



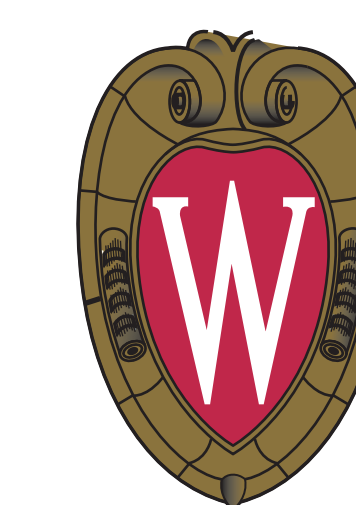
# Decoding attended vs. unattended information from working memory

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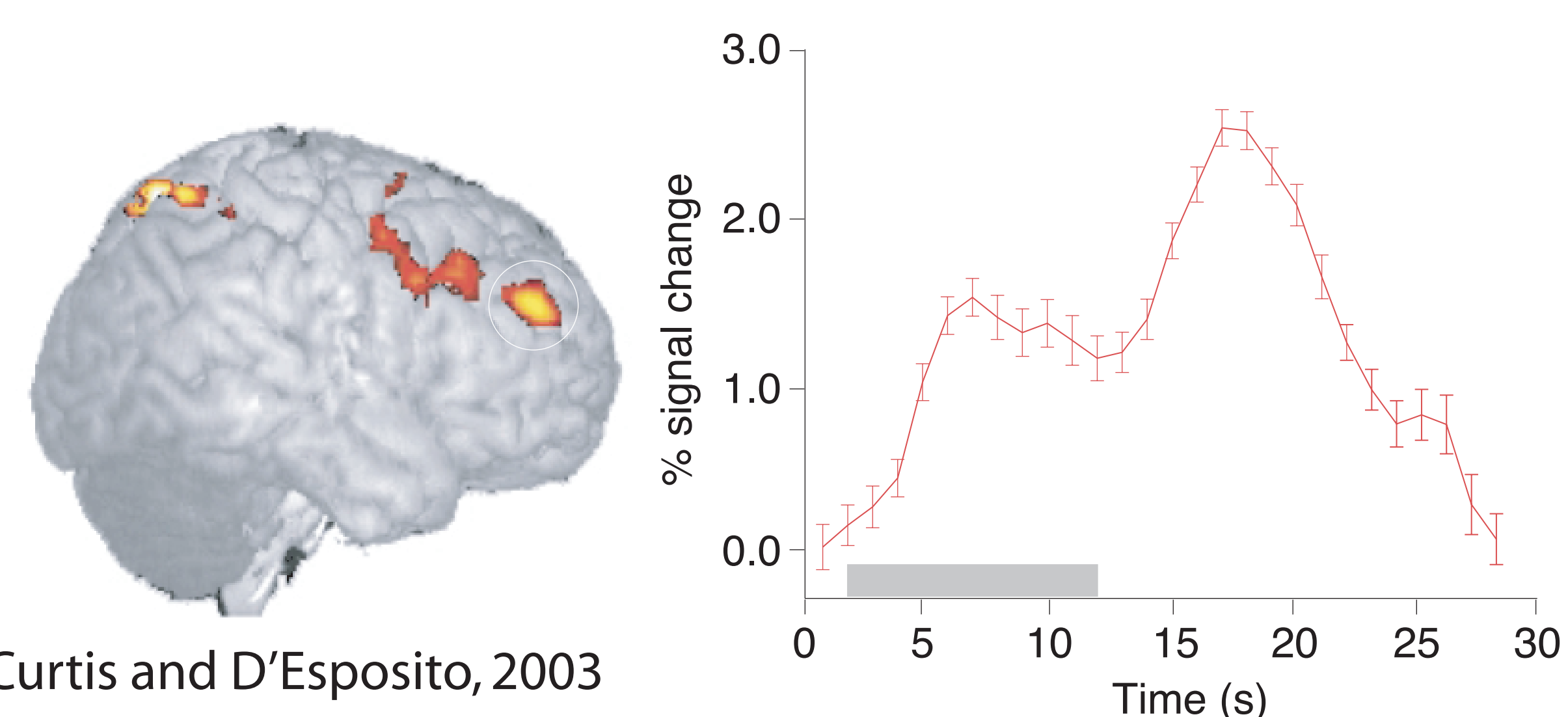
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## Background

- Neural activity during the delay period of working memory tasks has been attributed to the retention of information



Curtis and D'Esposito, 2003

- Nearly all such results do not account for attention, leaving open the possibility that attention and retention have been confounded
- Information in short-term memory can be in the focus of attention (**attended memory item, AMI**) or outside the focus of attention (**unattended memory item, UMI**)
- Previously, an fMRI study used multivariate pattern classification to show that delay-period activity corresponds to AMI but not UMI (Lewis-Peacock and Postle, 2012)
- However, there may be a signal corresponding to UMI to which fMRI is insensitive

Do EEG measures of delay period neural activity reflect the retention of information or attention?

