

# The effects of content-dependent competition on working memory capacity

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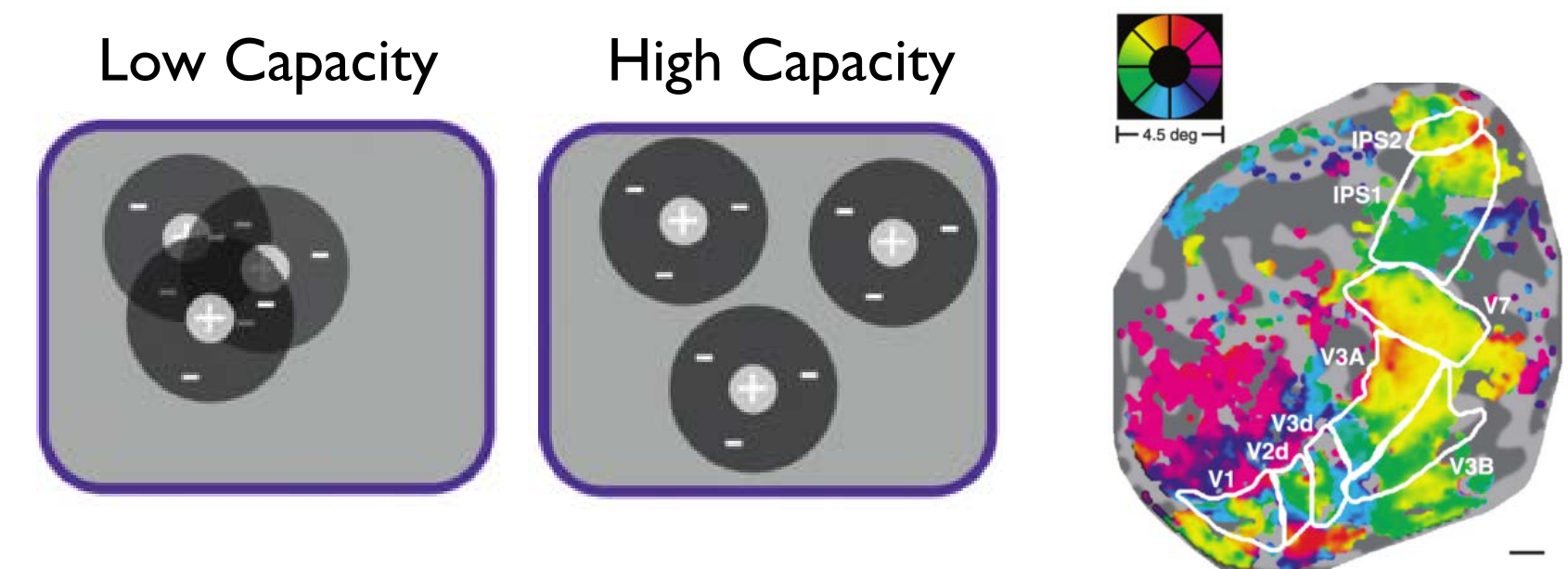
## QUESTION

How does competition within working memory impact memory capacity?

