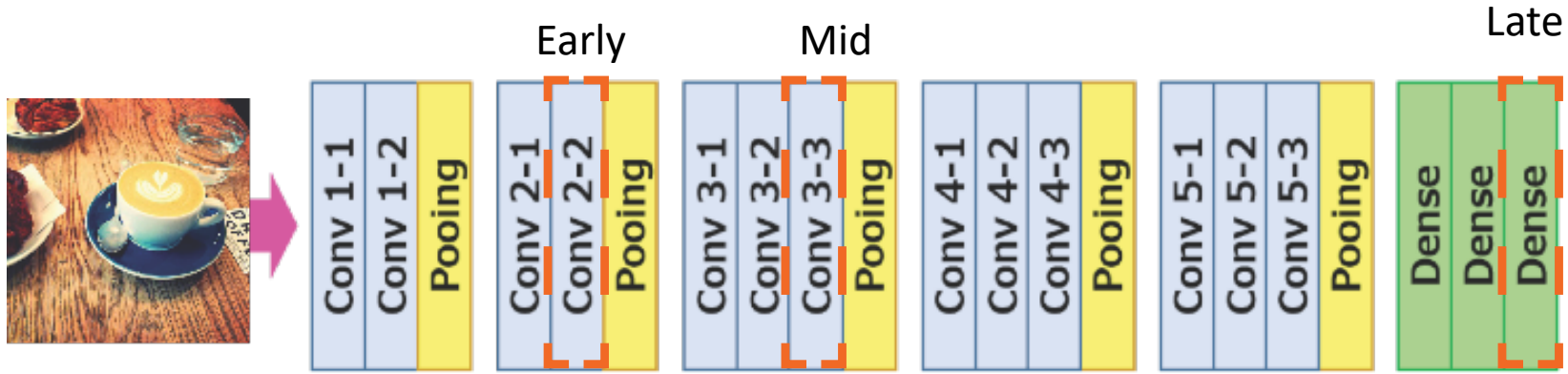
Method

- Subjects — N = 8
- Stimuli — ~10,000 images from COCO dataset
- Trials — ~30,000 per subject
  each image repeated up to 3 times
- Sessions — 30 - 40 fMRI scan sessions per subject
- Duration — 8 - 10 months

- Continuous recognition task
  - “Have you seen this image before?”
  - Yes/No



Quantifying memory content (VGG16)



Early layers: captures low level visual features

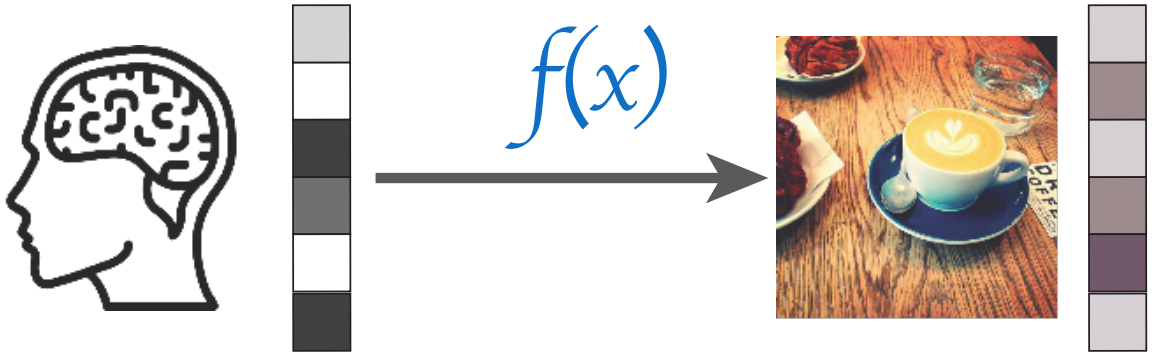
Extract feature maps from multiple layers

Late layers: captures semantic features

Plot stimuli based on feature map distance (t-SNE)

Mapping the memory signal to content

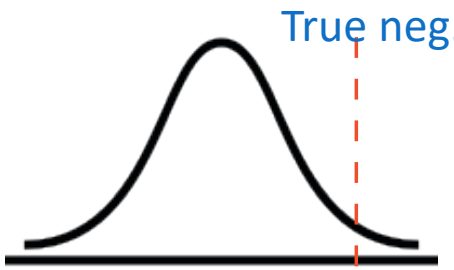
- Ridge regression



Brain signal

VGG feature maps (top 10 PCs)

