Characterizing the content and layer profile of feedback signals in human early visual cortex.

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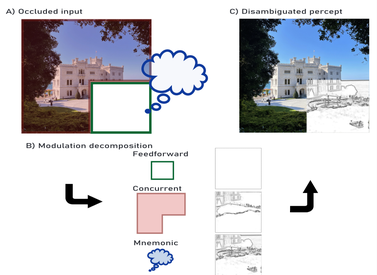
1) INTRODUCTION

Our visual experience is constructed from a combination of incoming information, contextual signals and content from our past experiences.

Predictive accounts of the brain postulate that incoming information can be integrated with other pieces of information by feedforward and feedback dynamics.

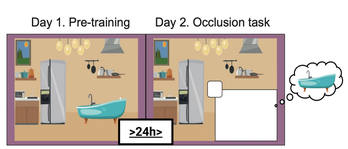


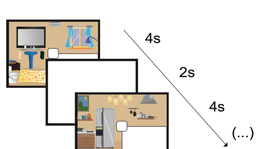
In this project we use fMRI (3 Tesla) and High Field fMRI (7 Tesla) to attempt at characterizing:

1) the different components of feedback signals and
2) their neural implementation across cortical layers in the human early visual cortex (EVC).

2) METHODS

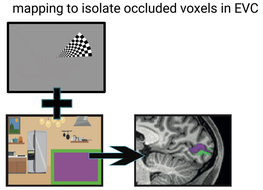
PARADIGM

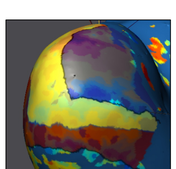




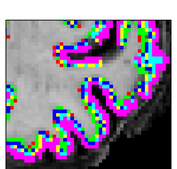
MEASUREMENTS

Functional retinotopy and field of view mapping to isolate occluded voxels in EVC





Example of V1, V2 and V3 delineations projected onto an inflated surface reconstruction of one participant's left occipital pole.



Example of the layer delineation of one participant's early visual cortex.

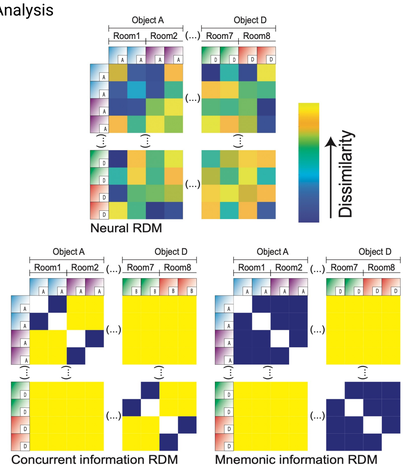
3) ANALYSES.

A: Representational Similarity Analysis

For each occluded ROI trial-wise Pearson correlations were run between every pair of trials to compute our neural RDMs.

Two model RDMs were computed to capture Concurrent and Mnemonic information.

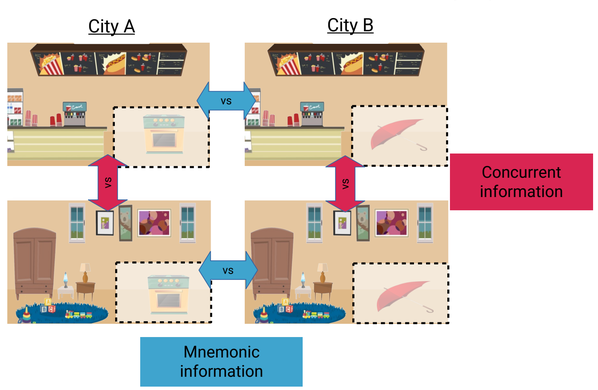
Variance partitioning was used to quantify the unique fraction of neural variance explained by each model RDM.



B: Linear support vector machine classifiers

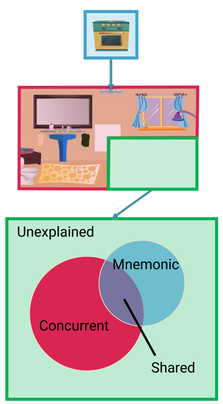
Two sets of binary linear SVM classifiers were set to test for the presence of the different types of information across cortical layers in each occluded ROI (cross-validation performed across four runs).

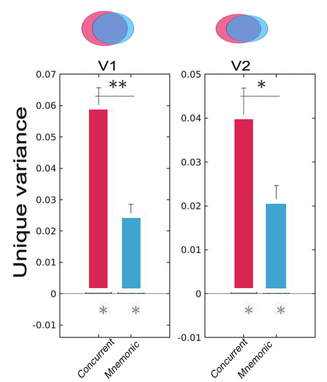
Concurrent SVMs classified between different room-same object pairs.
Mnemonic SVMs classified between same room-different object pairs.



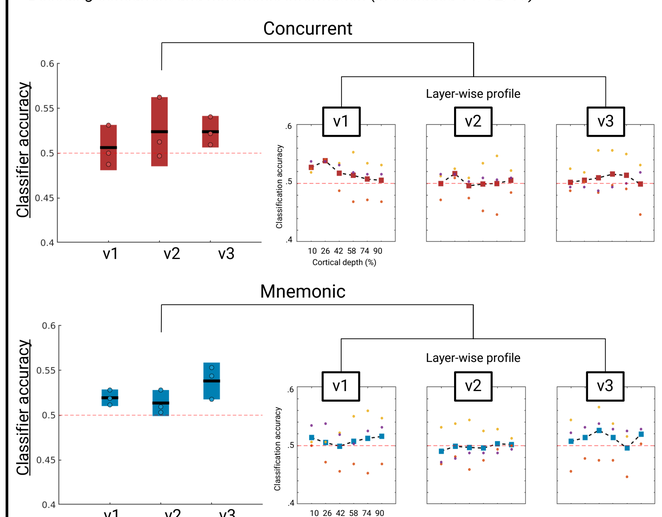
4) RESULTS.

A: Experiment I (SIEMENS Prisma, 3 Tesla). N = 29 participants.
Quantifying unique variance explained by concurrent and mnemonic models (in occluded V1/V2)





B: Experiment II (SIEMENS Terra, 7 Tesla). N = 3 participants.
Decoding concurrent and mnemonic information (in occluded V1/V2/V3)



5) DISUSSION AND OUTLOOK

Although much of the activity in occluded regions of the EVC is modulated by concurrent information from the contextual surrounding, mnemonic content from episodic memories still explains a unique fraction of variance.

Preliminary multivariate analysis of the 7T data shows worse decoding performance than the 3T data perhaps due to lower signal-to-noise ratio. Despite worse performance, accuracy for mnemonic classifiers was above chance level for all three participants.

Initial exploration of the layer profiles of the two types of information shows a differential pattern in V1 compatible with our initial hypothesis: while concurrent information would reach mainly superficial layers, mnemonic content would be more prominently found in deep layers.

Follow-up steps: Can we trace the distinction between concurrent and mnemonic information up the hierarchy to different layers of the entorhinal cortex?

6) RELEVANT RESEARCH

Dwivedi, Cichy, & Roig, (2020). Unravelling Representations in Scene-selective Brain Regions Using Scene Parsing Deep Neural Networks.

Muckli, De Martino, Vizioli, Petro, Smith, Ugurbil, Goebel, & Yacoub, (2015). Contextual Feedback to Superficial Layers of V1. *Current Biology.*

Barron, Auksztulewicz, & Friston, K. (2020). Prediction and memory: A predictive coding account. *Progress in Neurobiology, April*.

FUNDING

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