

Decoding of binocular motion extends the hierarchy of motion processing in the human brain

Puti Wen, Michael S. Landy, & Bas Rokers

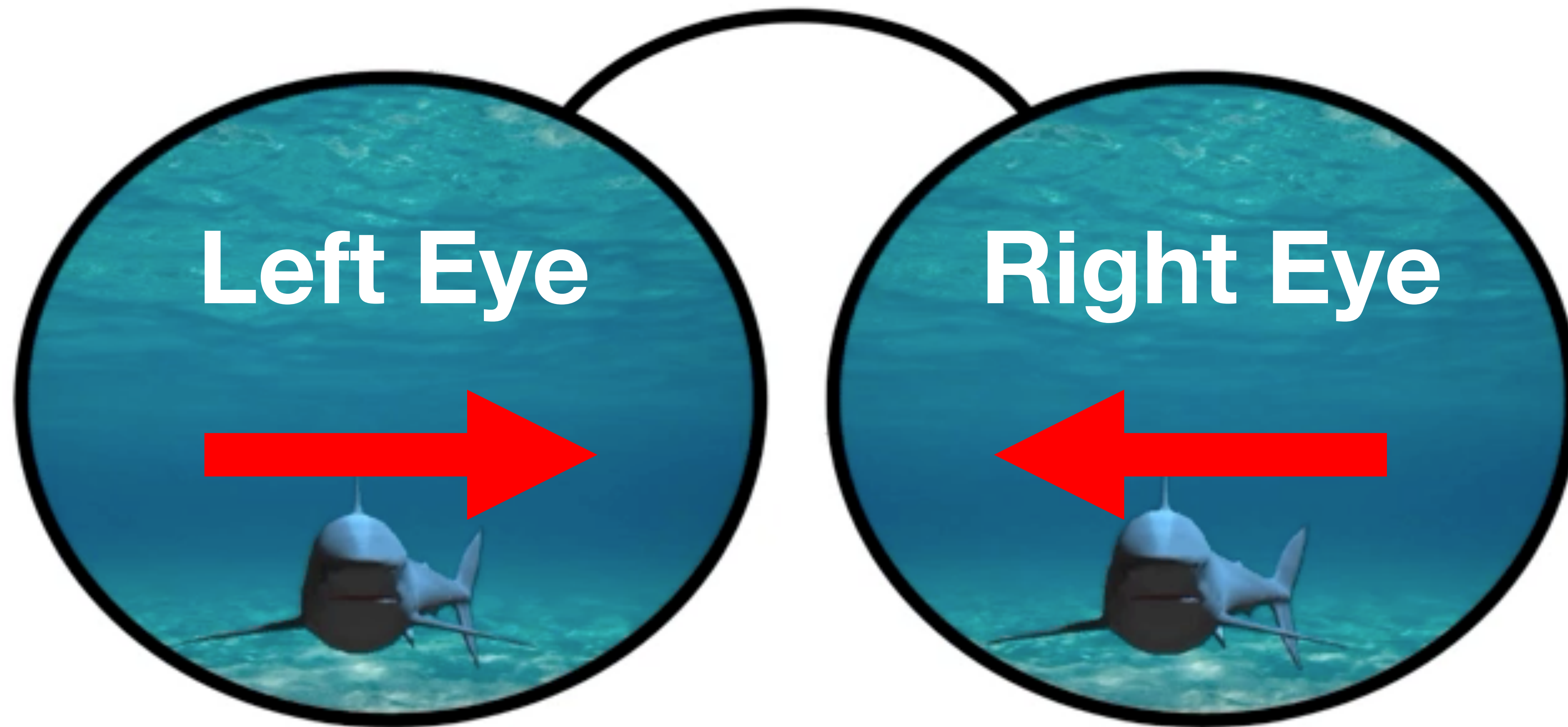
New York University & New York University Abu Dhabi

