Reactivation of Sequential Head Direction Memory Traces in Humans

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INTRODUCTION

- Episodic memory and navigation operate along time and space[1]
- Neuronal reactivation of prior encoded sequential memories during retrieval[2,3,4]
- Human studies: mostly virtual reality for testing reactivation of sequential spatial memories[5] -> lack information of self-motion cues

- This study: **incorporating real-world navigational movements in a sequence memory paradigm**

METHODS

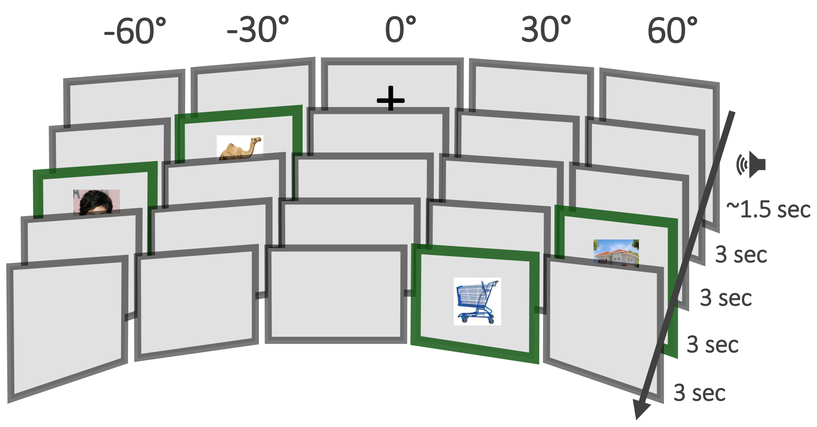
- 36 participants, (12 male, age range: 18-35)
- EEG, head motion tracking, EOG, Eye tracking

LOCALIZER TASKS

no vision → sound → eye movement → head movement → head movement cognition → image recognition

MEMORY PARADIGM

- Encoding



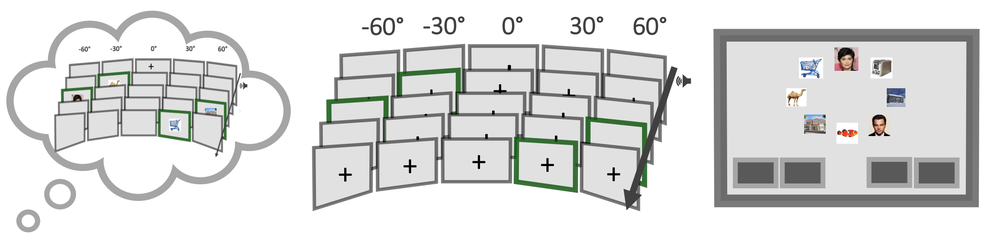
24 Sequences of 4 images associated with 4 specific head directions (HD)

Sequence learning → Sequence story → Sequence check

- Three-step immediate memory test:
  1. Covertly retrieving the sequence
  2. Performing the correct HD sequence
  3. Sorting the images according to order of the HD

Sequence immediate retrieval → Sequence head directions → Sequence image sorting

8x



- Distractor task [3 min]
- Three-step episodic memory (EM) test for all eight sequences

Sequence episodic recall → Sequence head directions → Sequence image sorting

DISCUSSION & OUTLOOK

- Above chance image category classification within image localizer
- Above chance image category cross-classification from image localizer to HD retrieval task
- Further steps
  - Classification of HD in immediate and episodic memory traces
  - GLM approaches for single trial analysis
  - Decoding of image and HD sequences with temporally delayed linear modelling (TDLM)[6]

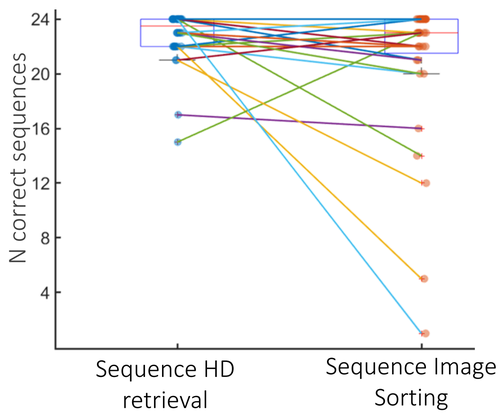
REFERENCES

1 Buzsáki & Moser (2013). *Nat Neurosci*
2 Carr et al. (2011). *Nat Neurosci*
3 Ólafsdóttir et al. (2018). *Curr Biol*
4 Wimmer et al. (2020). *Nat Neurosci*
5 Schonhaut et al. (2022). *bioRxiv*
6 Liu et al. (2021). *Elife*