## Methods

- High-density EEG data was collected from 18 volunteers (12 f) performing the phase 1 and phase 2 memory tasks (adapted from Lewis-Peacock and Postle, 2012)
- The EEG data was filtered and cleaned with ICA to remove electrical, ocular and muscular artifacts
- The data was time-frequency transformed using Morlet wavelets (1-50Hz) with .5 second windows
- This data was smoothed, z-scored and fed into an L2-regularized logistic regression classification algorithm
- Classifier accuracy is the percentage of trials on which the classifier guessed correctly 58.85

## Design

### Phase 1

- Collect EEG data from subjects performing a working memory task for one item
- Train and validate a subject-specific classifier to distinguish categories of remembered items

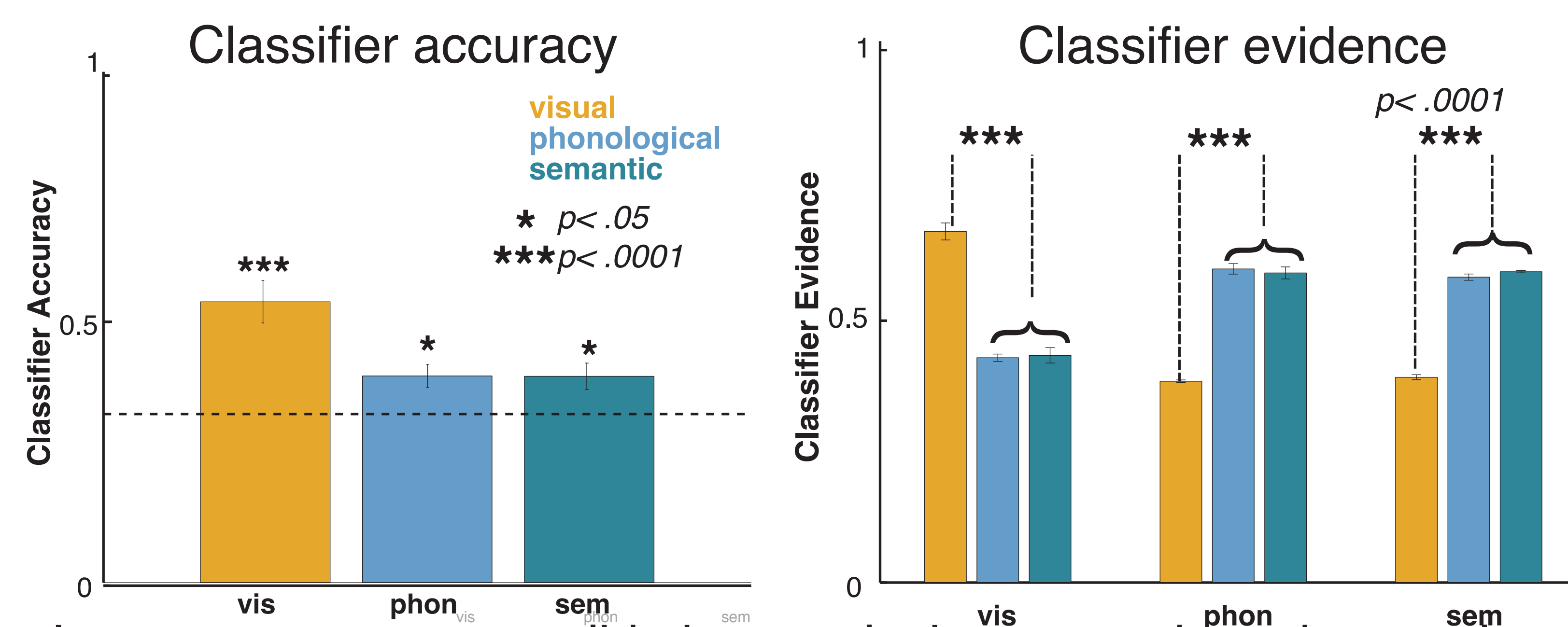
### Phase 2

- Collect EEG data from subjects performing a working memory task with two items, with attention cued to one of the two items
- Apply the classifiers trained in Phase 1 to the two-item task of Phase 2

