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## Regional analysis of representations

Sequence learning is fundamental to skilled movement, yet the underlying processes are not well understood.

Sequences of actions can be encoded as sets of sensory goals and sets of motoric actions. These two encoding modalities give rise to multiple learning mechanisms. There is speculation that these systems are orthogonal [1], but this has never been tested.

## Methods

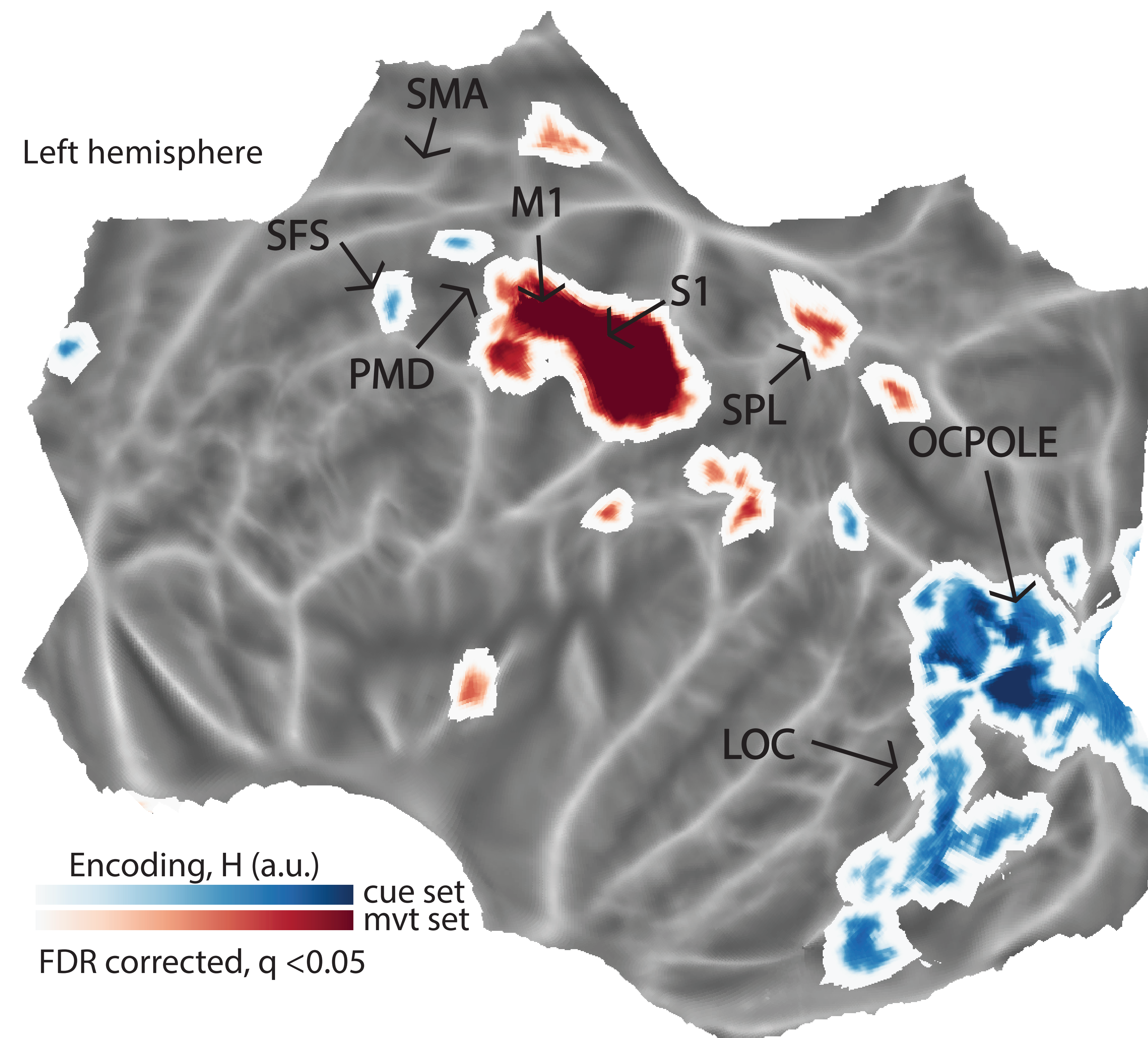
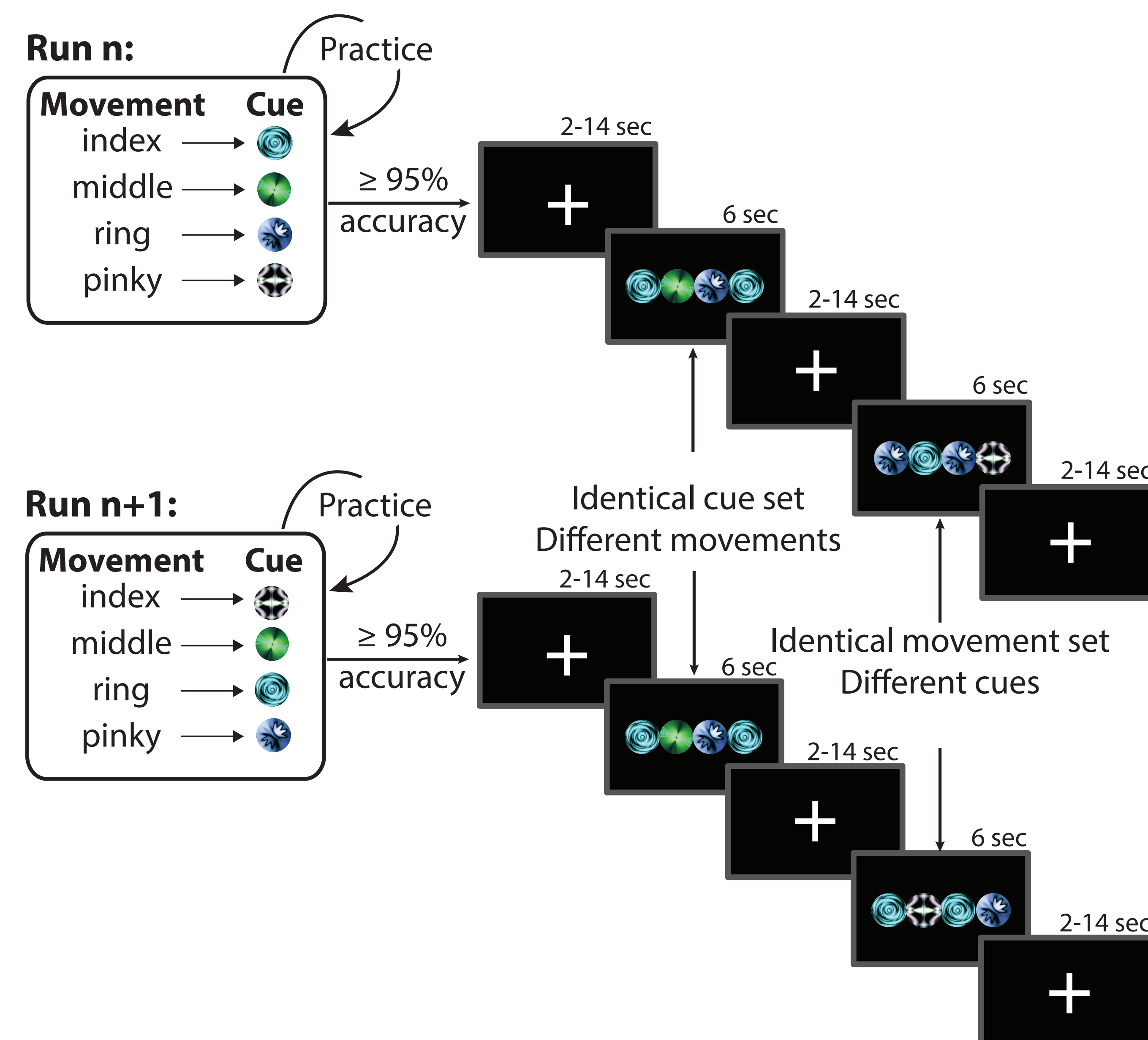
Dataset:

- 20 neurologically healthy adults (aged 21-37), 10 female
- Subjects executed 4 movement sets and 4 cue sets with their right hand
- Encoding was assessed using representational similarity analysis [3]

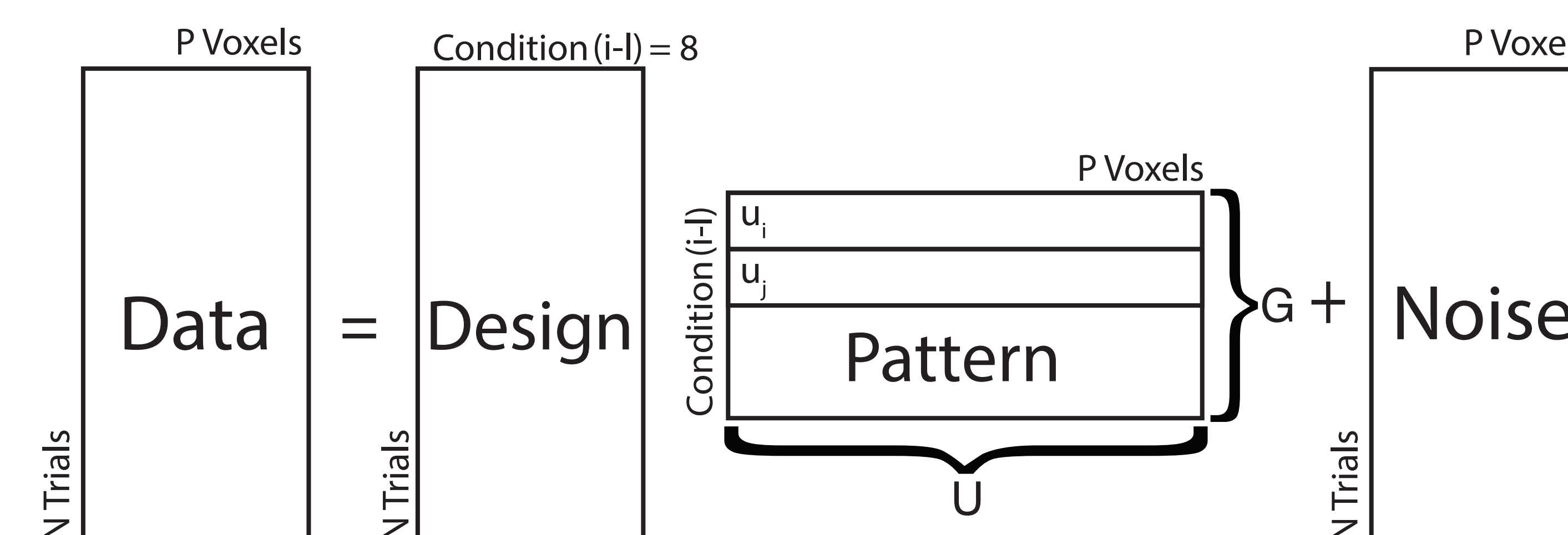
### Imaging Parameters:

3T (SIBR), TR: 2000ms, MB=3, 66 slices, 241 volumes, 2mm<sup>3</sup>, 8 independent runs

Task Design: see [2] for details.



