Within-category decoding of attended vs. unattended items in short-term memory

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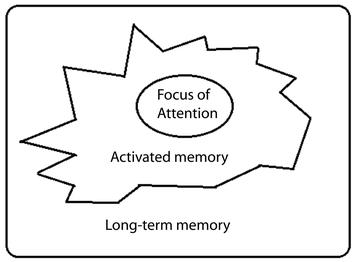
Introduction

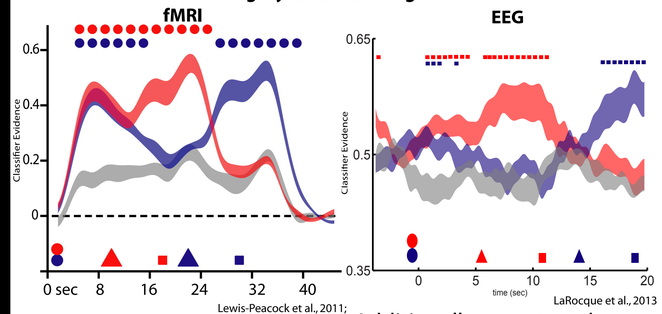
Several models of short-term memory (STM) posit distinct states for items held inside and outside the focus of attention.



Cowan 1993

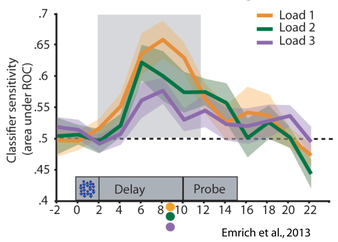
Recent work using multivariate pattern analyses (MVPA) decoded the category of memory items held inside the focus of attention; however, no evidence could be found for items outside the focus of attention.

Category-level decoding



Lewis-Peacock et al., 2011; LaRocque et al., 2013

Item-level decoding



Emrich et al., 2013

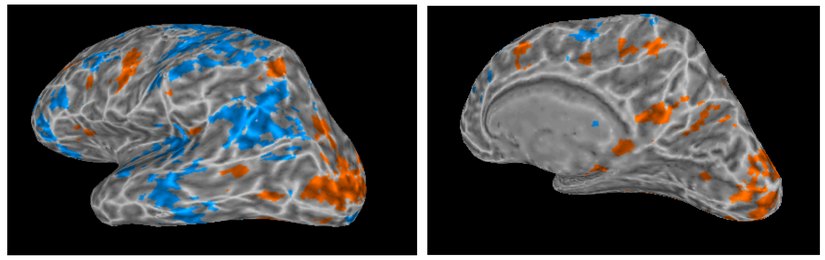
Additionally, recent work suggests that a memory item can be decoded when multiple items are simultaneously retained in STM, with no attention manipulation. It is unclear how to relate this result to previous category-level decoding.

Can item-level decoding of fMRI data find evidence for items retained in memory but outside the focus of attention?

	Vowel sounds		Line segment orientations		Word meanings
Category-level decoding	duf	vs.		vs.	happy
Item-level decoding		vs.		vs.	

Results

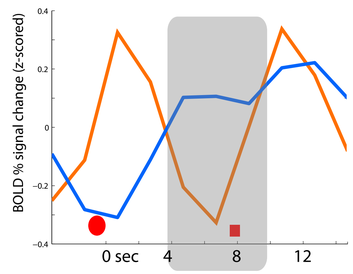
Functional ROIs for MVPA



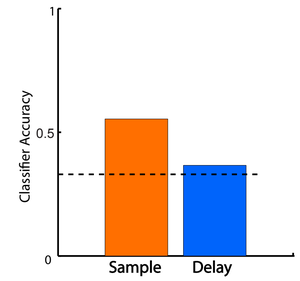
A GLM was solved to create parameter estimates for sample- and delay-period-evoked responses. The sample ROI was defined by a sample minus delay period contrast. The delay ROI was defined by a delay minus sample contrast.

