Hippocampal functions modulate transfer-appropriate cortical representations supporting subsequent memory

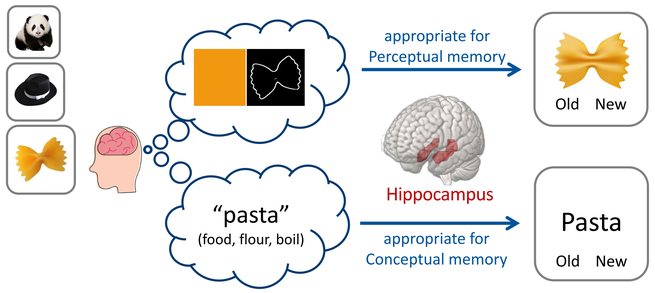
the electric dinosaur lab

Shenyang Huang[1], Cortney M. Howard[1], Mariam Hovhannisyan[2], Maureen Ritchey[3], Roberto Cabeza[1], Simon W. Davis[1]

[1]Duke University, [2]University of Arizona, [3]Boston College

cabeza lab

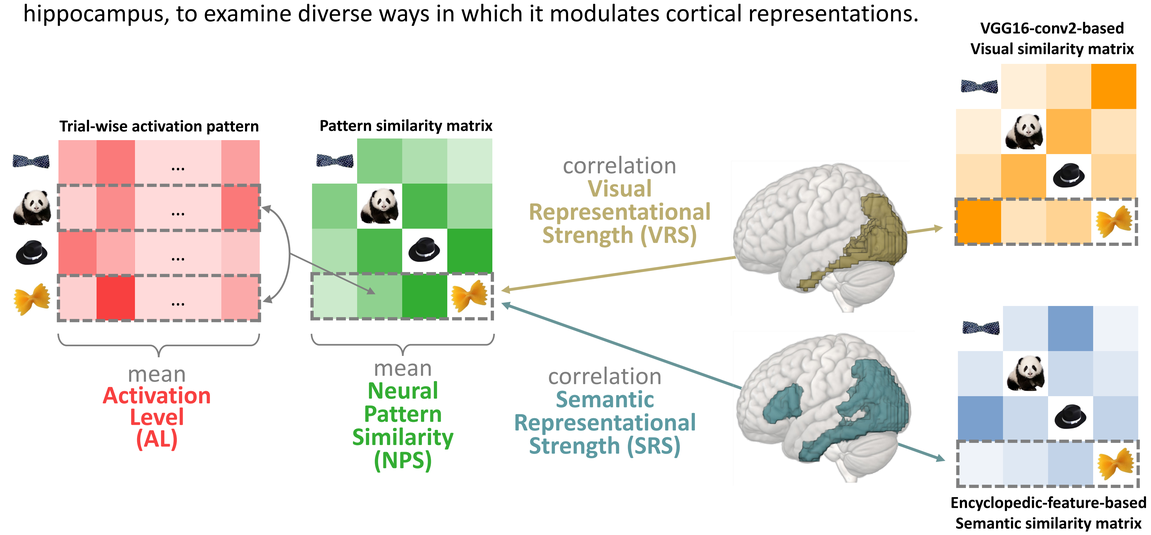
1. Transfer-Appropriate Representations



- Transfer-appropriate processing: matching cognitive operations during encoding and retrieval improve memory.[1]
- Encoding representations of **visual** and **semantic** properties may selectively support **perceptual** and **conceptual** memory, respectively.
- The hippocampus may be agnostic to stimulus properties,[2,3] yet it may modulate the mnemonic effect of cortical representations.

3. Activation Level, Neural Pattern Similarity, Representational Strengths

- We computed representational strengths (RS, **visual** and **semantic**)[4] for Brainnetome brain regions.[5]
- We additionally computed item-wise **Activation Level (AL)** and **Neural Pattern Similarity (NPS)** for the hippocampus, to examine diverse ways in which it modulates cortical representations.

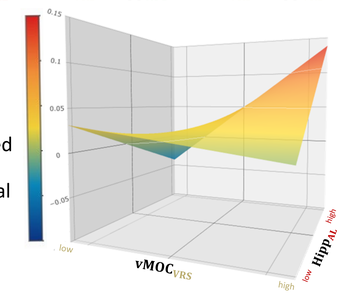


4. Hippocampal-cortical interactions

Transfer-appropriate models

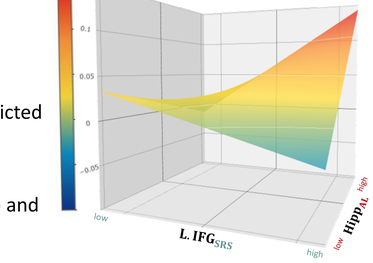
Perceptual memory ~ $(\text{Cort}_{\text{VRS}} * \text{Hipp}_{\text{AL}}) + (\text{Cort}_{\text{VRS}} * \text{Hipp}_{\text{NPS}}) + (\text{Cort}_{\text{VRS}} * \text{Hipp}_{\text{VRS}})$

Perceptual memory was predicted by the interaction between representational strength of visual information in medio-ventral occipital cortex (vMOC_{VRS}) and hippocampal activation level (Hipp_{AL}).