VSS 2022

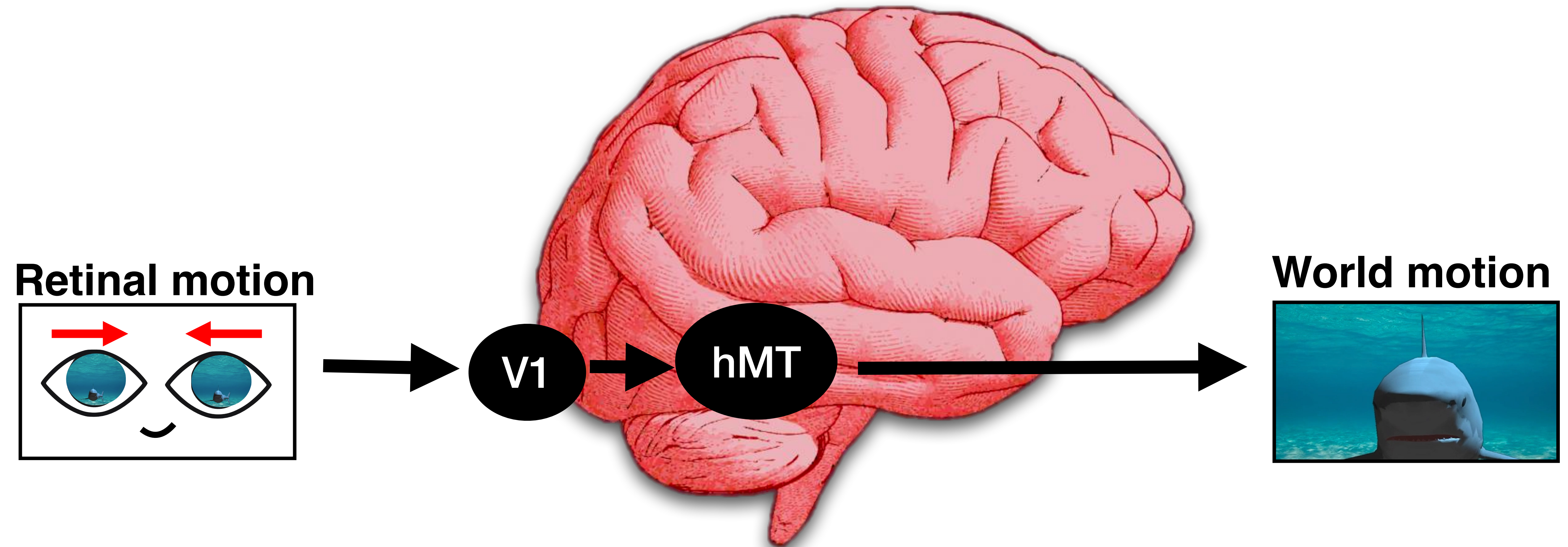








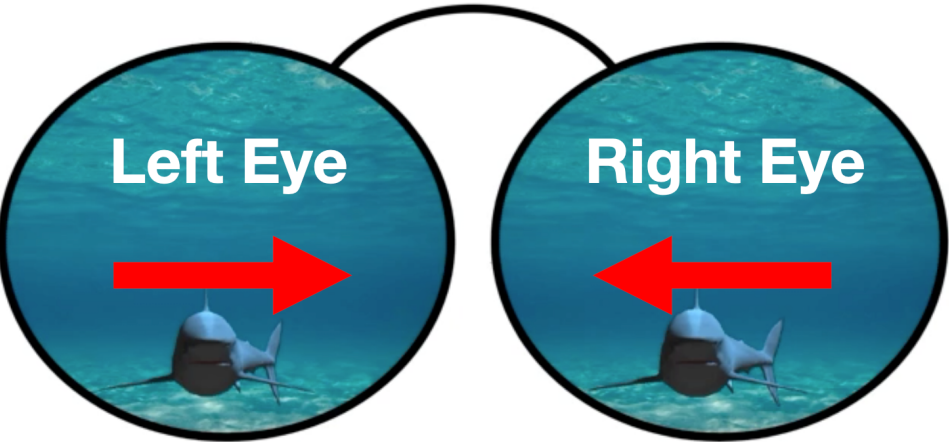
Representation of motion signals



Primary visual cortex (V1)

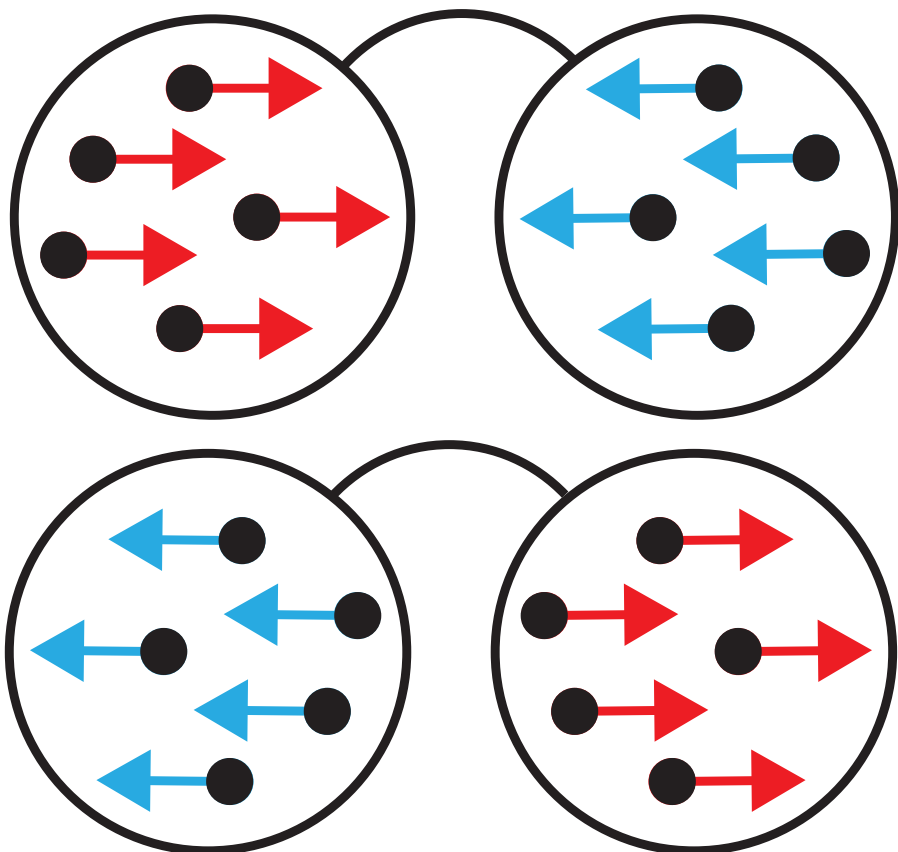
Human middle temporal complex (hMT)

