Mapping short-term memory representations for visual motion with MVPA

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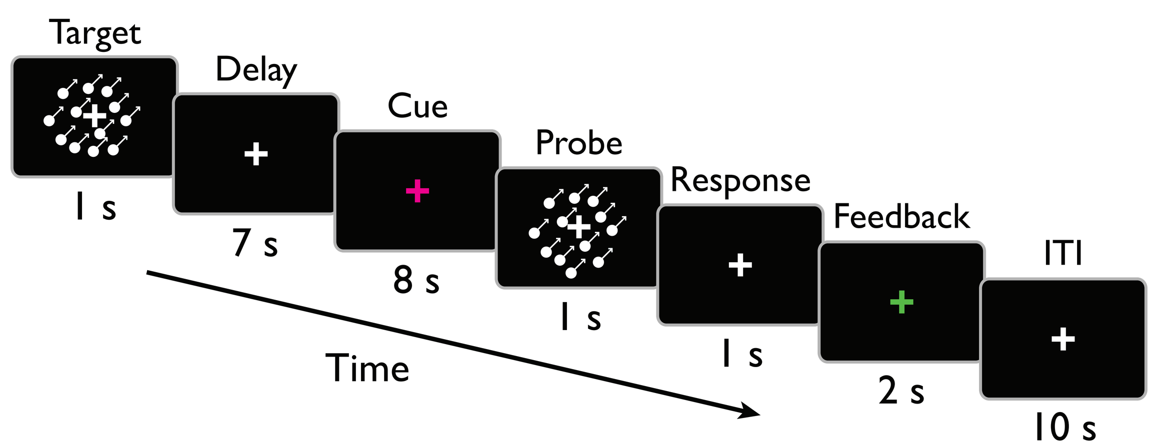
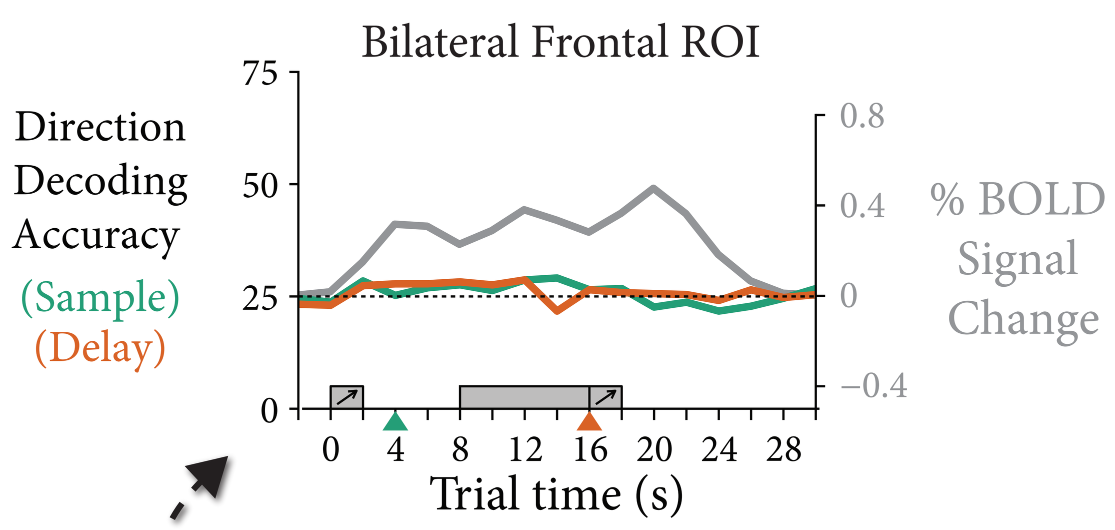
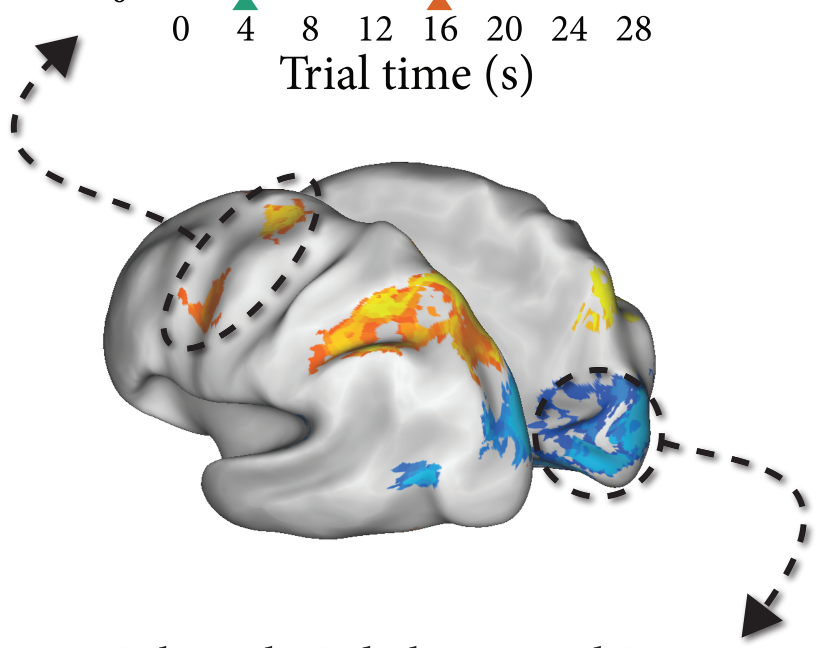
Introduction

