CA3 and dentate gyrus adaptively inverse the behaviorally-relevant dimensions of visual similarity

Soroush Mirjalili, Guo Wanjia, Dominik Grätz, Eric Wang, Ulrich Mayr, Brice A. Kuhl

Department of Psychology, University of Oregon

UNIVERSITY OF OREGON

OMG

Kuhl Lab

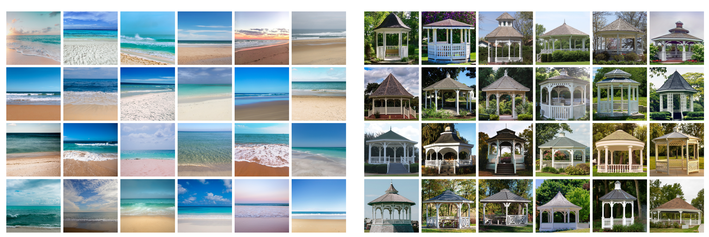
Preprint

Introduction

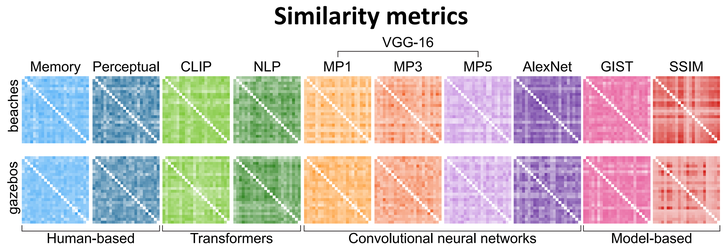
- Similarity between stimuli creates potential for memory interference[1], and the hippocampus plays a key role in resolving such interference[2,3].
- One approach to understand how the hippocampus resolves interference is to consider **'input-output'** functions.
  - Input: similarity of visual stimuli, output: corresponding similarity of hippocampal activity patterns.
- However, these input-output functions can take surprisingly different forms[3-6].
- Here, we consider the possibility that the hippocampus prioritizes different dimensions of visual similarity across different stages of learning.

Dimensions of similarity

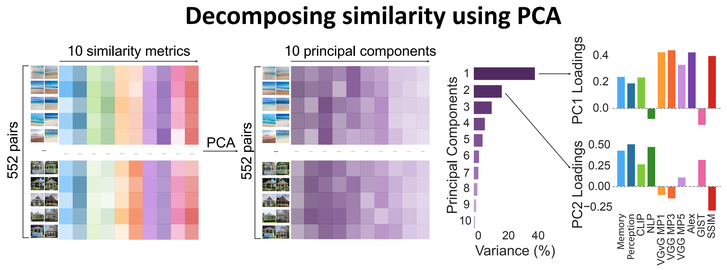
Stimuli: 24 beaches + 24 gazebos



Similarity metrics



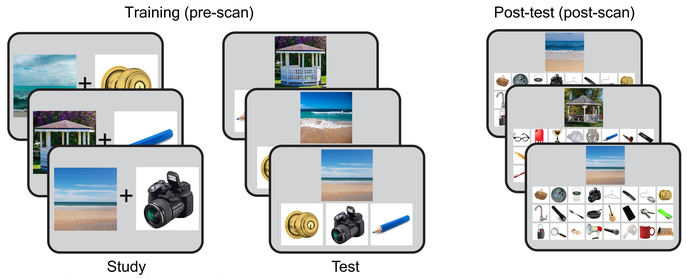
Decomposing similarity using PCA



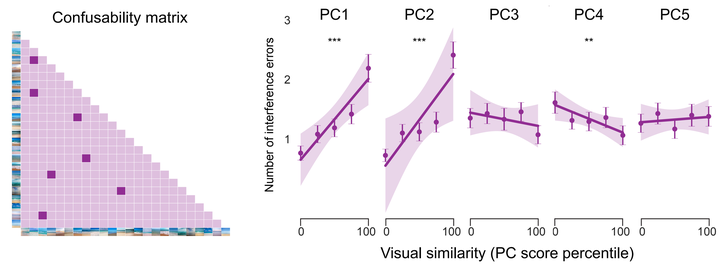
Establishing behaviorally relevant similarity dimensions