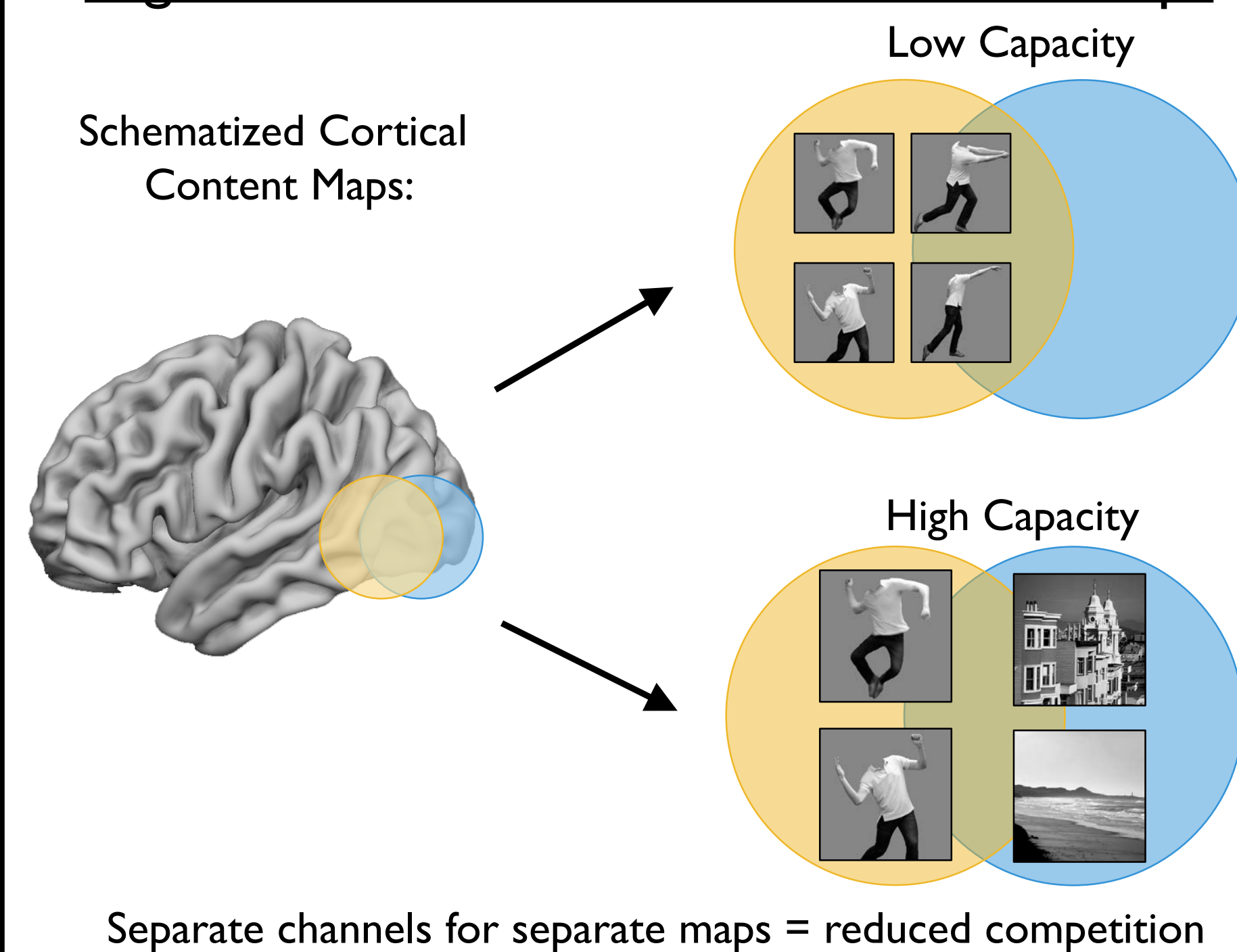
## Background

- Attention and working memory (WM) have limited capacity<sup>1</sup>
- Sensory-recruitment theory: WM maintenance depends on the same neural substrates that support sensation and perception<sup>2</sup>
- Hypothesis:** flexible capacity limits for attention and WM stem from competition for representation in cortical content maps that correspond to distinct information channels<sup>1,3-6</sup>