Conceptual memory ~ $(\text{Cort}_{\text{SRS}} * \text{Hipp}_{\text{AL}}) + (\text{Cort}_{\text{SRS}} * \text{Hipp}_{\text{NPS}}) + (\text{Cort}_{\text{SRS}} * \text{Hipp}_{\text{SRS}})$

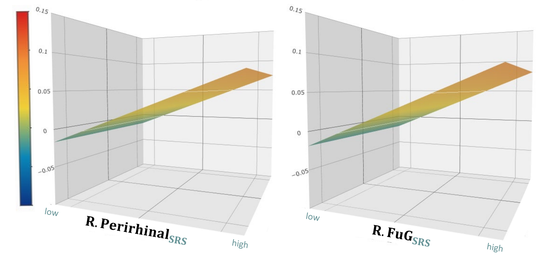
Conceptual memory was predicted by the interaction between representational strength of semantic information in left inferior frontal gyrus (L. IFG_{SRS}) and hippocampal activation level (Hipp_{AL}).



Transfer-incongruent models

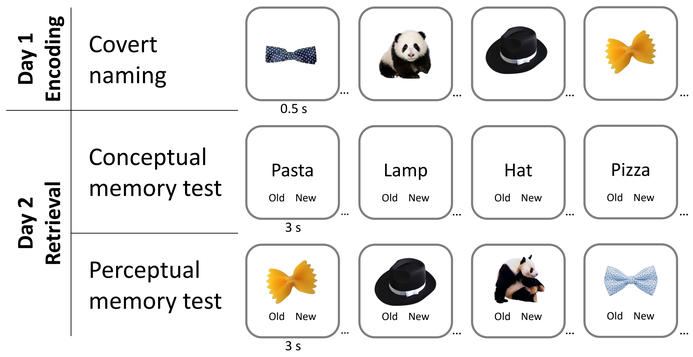
Perceptual memory ~ $(\text{Cort}_{\text{SRS}} * \text{Hipp}_{\text{AL}}) + (\text{Cort}_{\text{SRS}} * \text{Hipp}_{\text{NPS}}) + (\text{Cort}_{\text{SRS}} * \text{Hipp}_{\text{SRS}})$

Perceptual memory was boosted by **semantic representation** in the right perirhinal cortex and fusiform gyrus; no effects found for conceptual memory.

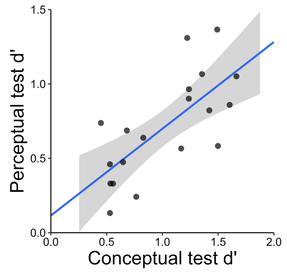


2. Experimental Design

N = 19, 7 females, age = 23.08 ± 2.73, native English speakers



Individual sensitivity (d') to Old/New concepts and images are positively correlated (r = 0.72, p < .001).



5. Discussion

- Cortical regions, but not the hippocampus, robustly represent visual and semantic information of everyday objects.
- Hippocampal functions modulated the mnemonic impact of cortical representations that are **transfer-appropriate**.
- No evidence for **transfer-incongruent** hippocampal-cortical interactions supporting subsequent memory.
- Future studies may evaluate the impact of other non-representational regions, such as prefrontal control regions[6] on episodic memory.

References

1. Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior, 16*(5), 519–533.
2. Huffman, D. J., & Stark, C. E. L. (2014). Multivariate pattern analysis of the human medial temporal lobe revealed representationally categorical cortex and representationally agnostic hippocampus. *Hippocampus, 24*(11), 1394–1403.
3. Xiao, X., Dong, Q., Gao, J., Men, W., Poldrack, R. A., & Xue, G. (2017). Transformed Neural Pattern Reinstatement during Episodic Memory Retrieval. *Journal of Neuroscience, 37*(11), 2986–2998.
4. Davis, S. W., Geib, B. R., Wing, E. A., Wang, W.-C., Hovhannisyan, M., Monge, Z. A., & Cabeza, R. (2021). Visual and Semantic Representations Predict Subsequent Memory in Perceptual and Conceptual Memory Tests. *Cerebral Cortex, 31*(2), 974–992.
5. Fan, L., Li, H., Zhuo, J., Zhang, Y., Wang, J., Chen, L., Yang, Z., Chu, C., Xie, S., Laird, A. R., Fox, P. T., Eickhoff, S. B., Yu, C., & Jiang, T. (2016). The Human Brainnetome Atlas: A New Brain Atlas Based on Connectional Architecture. *Cerebral Cortex, 26*(8), 3508–3526.
6. Takehara-Nishiuchi, K. (2020). Prefrontal–hippocampal interaction during the encoding of new memories. *Brain and Neuroscience Advances, 4*.

Duke UNIVERSITY

Shenyang.Huang@Duke.edu

K01-AG053539
R01-AG075417
R01-AG066901

NIH