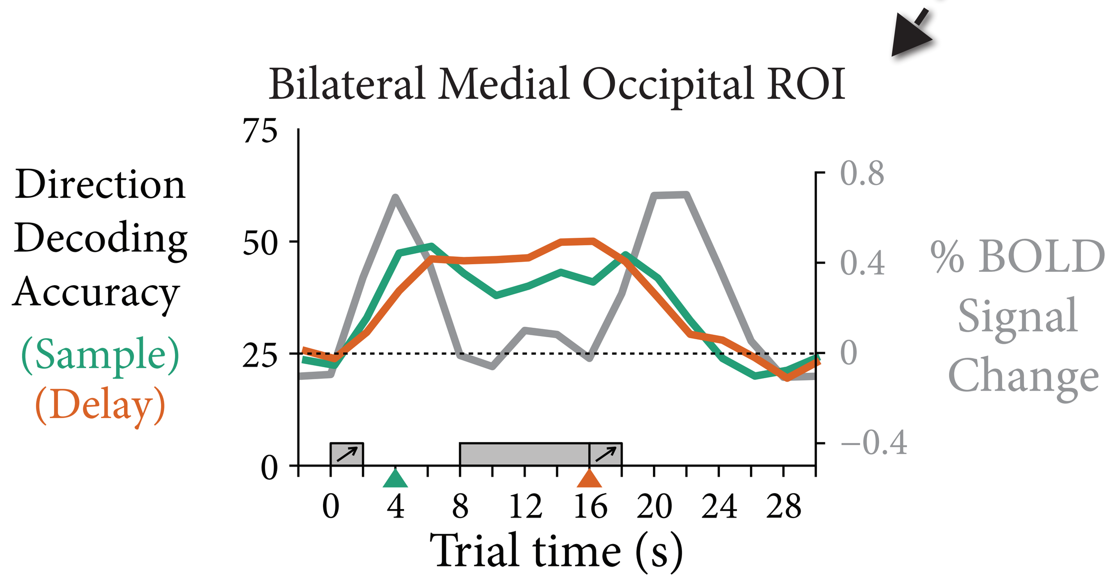
We have recently demonstrated successful decoding of stimulus-specific patterns of BOLD activity throughout the delay period of a delayed-recognition task for visual motion (Riggall & Postle, 2012).



Stimulus-specific information was decodable only from posterior visual regions and NOT from frontal and parietal areas that showed sustained, elevated BOLD activity during the delay-period.