### Spatial attention and topographic maps:



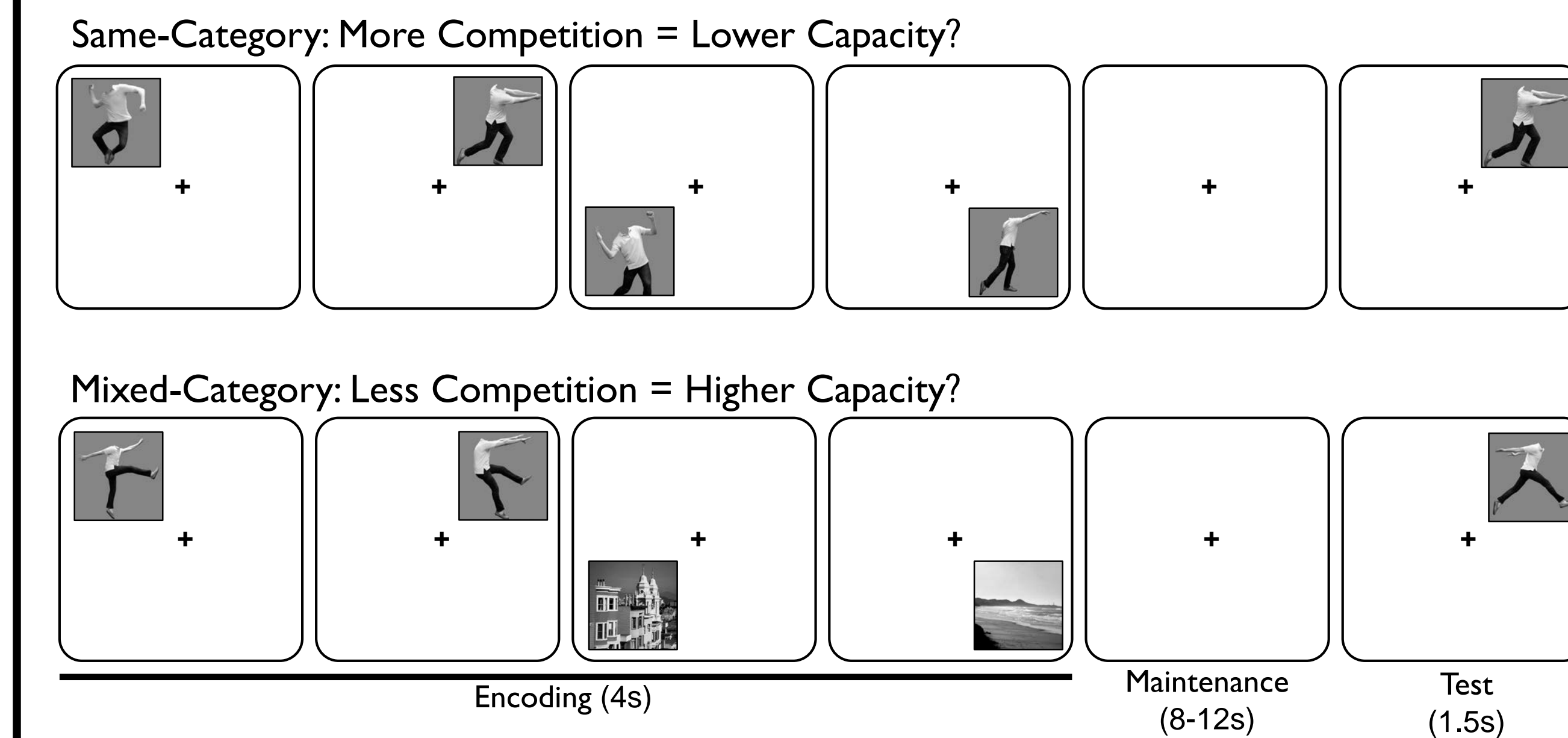
### High-level visual attention and content maps:



- Prediction:** WM is likewise limited by content-dependent competition that occurs between internally maintained representations