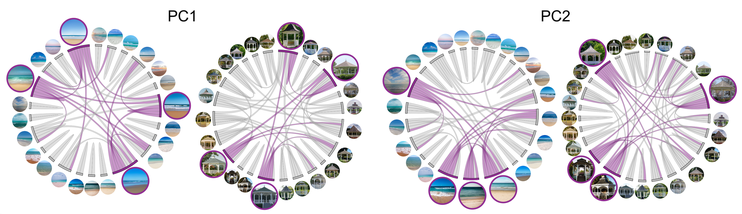
fMRI experiment (N = 52)

One category = high training, one category = low training

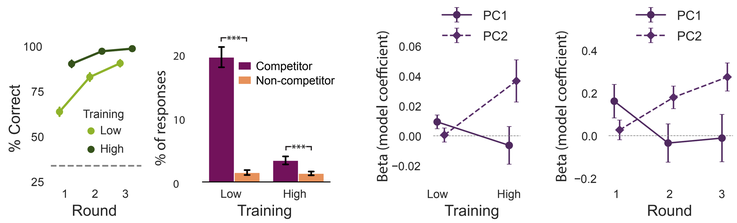


- The first two similarity dimensions predicted interference errors.



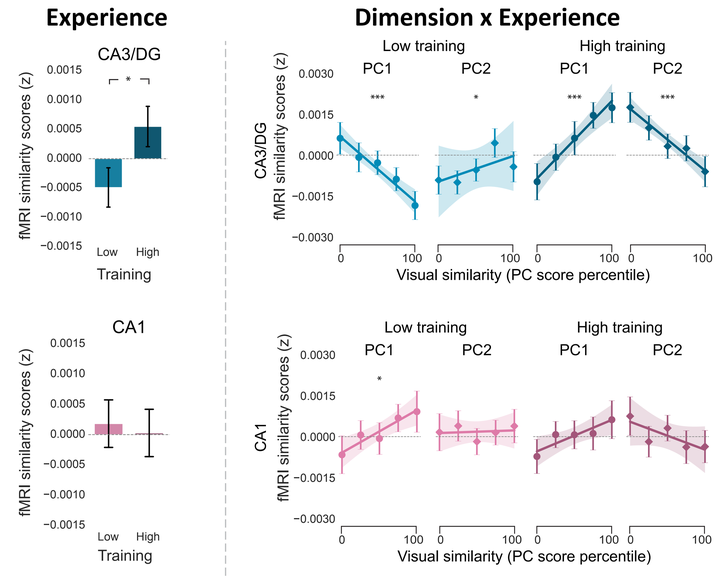


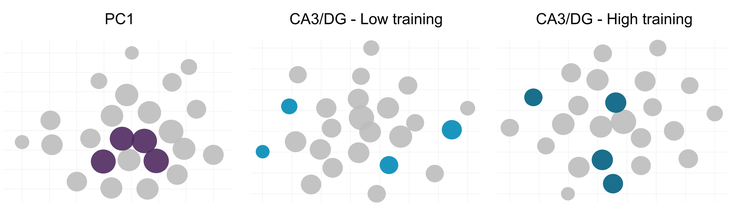
Influence of experience on behavior



- The two dimensions of similarity predicted memory interference *sequentially* (at successive stages of learning).

Hippocampal similarity by dimension and experience





Conclusions

- We show that, in behavior and the hippocampus, memory interference is resolved *one dimension at a time*.
- When a particular dimension of visual similarity is actively contributing to memory interference, CA3/DG dramatically—but transiently—inverts that dimension.
- The hippocampus selectively exaggerates the representational distance between memories that are most 'at risk' for interference.

References & Acknowledgements

[1] Anderson, M. C., et al. (1995) Psychol. Rev. [2] Colgin, L. L., et al., (2008) Trends Neurosci. [3] Yassa, M. A. & Stark, C. E. L. (2011) Trends Neurosci. [4] LaRocque, K. F., et al. (2013) J. Neurosci. [5] DimsdaleZucker, H. R., et al. (2018). Nature Communications. [6] Favila, S. E., et al. (2016). Nature Communications.

This research was supported by Grant NIH-NINDS 2R01NS089729 to B.A.K.