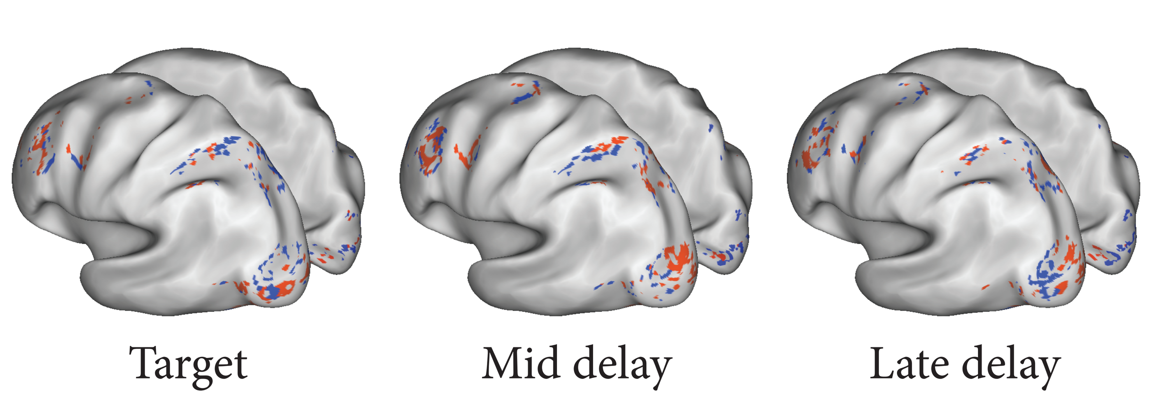






Whole-brain decoding "importance maps" revealed two results that appear at odds with these ROI decoding findings:

1. Informative voxels appear in frontoparietal regions
2. Informative voxels change timepoint to timepoint.



What can maps of the informative voxels for decoding tell us about the underlying representations used during STM for visual motion?

Decoding Approach

http://www.pymvpa.org

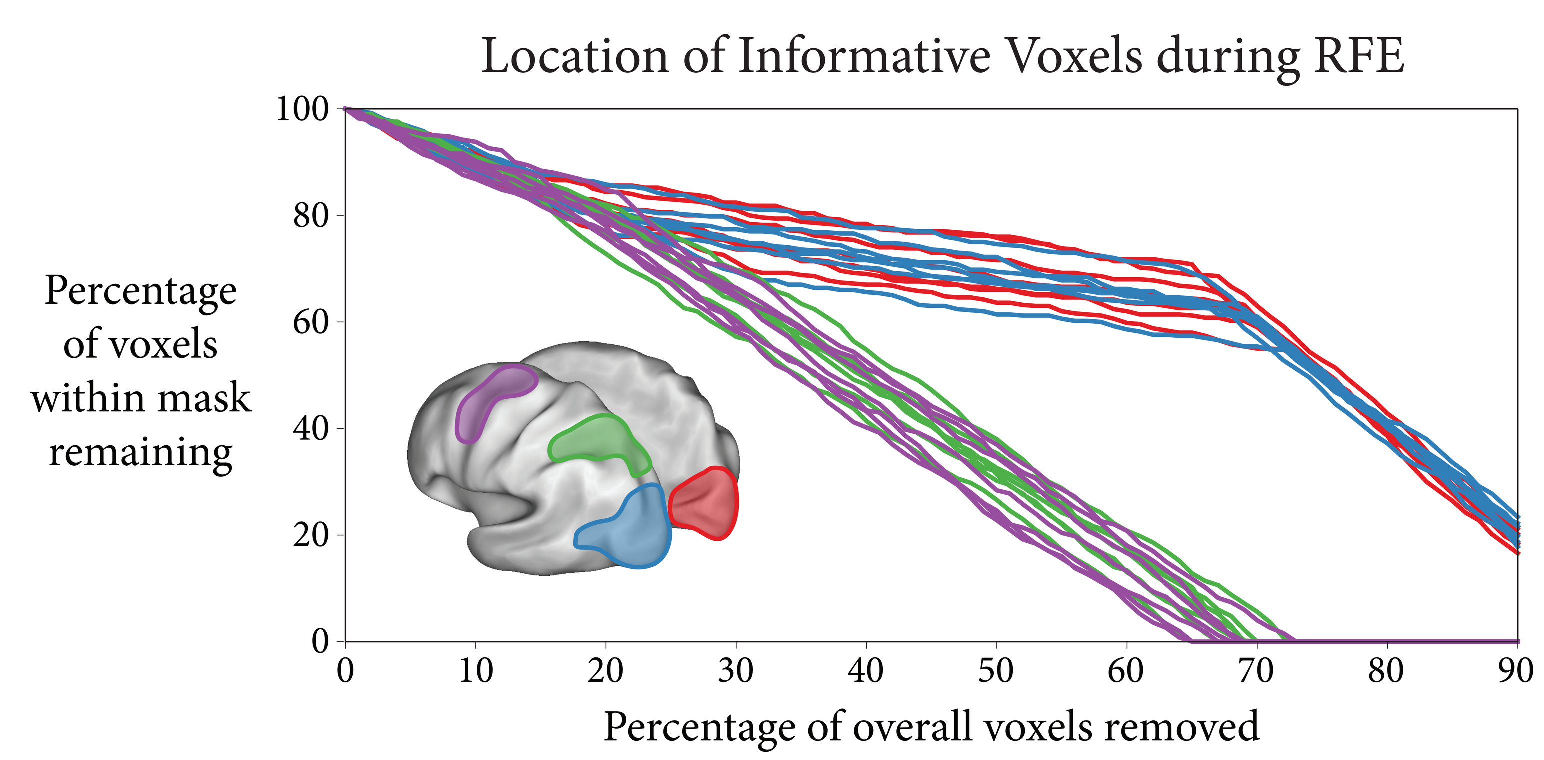
Classification with L2-regularized logistic regression (λ = 25) between pairs of directions