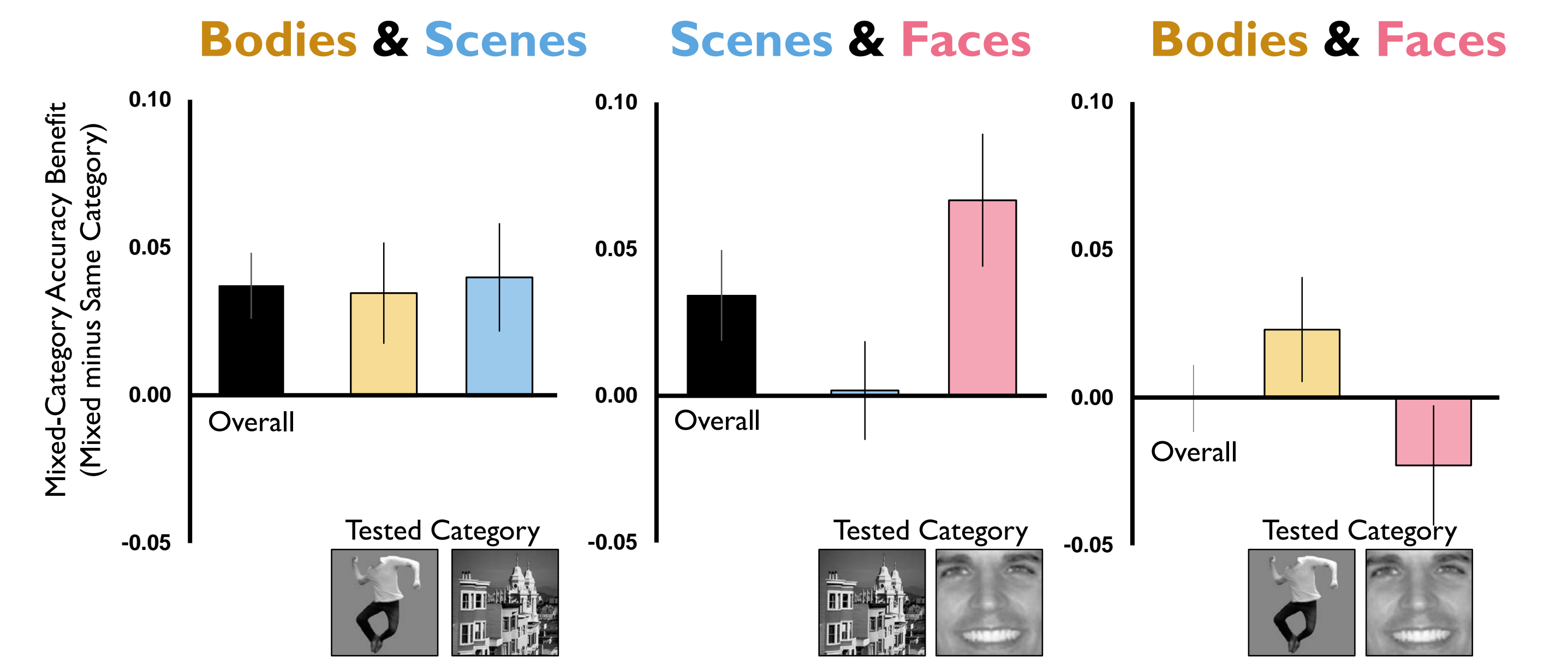
## How is WM capacity impacted by content-dependent competition?

### Task & Logic:



- Sequential encoding restricts competition to within WM<sup>7</sup>
- Competition should be less when items spread across categories<sup>1,4</sup>

