BRAIN NETWORKS SUPPORTING THE COMPOSITION AND PRECISION OF EPISODIC MEMORY

Rose Cooper & Maureen Ritchey

Presentation #: 248.03

Department of Psychology, Boston College, MA

BACKGROUND

Remembering past experiences involves the reinstatement and integration of different types of details as a coherent event. This process of recollection is accompanied by increased communication of a widespread network of brain regions with hubs such as the hippocampus [1,2].

Despite this behavioral and neural complexity, we still know very little about how specific interactions between brain regions support episodic retrieval and the precision of different types of features within memory.

Previous research [3] has proposed that memory for item-specific and emotional details is supported by an *anterior-temporal (AT) system* connected to perirhinal cortex (PRC), whereas memory for spatial-contextual information is supported by a *posterior-medial (PM) system* connected to parahippocampal cortex (PHC).

Here we test how these networks interact with each other and the hippocampus to support the reinstatement and precision of distinct features bound within multimodal episodic memories.

STUDY DESIGN

28 healthy young adults scanned (12 males and 16 females).

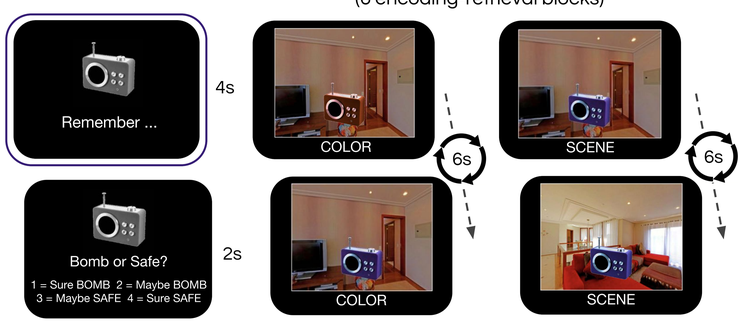
ENCODING PHASE

144 objects with:

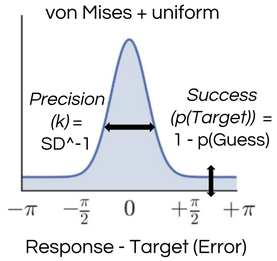
1. a negative 'bomb' or neutral 'safe' *sound*.
2. a *color* from a circular color spectrum.
3. a *location* within a 360° panorama scene (6 total).

RETRIEVAL PHASE

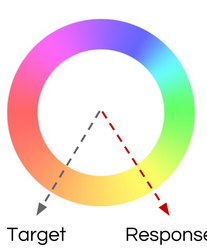
(6 encoding-retrieval blocks)



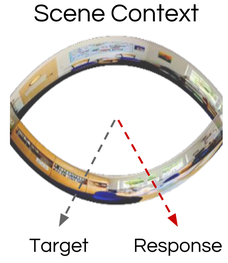
Mixture Model:
von Mises + uniform



Item Color

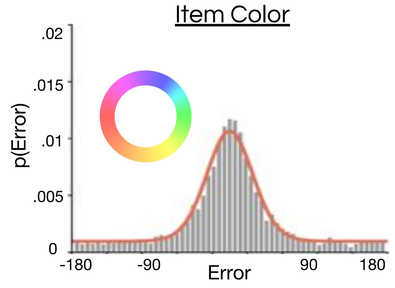


Panorama Scene Context

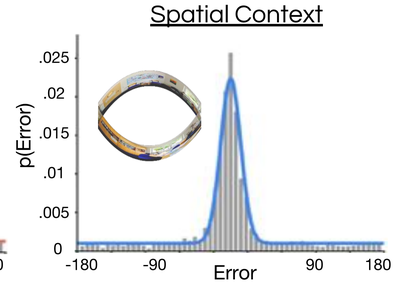


BEHAVIOR

Item Color

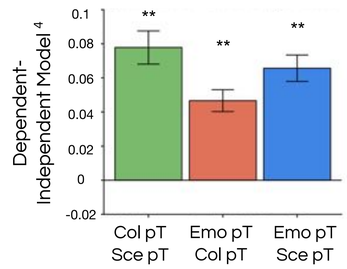


Spatial Context



Emotion:
pT = .76 (SE = .02)
high confidence = .72 (SE = .03)

Item color, spatial context, and emotion features are 'bound' within episodic memory.