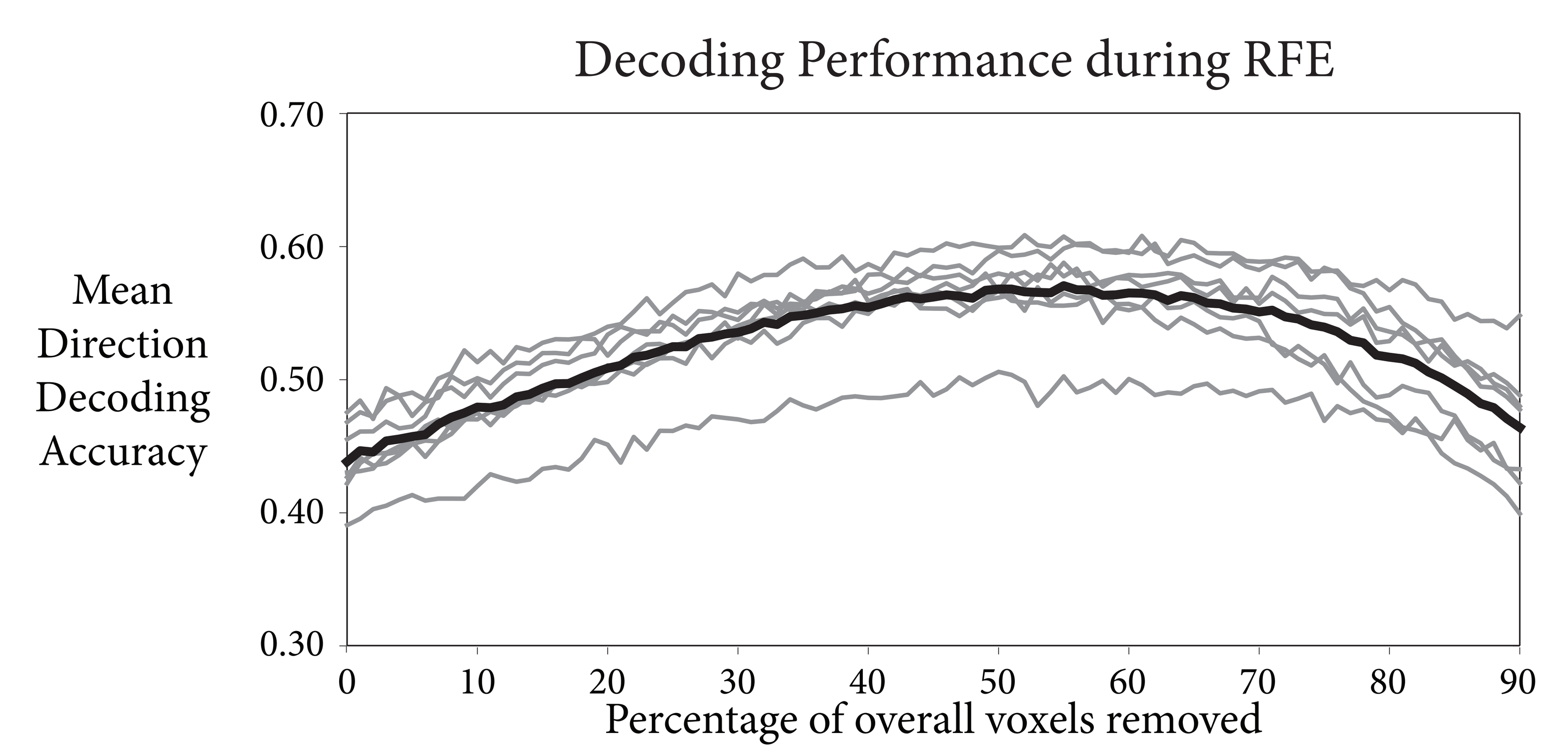
175 cross validation iterations using 80 randomly sampled training trials (20 per direction) and 8 testing trials (2 per direction)