### Results:

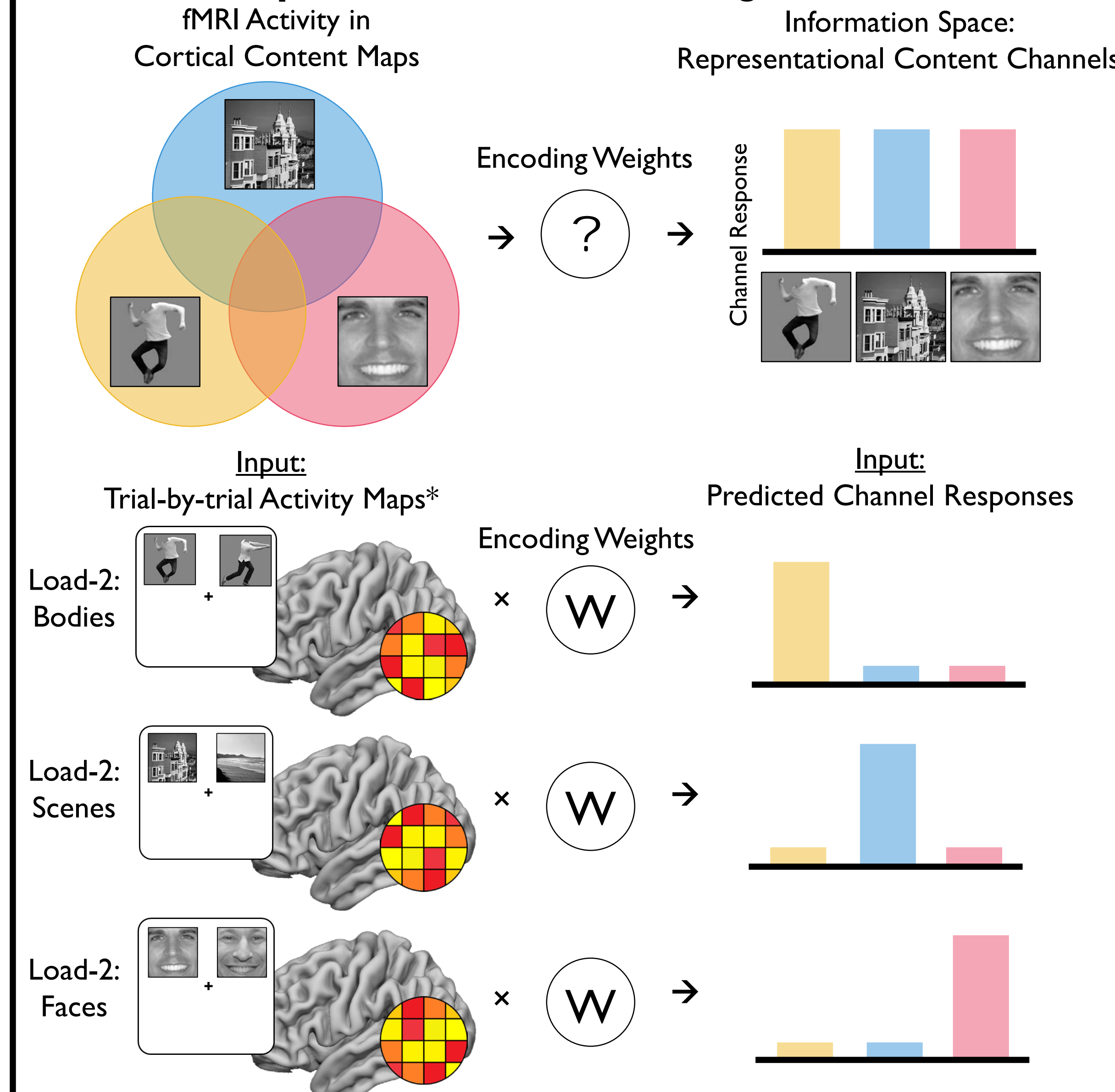


- Capacity is higher when memoranda are spread over multiple categories
- Magnitude of mixed-category benefit depends on specific content pairing

## Reconstructing representational channels from cortical content maps

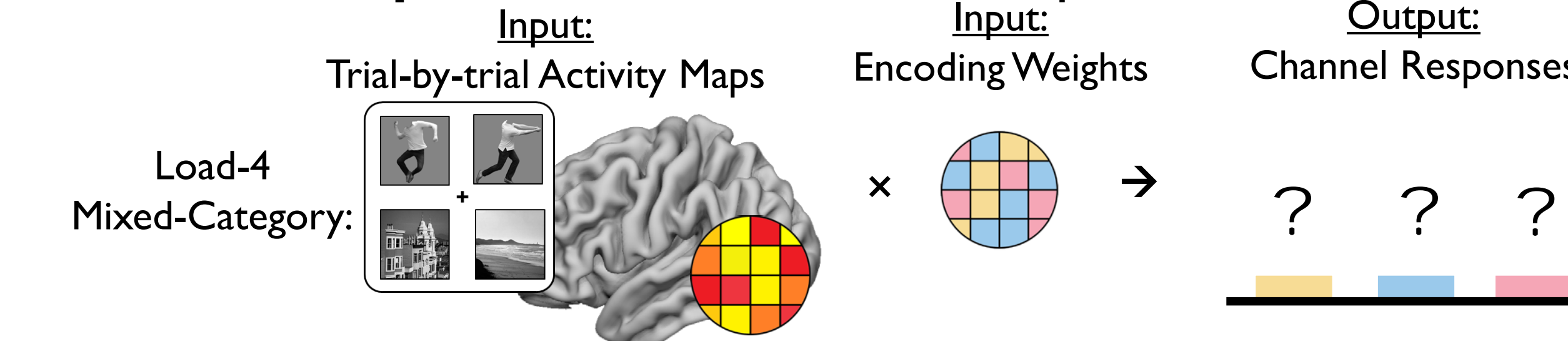
**Approach:** reconstruct maintained information in representational content channels from multivariate delay-period activity