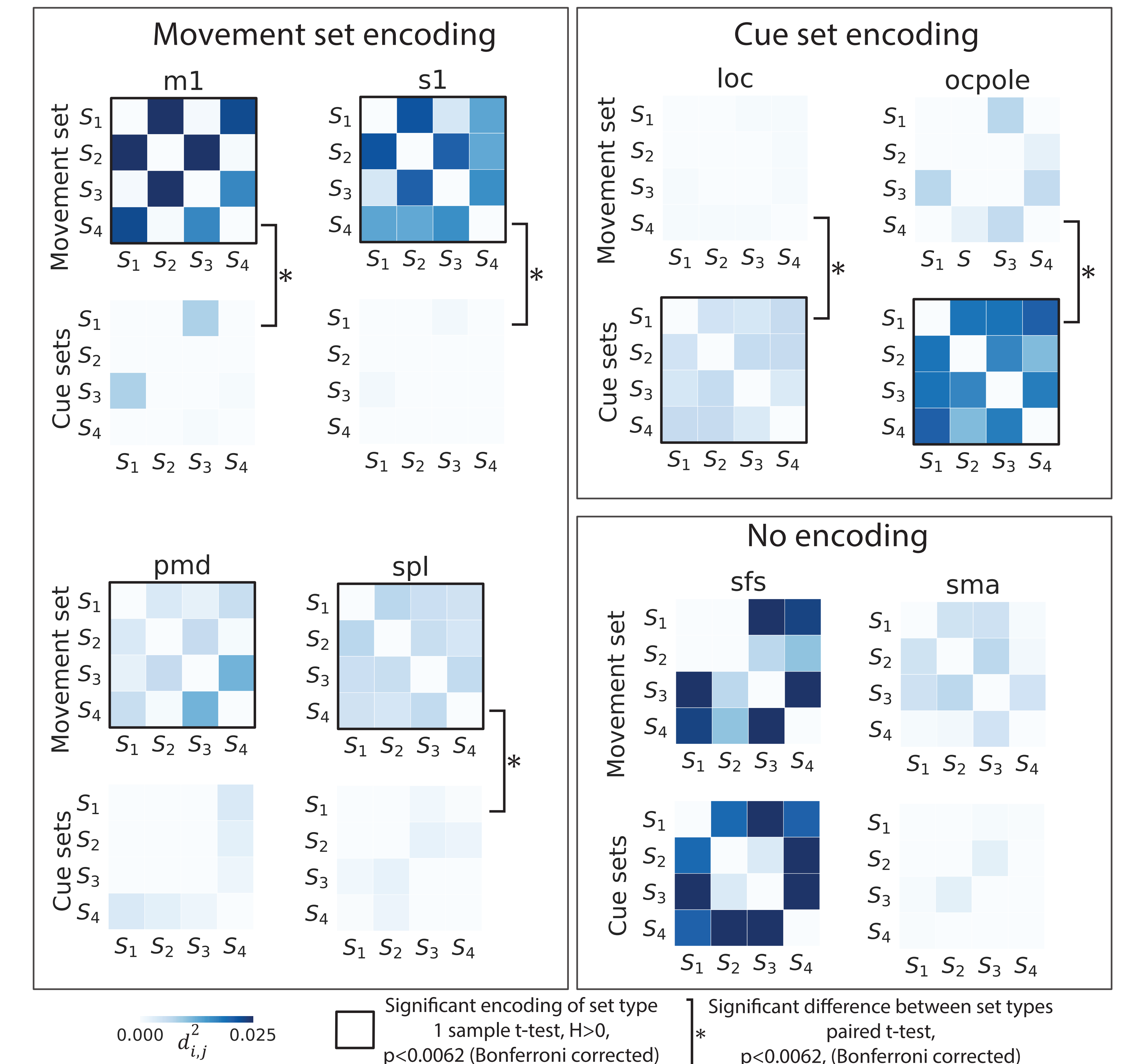
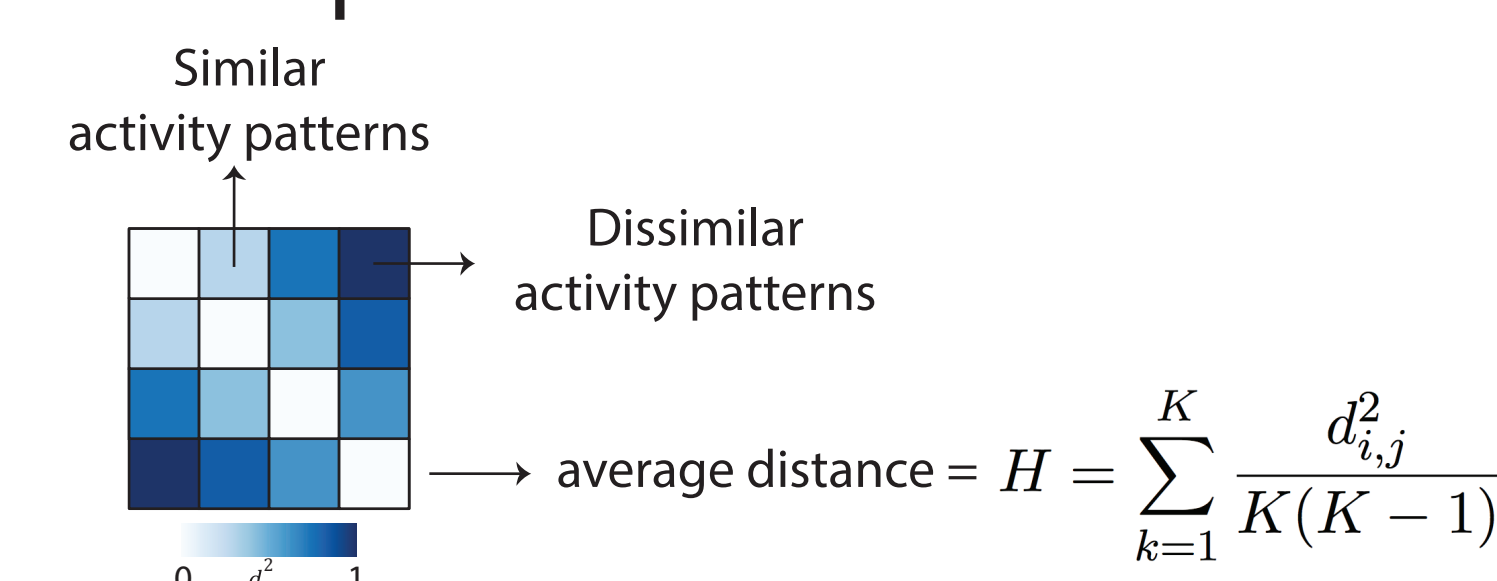
## Representational similarity analysis



Encoding was assessed with the crossvalidated (across runs  $M$ ) Mahalanobis distance between prewhitened coefficients ( $u$ ):

$$\hat{d}_{i,j}^2 = \frac{1}{MP} \sum_{m,l:m \neq l}^M (u_i^m - u_j^m)^T (u_i^l - u_j^l)$$

Dissimilarity matrix summarizes the representational structure:



## Conclusions

- Primary motor (M1) and primary somatosensory cortex (S1), superior parietal lobule (spl), and dorsal premotor cortex encode movement sets.
- The occipital pole (ocpole) and lateral occipital complex (loc) encode cue sets.
- Movement and cue set encoding is entirely distinct, i.e. no region encodes both cue and movement sets.
- A single region along the superior frontal sulcus (sfs) showed weak evidence of encoding both modalities but exhibited high variability across subjects.
- These results suggest that sequence learning can proceed along two orthogonal channels.

## References

1. Hikosaka O., et. al. *Curr Opin Neurobiol.* 2002 Apr;12(2):217-22.
2. Lynch B., Beukema P., Verstynen T. (2017). *J Cogn Neurosci* 29:125–136.
3. Diedrichsen, J. & Kriegeskorte, N. *PLoS Comput. Biol.* 13, e1005508 (2017)