Conceptual design of the stimulus

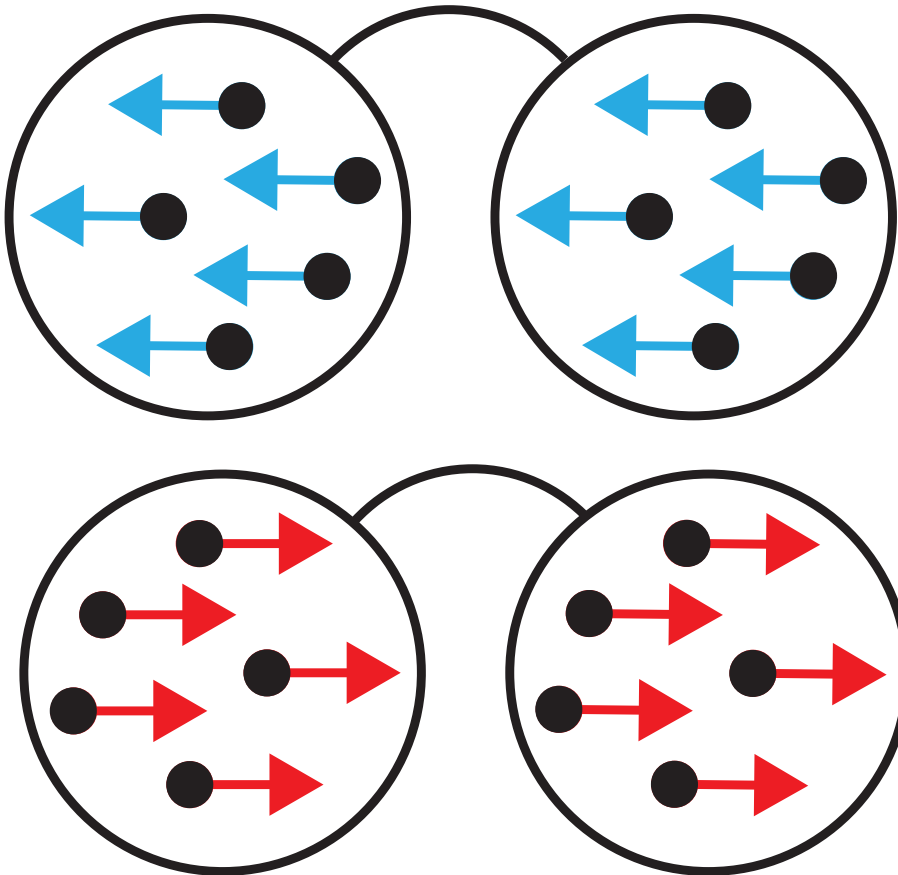


Opposite
Retinal motion

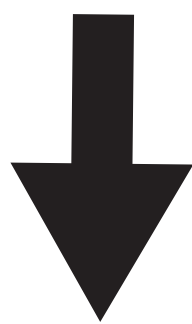
Retinal motion



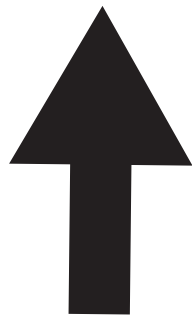
Identical