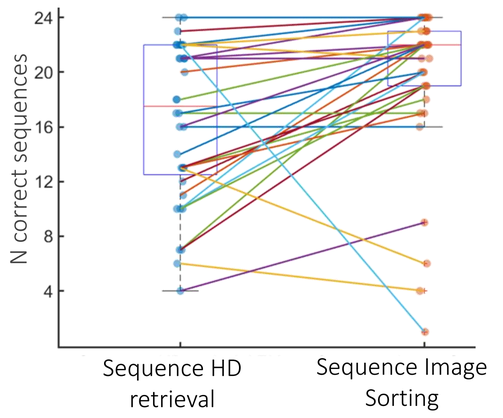
RESULTS

MEMORY PERFORMANCE

N=36



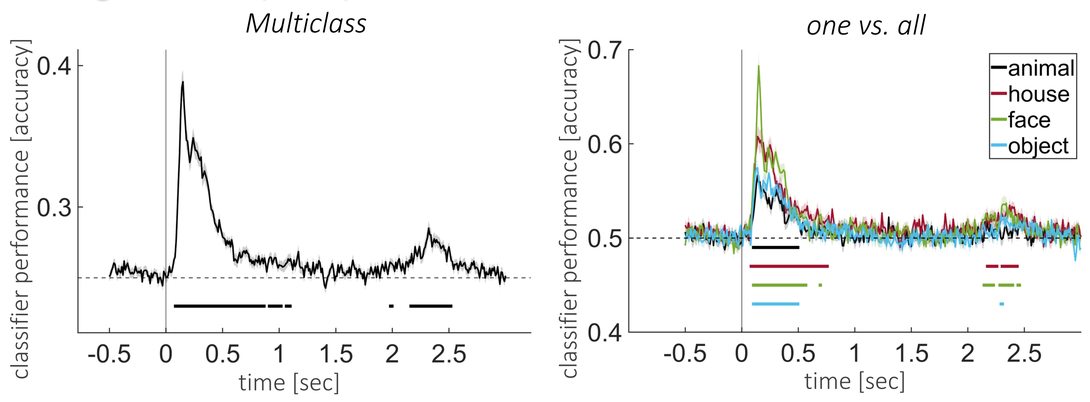
Memory performance immediate memory test



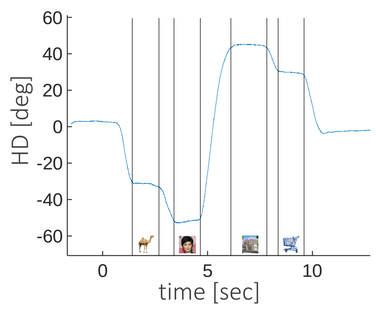
Memory performance episodic memory test

DECODING

- Image localizer (N=36)