Classifier training - one-item delayed-recognition task

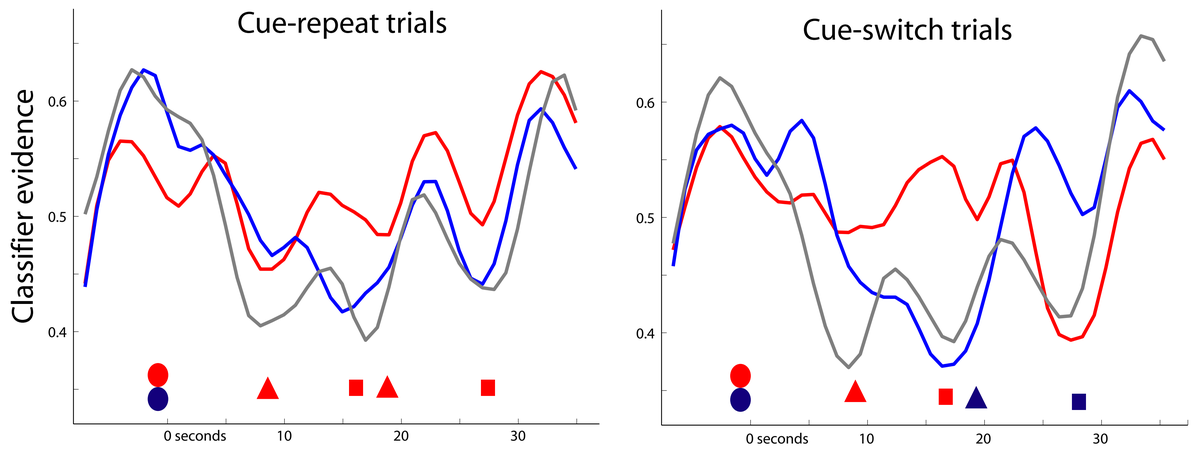
Aggregated regional univariate activity



Multivariate decoding of active neural representations of individual stimuli



Classifier testing - two-item attention-cuing task



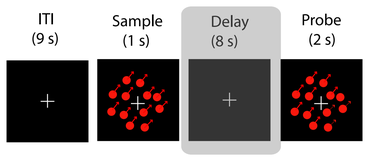
- Decoding of delay-period activity in an ROI defined by phasic response to the sample was superior to decoding in an ROI defined by sustained delay-period activity.
- Classification was also attempted in V1 (43%), V2 (56%), and area MT (45%)
- Using the sample ROI to decode the attention-cuing trials revealed evidence for the cued memory item, but not the uncued memory item

Item level decoding fails to find evidence for active neural representation of items in STM but outside the focus of attention.

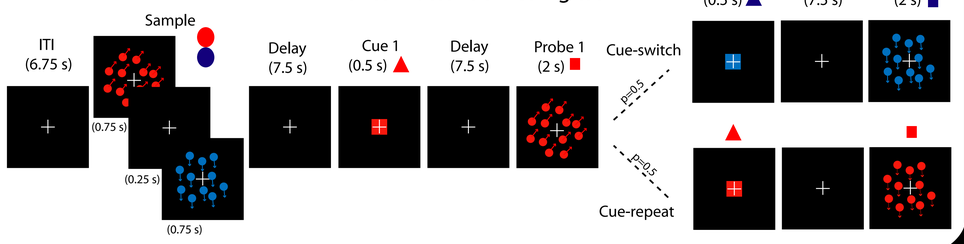
Task and Methods

Participants (N=3, 1 female) performed alternating blocks of a one-item delayed-recognition task and a two-item delayed-recognition task with retroactive cues.
Neural activity was measured by fMRI in a 3-Tesla scanner.
The stimuli were circular apertures filled with dots coherently moving in one of three canonical directions (73, 193, 313 degrees).
MVPA classifiers were trained to decode direction of motion on fMRI signal from the delay period of the one-item task. These classifiers were validated using leave-one-out cross validation.
The classifiers were then used to decode fMRI signal from the entirety of the two-item task. Classifier estimates of the evidence for cued, uncued, and not present directions of motion were averaged across trials.

One-item classifier training task



Two-item attention-cuing task



Conclusions

Preliminary results suggest that item-specific information can be decoded from neural activity only for items in the focus of attention, in agreement with previous category-level decoding results.
The retention of memory items outside the focus of attention may be accomplished by a structural trace rather than an active trace.
Decoding active neural representations for multiple items in memory is possible, but manipulating the focus of attention reveals that these active traces may not be necessary for retention.

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