Retinal motion



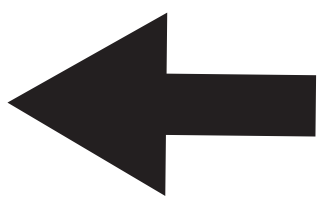
World motion



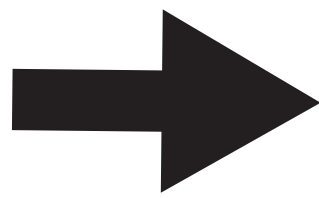
Toward



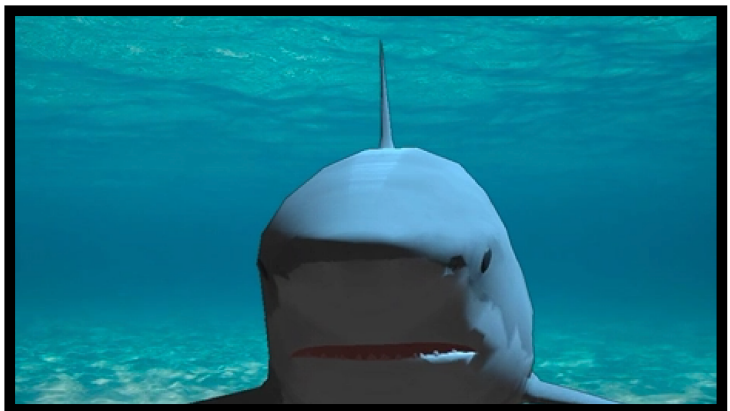
Away



Left



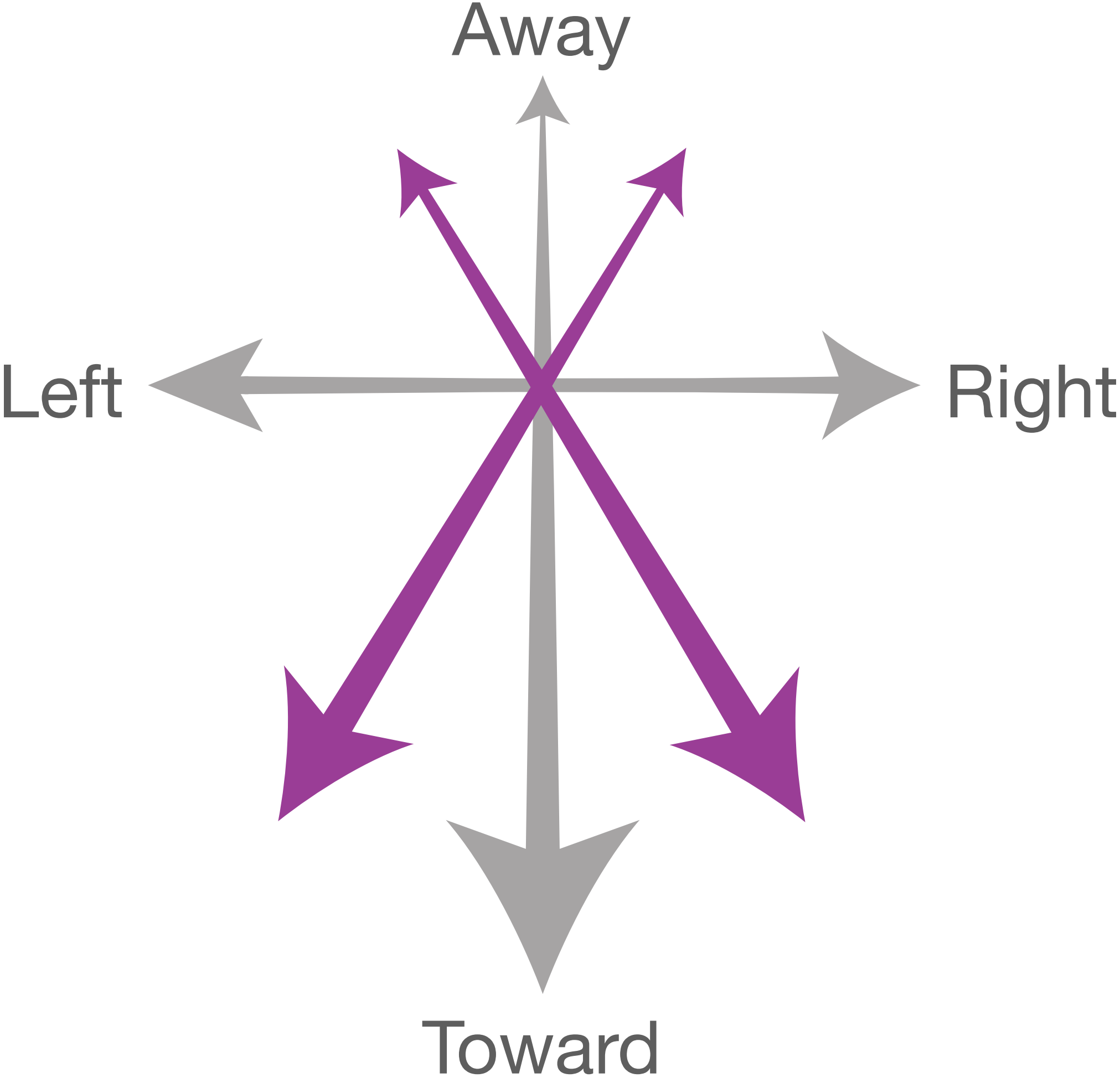