- Z-scored neg. MSE

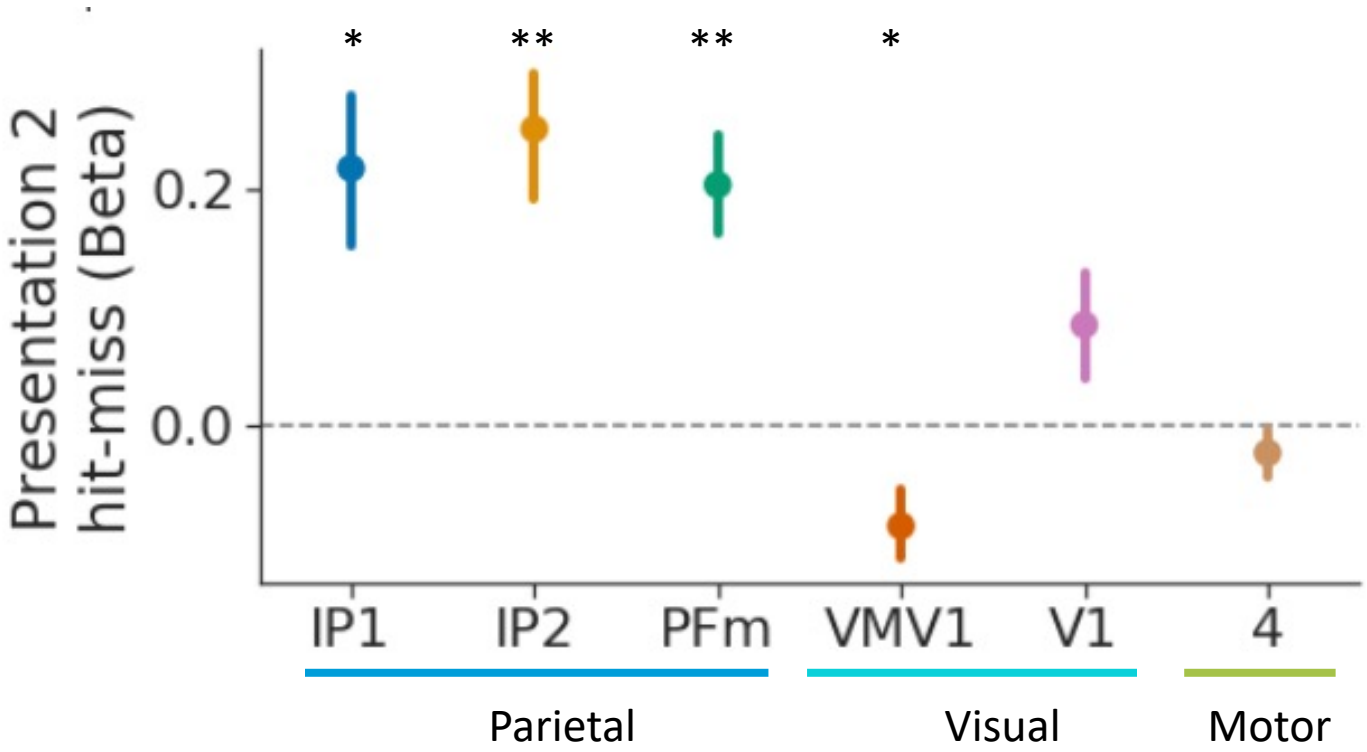


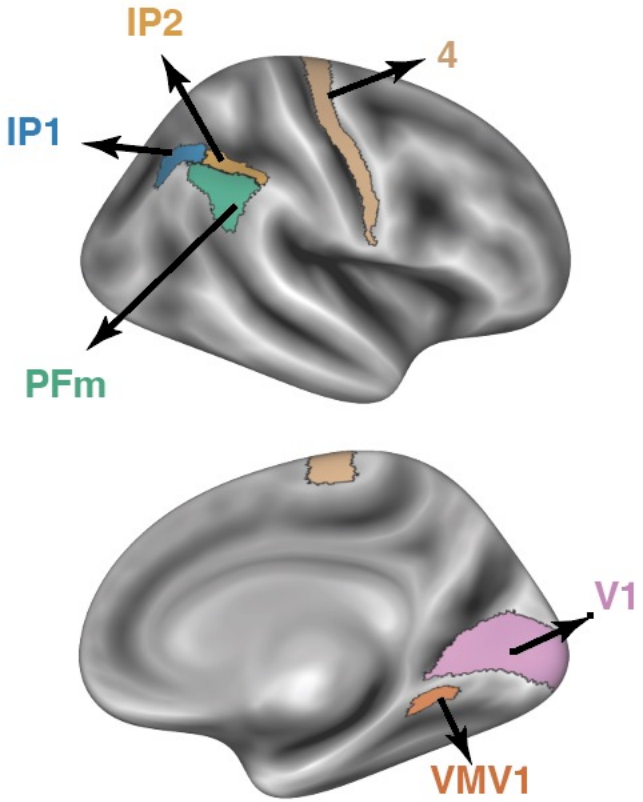
100 permutation tests neg. MSE distribution