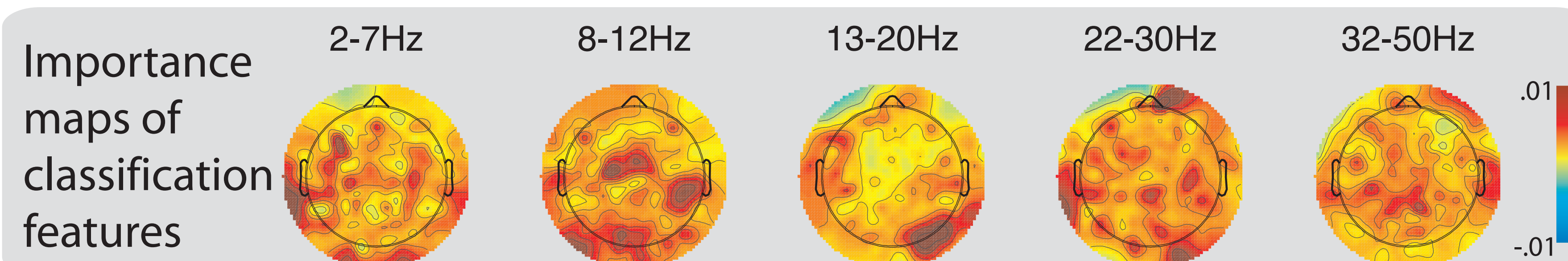
## Phase 1 - task

Categories	cue (1 s)	target (.5 s)	delay (5 s)	probe (.5 s)	response/feedback (1.5 s)
visual	line orientation				
phonological	vowel sounds	weeb		duf	
semantic	meaning	endure		survive	

## Phase 1 - results

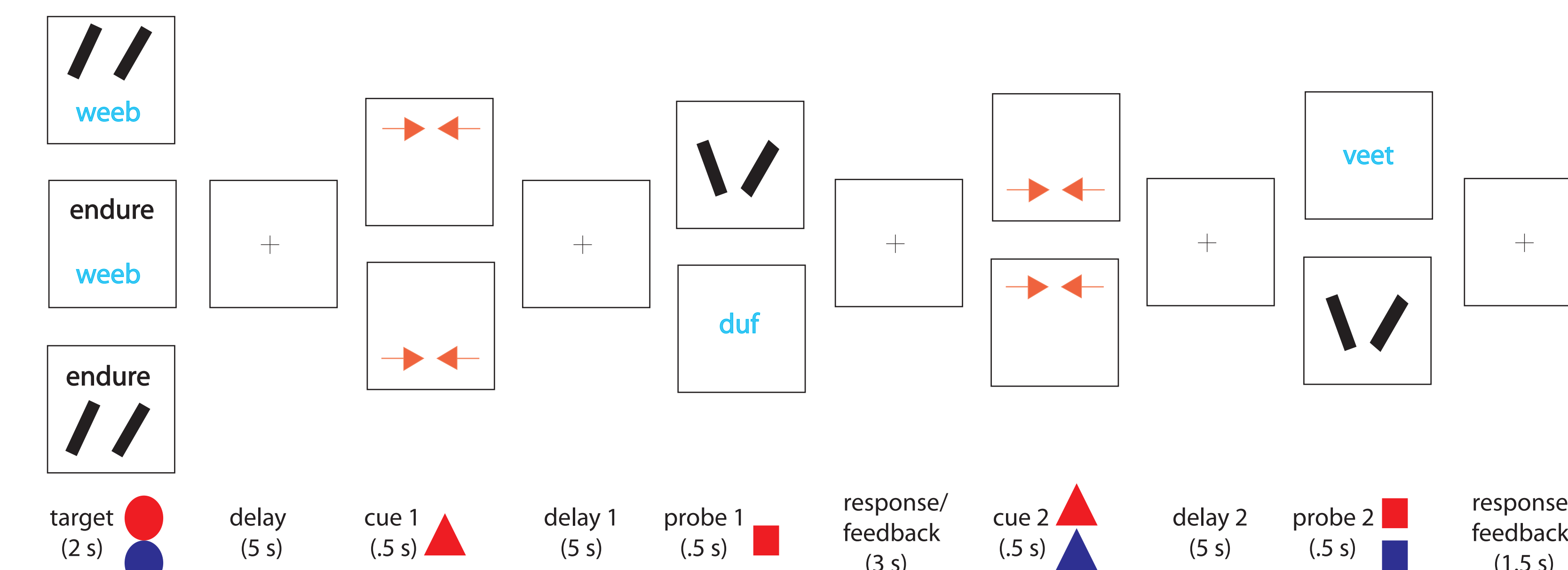


- Leave-one-out cross validation results in greater than chance classification for all three categories
- Plotting the raw output of the classifier (**classifier evidence**) shows strong discrimination between categories except for the phonological vs. semantic discrimination



- Features important for the classification included a broad spectrum, non-localized subset of the input features

## Phase 2 - task



- One of the two memory items is cued (red arrows) as the item to be probed (AMI)
- The other, uncued item (UMI) must still be remembered
- The cues may indicate the same item twice (**repeat trials**) or different items (**switch trials**)