Right



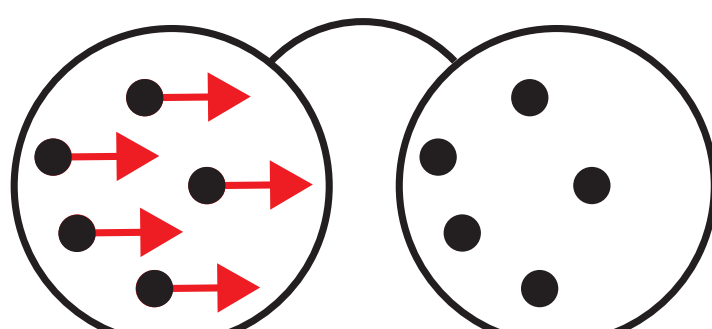
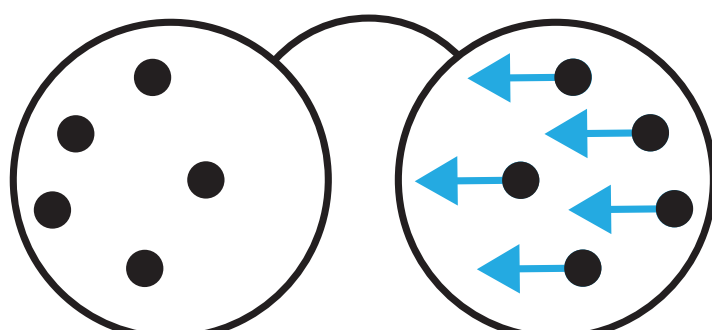
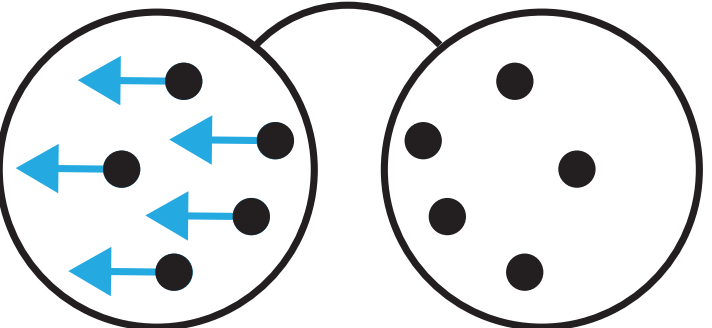
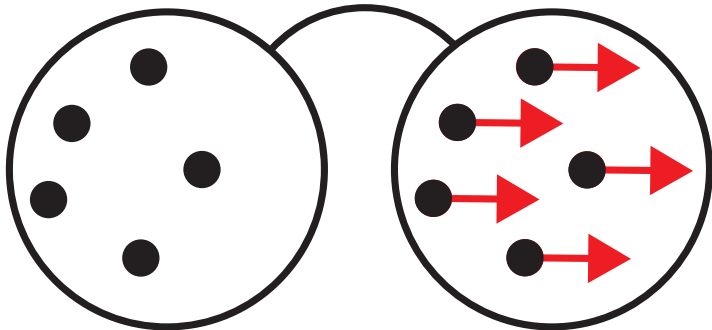
Motion-in-depth
World motion

