





Max-Planck-Institut für Bildungsforschung Max Planck Institute for Human Development



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How can we study fast sequential neural events using fMRI?

Hippocampal replay: fast and sequential reactivation of hippocampal activity patterns



Can we overcome the temporal limitations of fMRI?

Recent fMRI evidence for sequential hippocampal replay in humans: Sequential replay of non-spatial task states in the human hippocampus (Schuck & Niv, 2018, *bioRxiv*)

Decoding sequential fMRI patterns of visual objects







 $ISI \in \{32, 64, 128, 512, 2048 \text{ ms}\}$

Probabilities of sequential events diverge over and within TRs



Event 4

Event 5



Cumulated and baseline-adjusted probabilities over time



Event 5



Average slope of linear fit across probabilities within each TR







Summary and outlook

- Slow sequential neural events are decoded in forward order, while fast sequences seem to be more likely decoded in backward order
- Transitions of probability patterns of decoded events from forward to backward ordering seems to be temporally more compressed with increasing sequence speed
- Decoded activation patterns of fast sequential events seem to be dominated by the last serial event
- **On-going work** includes: Improvement of fMRI preprocessing and classification accuracy, development of a sequence similarity metric









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Which serial event position does the classifier decode?





Transitions between events are translated into step-sizes...





... which can be aggregated to forward vs. backward steps







Time-shifted HRFs reflect changes in neural response timing



Aguirre et al., 1998, Neurolmage

Miezin et al., 2000, Neurolmage

Menon et al., 1998, PNAS

Relating pattern transitions to event distances / step-sizes





Data acquisition

- 40 healthy younger adults (20 35 years)
- mean age = 24.5 years (SD = 3.6 years), 24 female
- 2 sessions with 70 minutes scanning time per subject
- 3T Siemens Magnetom TimTrio with 32-channel head coil
- TR = 1.25 s, TE = 26 ms
- 2 mm isotropic voxels, +15° tilt from AC-PC



Classifier training on a set of visual object categories



Apply classifier to fast sequences of visual objects



Analyze decoded sequence



Can we decode the true sequence?



Oddball task: Detect whether objects are presented upside down or not



cf. Haxby et al., 2001, Science



Sequence task: Detect serial position of cued target object