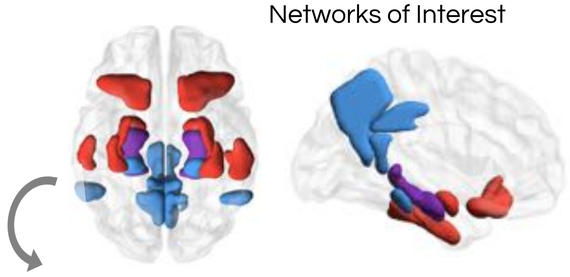


pT = Memory Success, i.e. p(Target)

** $p < .001$

BACKGROUND CONNECTIVITY

Networks of Interest

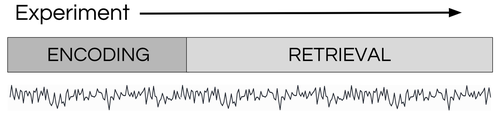


PRC, AMYG, ITC, FUS, OFC

AT Network
Hippocampus
PM Network

PHC, RSC, ANG, PREC, PCC

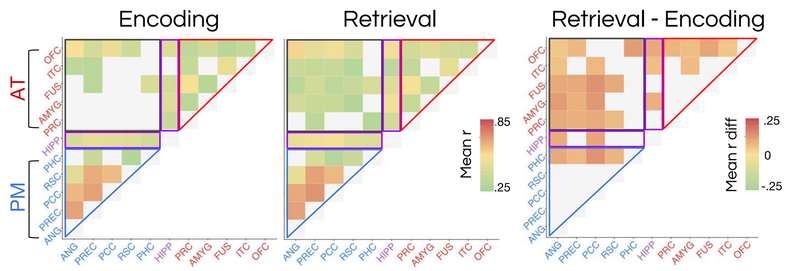
Experiment



Pearson's correlation between residual mean ROI time-series.

(Motion/nuisance and task-related activity regressed out)

Inter-network background connectivity between the hippocampus and cortical systems is increased during episodic retrieval:

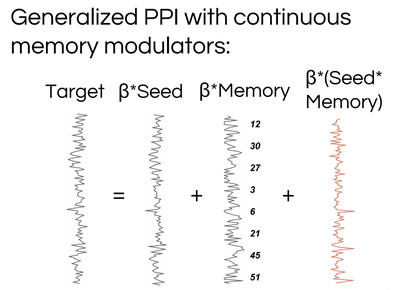


Mean r > .25 ($p < .05$ FDR corrected)

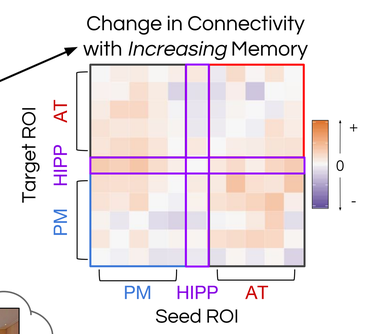
Mean ≠ 0 ($p < .05$ FDR corrected)

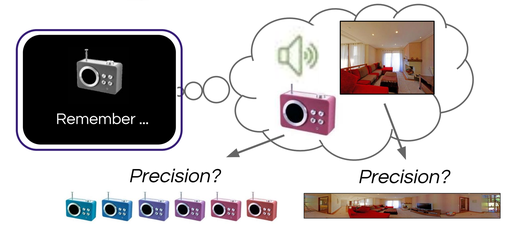
MEMORY-MODULATED CONNECTIVITY

Generalized PPI with continuous memory modulators:



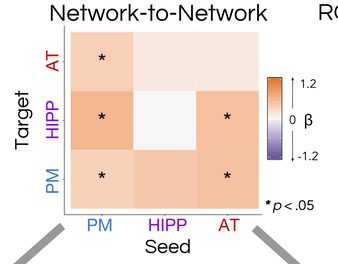
Change in Connectivity with *Increasing* Memory





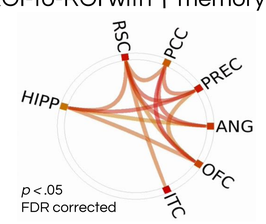
Overall memory quality = sum of feature retrieval success (0-3), weighted by precision (180-error) of each remembered feature.