**Method - Step 1:** build forward-encoding model<sup>9</sup> with Load-2 trials



<sup>9</sup>all items presented sequentially; fMRI activity from 8-12s maintenance period  
<sup>10</sup>occipitotemporal ROI defined from independent localizer: Load-2 change detection task

**Method - Step 2:** reconstruct channel responses for novel data



### Predictions:

- Encoding model can reconstruct representational channels for high-level visual categories during WM maintenance
- Information on mixed-category trials is spread across multiple representational channels

### Results:



- Representational channels supporting WM maintenance for high-level visual stimuli can be successfully reconstructed via novel forward-encoding model
- Consistent with map framework that posits content-dependent information channels<sup>1</sup>

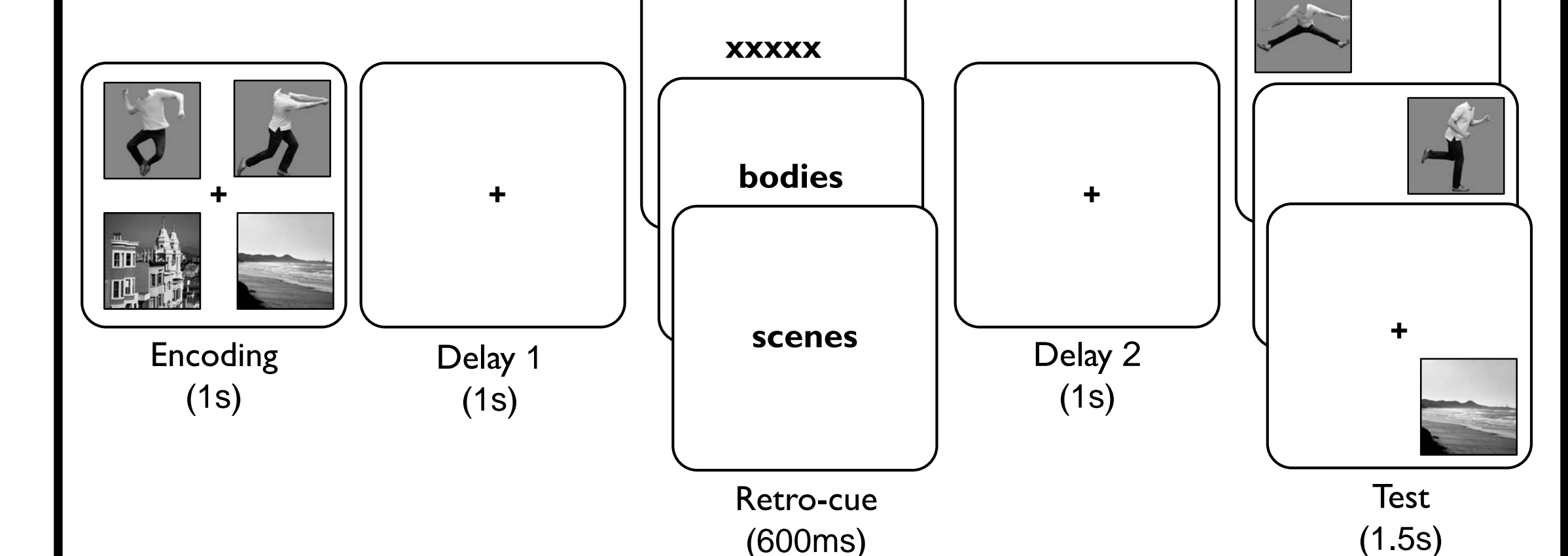
## CONCLUSIONS

- Competition depends on the nature of memory content and contributes to WM capacity limits
- Representational channels in occipitotemporal cortex support WM maintenance; can be reconstructed via forward-encoding modeling
- Top-down control can prioritize among competing categories within WM