- Decoding image category during HD sequential retrieval

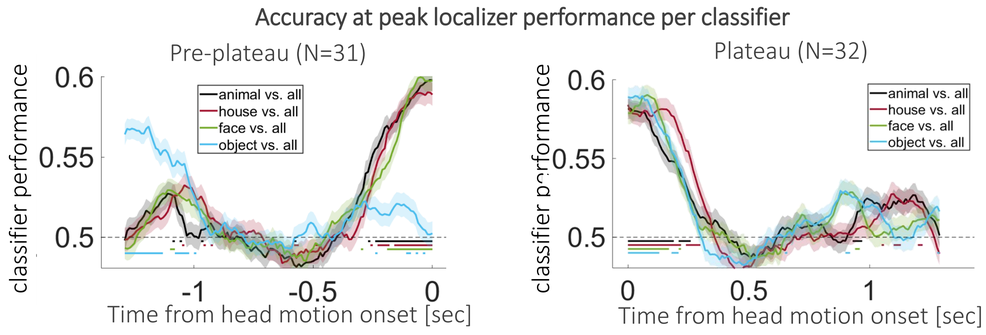


Training data: localizer image recognition, locked to stimulus onset

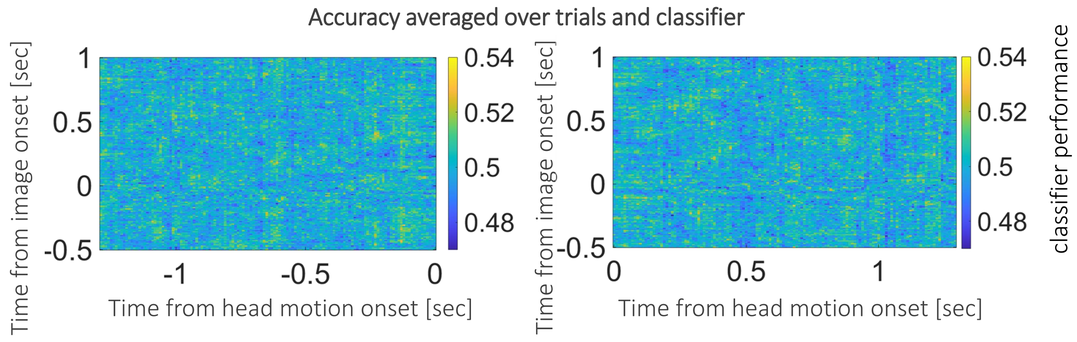
Test data: sequence HD retrieval, locked to head motion onset

Immediate HD memory test

Accuracy at peak localizer performance per classifier

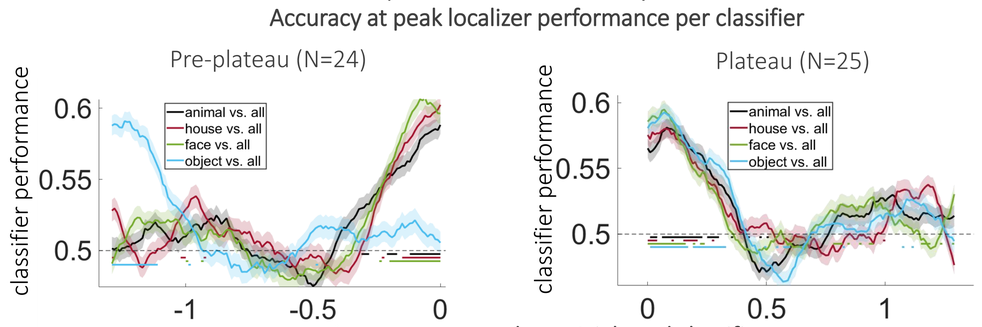


Accuracy averaged over trials and classifier

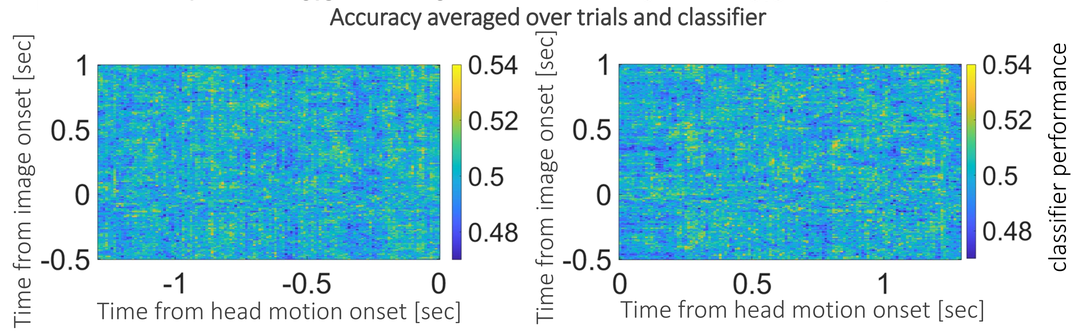


Episodic HD memory test

Accuracy at peak localizer performance per classifier



Accuracy averaged over trials and classifier



Decoding of image category in immediate HD memory test and episodic HD memory test

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