Z-scored neg. MSE: higher value, better prediction

ROI selection

- Univariate activity reflects memory success

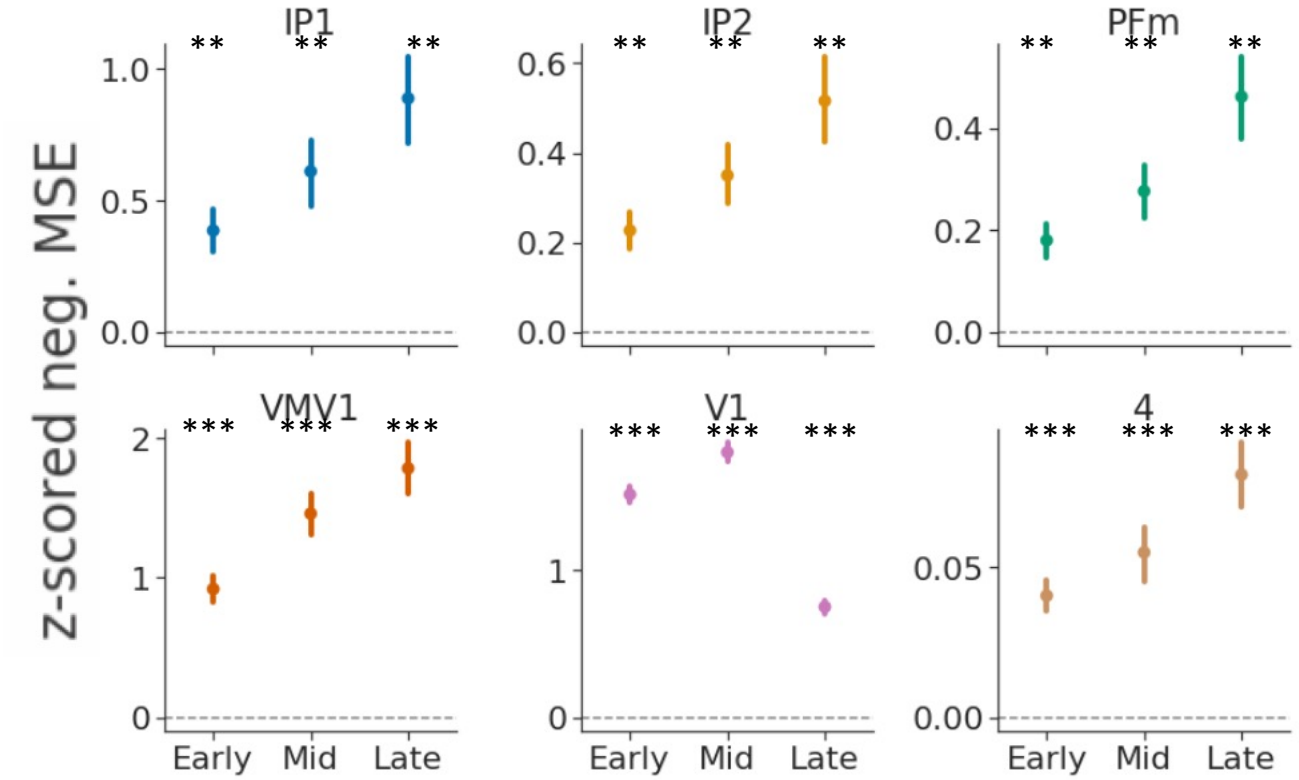


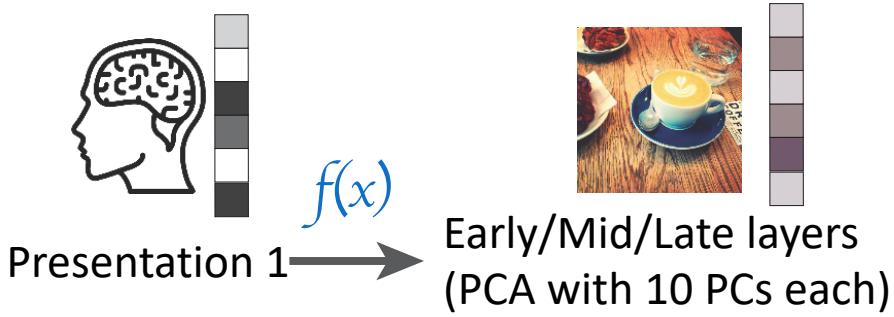


* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

ROI selection

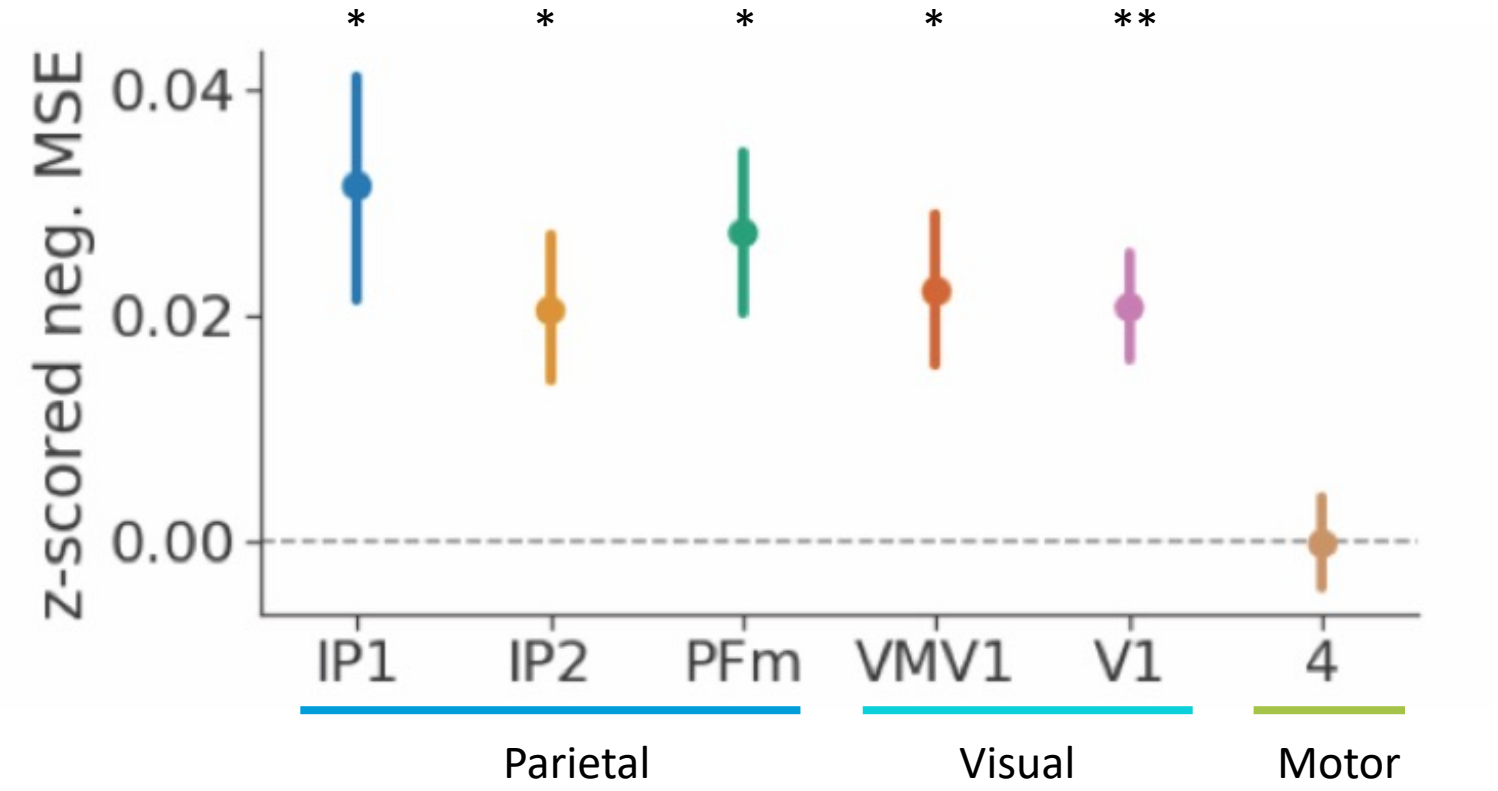
- Neural activity during presentation 1 predicts memory content