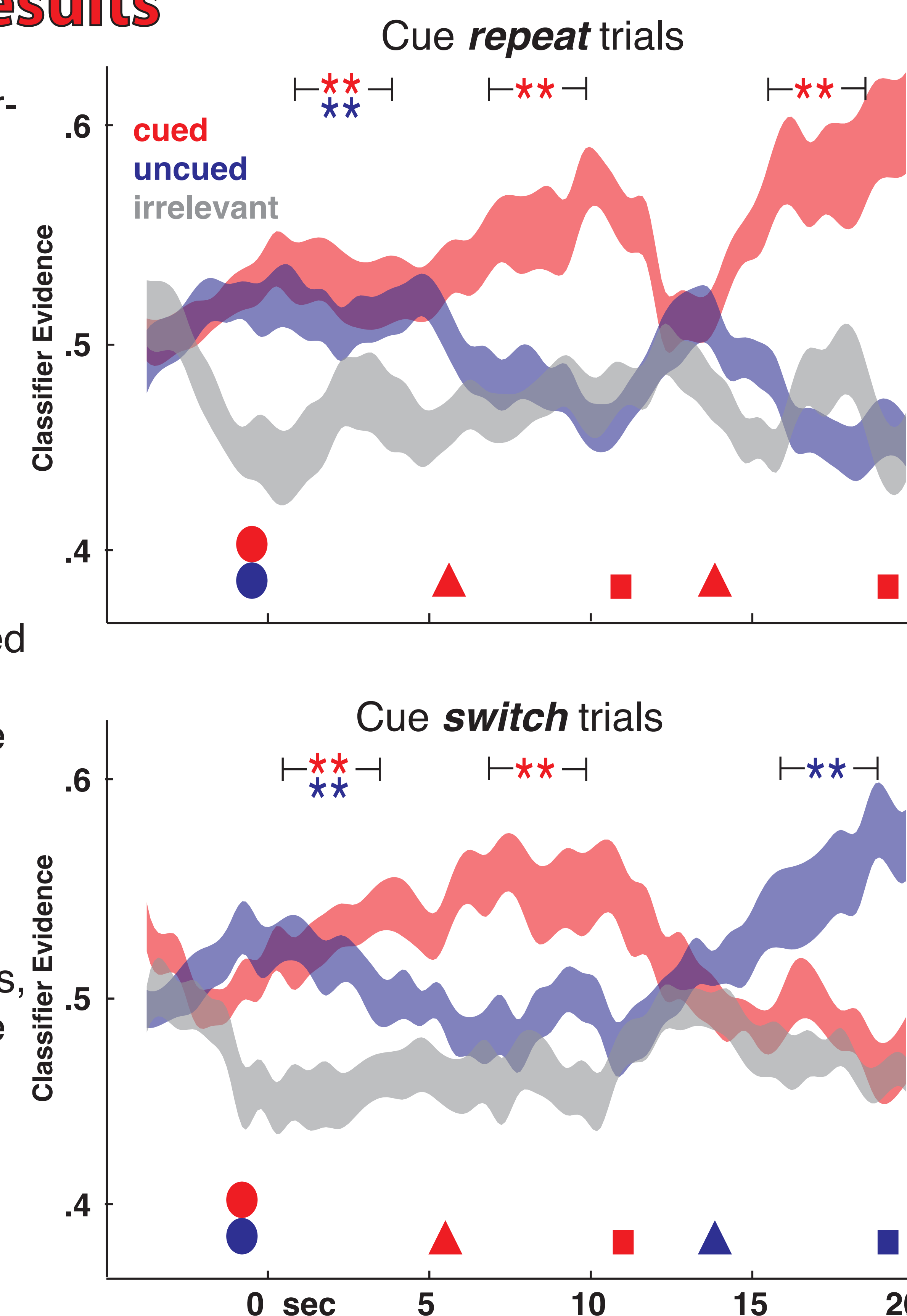
## Phase 2 - results

- Statistical tests performed for the indicated category vs. baseline (\*\* $p < .001$ )

- Before the cue, evidence for both items is initially above baseline

- After the first cue, evidence for the cued category (AMI) rises and evidence for the uncued category (UMI) falls to baseline

- On cue switch trials, after the second cue evidence for the initially uncued item reappears



No evidence was found for items retained outside the focus of attention. This supports the view that a sustained, active trace is not necessary for working memory retention.

We gratefully acknowledge the contributions of Jarrod Lewis-Peacock to the design of this experiment.

### References

- Lewis-Peacock, J.A. and Postle, B.R. (2012) Decoding the Internal Focus of Attention. *Neuropsychologia*, 50: 470-478.
- Curtis, C.E. and D'Esposito, M. (2003) Persistent Activity in the Prefrontal Cortex During Working Memory. *Trends in Cognitive Sciences*, 7(9) 415-423.