Lateral
World motion

Conceptual design of the stimulus



Retinal motion



One-eye-only

Retinal motion

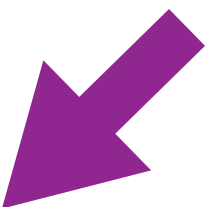
World motion



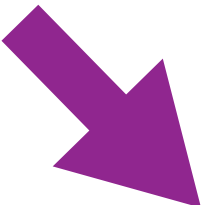
Rightward away



Leftward away



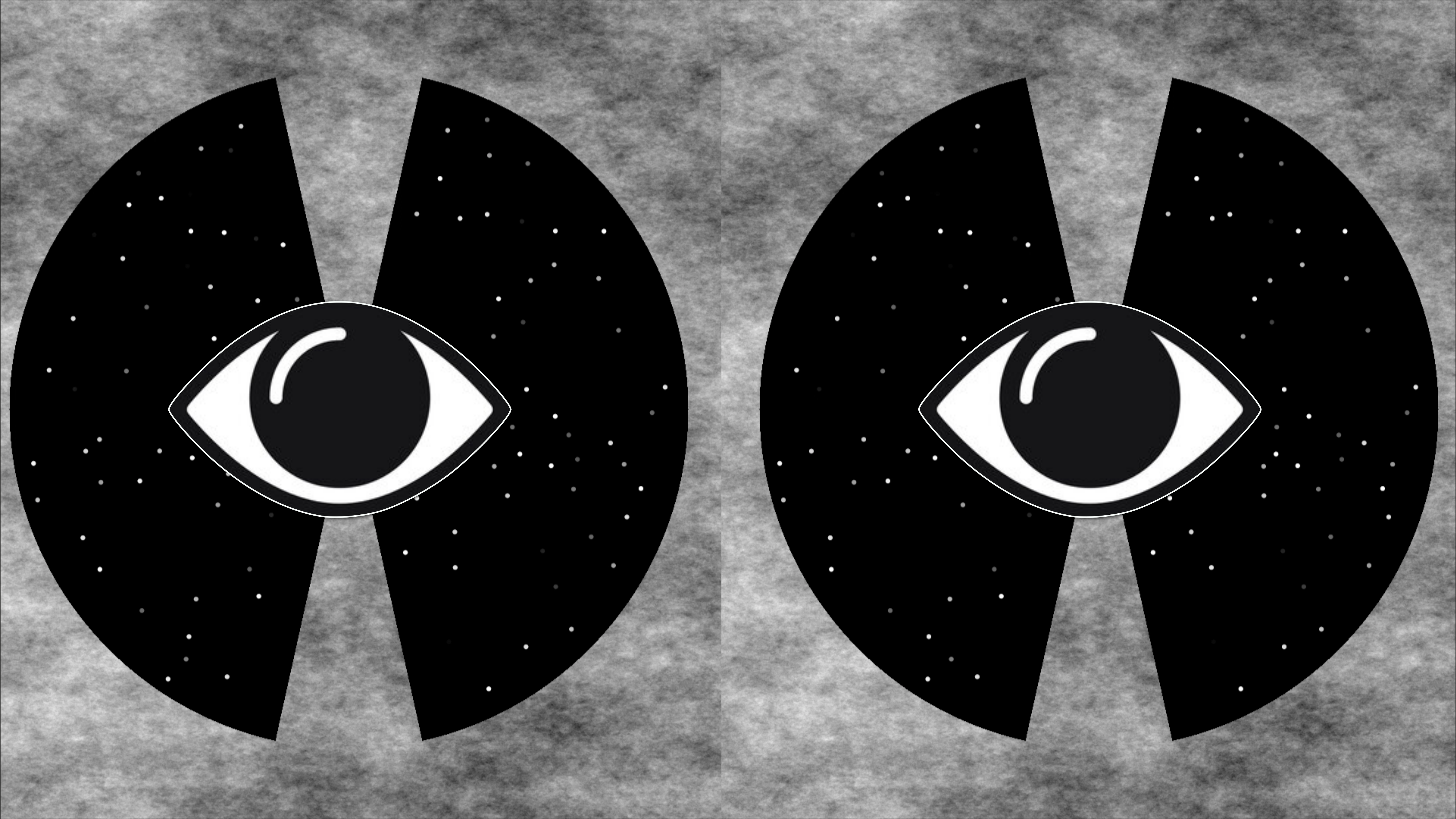
Leftward toward



Rightward toward

Oblique

World motion

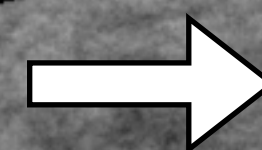
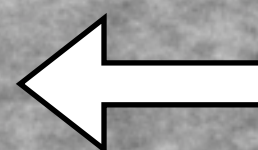
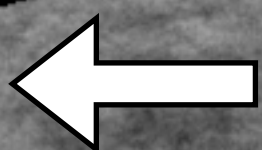
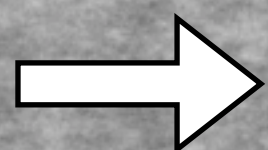


**World motion
Away**

**World motion
Toward**

**World motion
Away**

**World motion
Toward**



The dataset

1 Subject

Eight motion directions



(3s per direction)