Train on single timepoint from trial

Results: Recursive Feature Elimination (RFE)

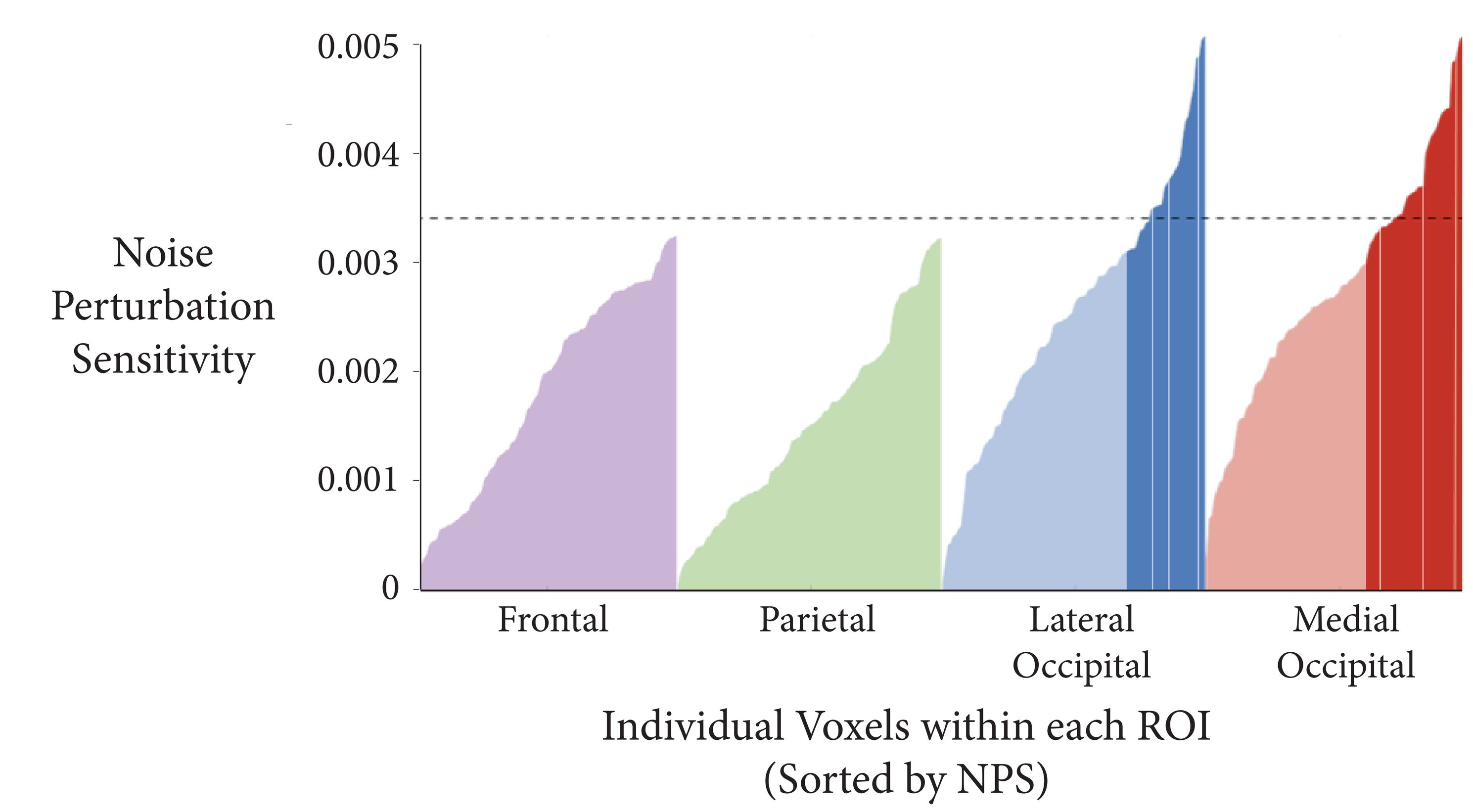
Approach: Eliminate the 10 least informative voxels (those with the smallest absolute value weights) each iteration