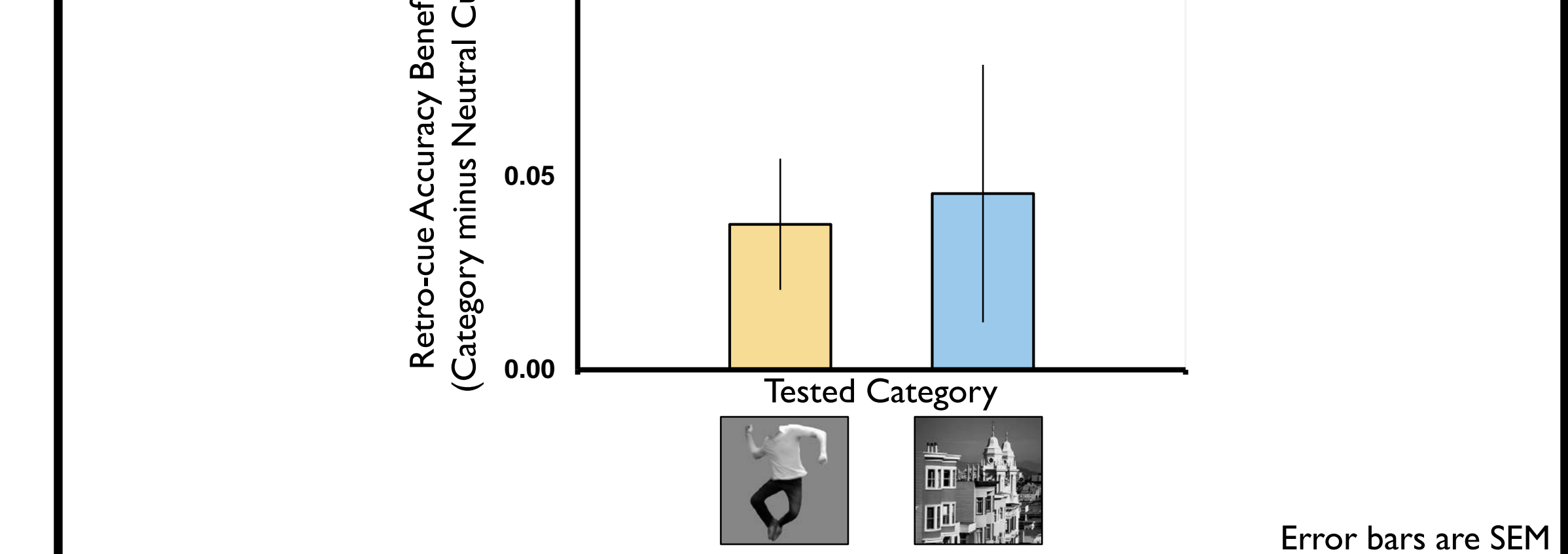
## Controlling competition

- Top-down control can manage limited attentional and memory resources<sup>2,5</sup>
- Can a **retrospective cue** be used to prioritize a category competing for representation in WM?<sup>10,11</sup>

### Task:



### Results:



- Benefit for categorical retro-cues to multiple items
- Demonstrates benefit beyond spatial cues / single items
- Next: probing the causal influence of top-down control with simultaneous TMS-fMRI

<sup>1</sup> Franconeri et al., 2013, JCS; <sup>2</sup> D'Esposito & Postle, 2015, Ann Rev Neuro; <sup>3</sup> Scimeca & Franconeri, 2015, WIREs; <sup>4</sup> Cohen et al., 2014, PNAS; <sup>5</sup> Desimone & Duncan, 1995, Ann Rev Neuro; <sup>6</sup> Silver & Kastner, 2009, JCS; <sup>7</sup> Beck & Kastner, 2005, Nat Neuro; <sup>8</sup> Brouwer & Heeger, 2009, JNeurosci; <sup>9</sup> Souza & Oberauer, 2016, AnP; <sup>10</sup> Myers, Stokes, & Nobre, 2017, JCS; <sup>11</sup> We thank N. Quazi, Y. Nishi, W. Huerta, C. Muse-Fisher, A. Kyonaga, & E. Lorenz for assistance and insight. This research is supported by NIH grant MH63901. Questions or comments? Please contact Jason Scimeca: jscimeca@gmail.com