x 15 repeats

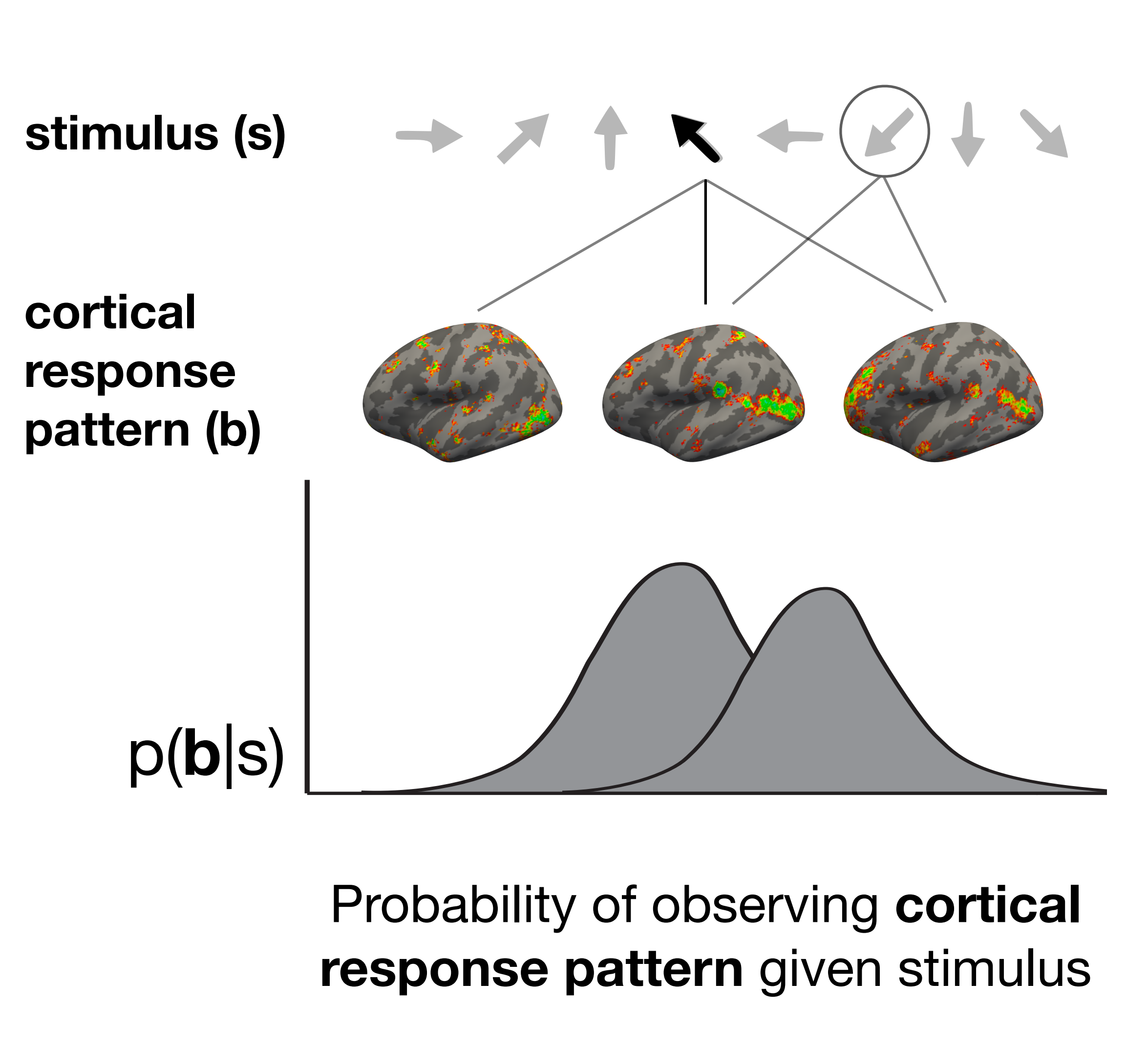
1 cycle (24s) x 15 = 120 trials (6 min)

x 20 scans

1 scan x 20 = 2400 trials (2 hrs)