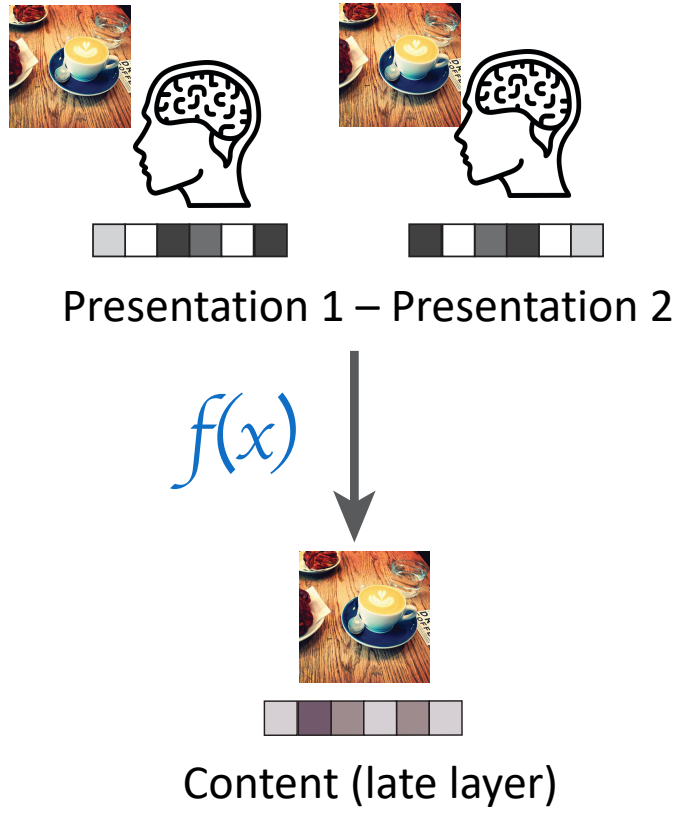




Repetition-related differences and content decoding

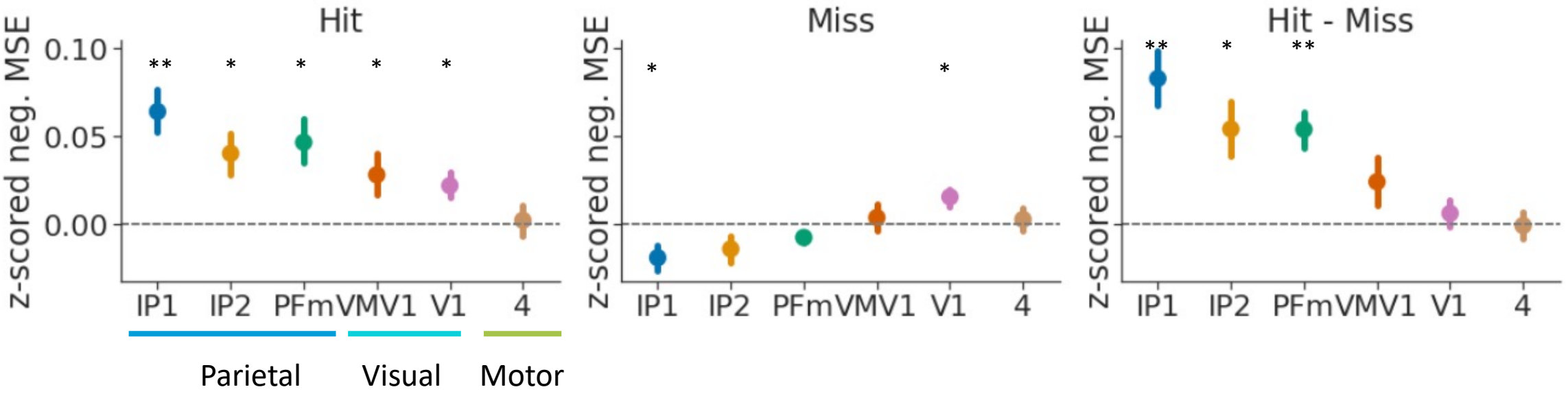
- Repetition-related differences in visual and parietal regions predict memory content





Repetition-related differences across memory outcomes

- Repetition-related differences in parietal regions predict memory content for successful recognition only



Discussion

- Repetition-related differences in parietal activity predict image content.
- Predictions were significantly better for hits (correct recognition) compared to misses (failed recognition)
  - *Indicates that content information was directly related to successful recognition.*
- Repetition-related differences in occipitotemporal cortex also predicted image content, but the success of these predictions was less dependent on behavioral measures of successful memory recognition.
- Collectively, our results indicate that repetition-related increases in activation—which have consistently been observed in parietal cortex—integrate information about the content of what is being remembered.

Reference

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