Network-to-Network



*$p < .05$

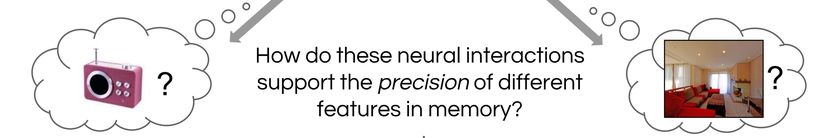
ROI-to-ROI with ↑ memory

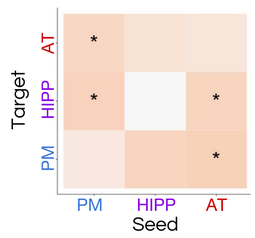


$p < .05$ FDR corrected

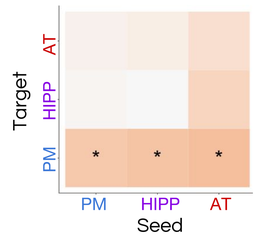
Greater quality of episodic memory -- increased functional connectivity of *the hippocampus and cortical systems.*

How do these neural interactions support the *precision* of different features in memory?



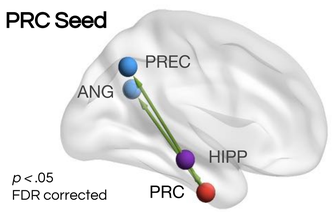


Item color precision within memory -- increased connectivity of *PRC and AT system to PM regions.*



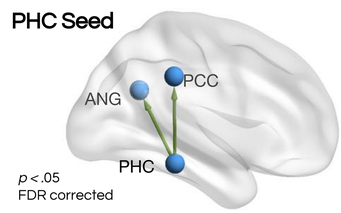
Spatial context precision within memory -- increased connectivity of *PHC and PM system to other PM regions.*

PRC Seed



$p < .05$ FDR corrected

PHC Seed



$p < .05$ FDR corrected

SUMMARY

- Multimodal details of events can vary in the precision with which they are reinstated, and are bound into a dependent representation in memory.
- Episodic retrieval is accompanied by substantial increases in background connectivity among the hippocampus, anterior-temporal, and posterior-medial systems, reflecting a less modular organization, compared to memory encoding.
- Increased functional integration of the hippocampus, PM, and AT systems parametrically tracks the overall detail and fidelity with which episodic memories are retrieved.
- Specific connections underpin the fidelity of different features in memory: connectivity between the PRC and ANG supports item-specific precision, and connectivity between the PHC and ANG supports the precision of spatial context.

References: [1] Westphal, A. J., Wang, S., & Rissman, J. (2017). Episodic Memory Retrieval Benefits from a Less Modular Brain Network Organization. *The Journal of Neuroscience*, *37*(13), 3523–3531. [2] King, D. R., de Chastelaine, M., Elward, R. L., Wang, T. H., & Rugg, M. D. (2015). Recollection-related increases in functional connectivity predict individual differences in memory accuracy. *The Journal of Neuroscience*, *35*(4), 1763–1772. [3] Ritchey, M., Libby, L. A., & Ranganath, C. (2015). Cortico-hippocampal systems involved in memory and cognition: the PMAT framework. *Progress in Brain Research*, *219*, 45–64. [4] Horner, A. J., & Burgess, N. (2013). The associative structure of memory for multi-element events. *JEP: General*, *142*(4), 1370–1383.

FMRI data were collected at the Harvard Center for Brain Science. Questions or comments? Contact us via **www.thememolab.org**