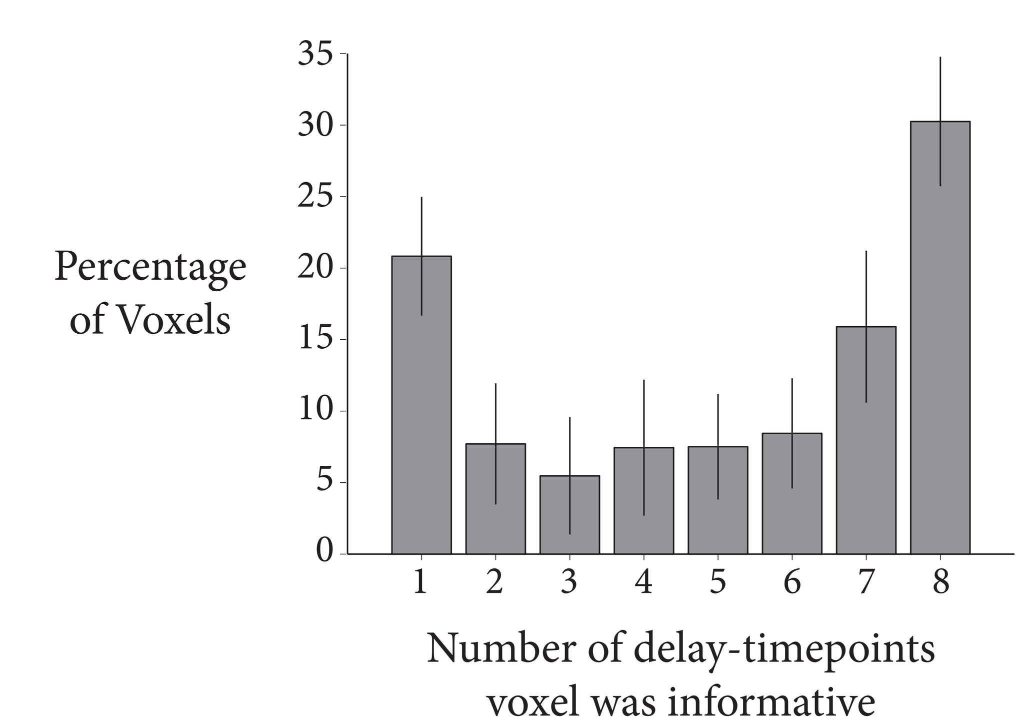
Results: Noise Perturbation Sensitivity (NPS)

Approach: Add noise to single voxel, recompute decoding accuracy, compute difference between original and noise-added accuracies. Repeat for all voxels. Larger values indicate noise had a significant effect on decoding performance, and thus the voxel is informative.



Results: Temporal Stability of Informative Voxels

Approach: Perform RFE, training on each of the 8 delay-period time-points separately, then extract all voxels that appear in the feature-set at the point of maximum decoding performance. Count how many timepoints each of these voxels is included in the final set.



Conclusions

The patterns that support decoding of visual motion memory representations are spatially confined to posterior visual regions

These patterns appear to be partially stable and partially dynamic

Distributed decoding approaches provide valuable insight into the neural representations used for short-term storage

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