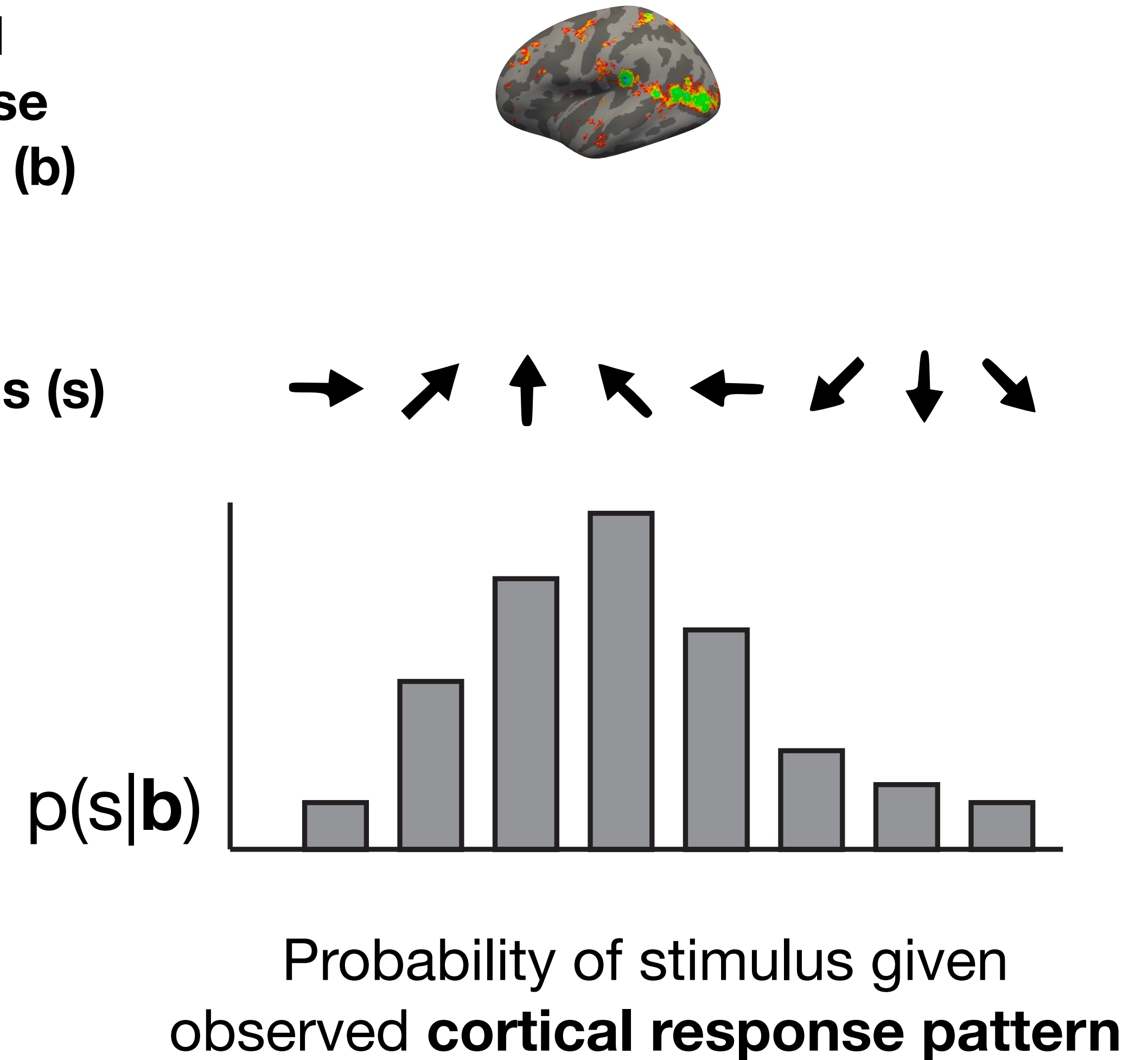
x 9 Subjects

Decoding method: TAFKAP



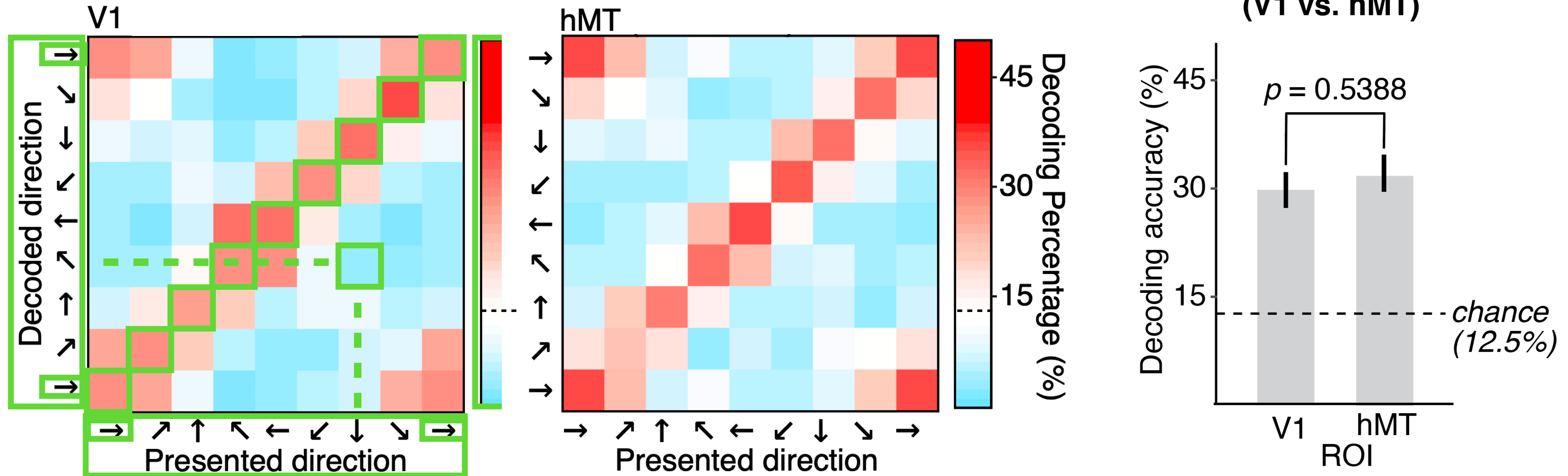
cortical response pattern (b)

stimulus (s)



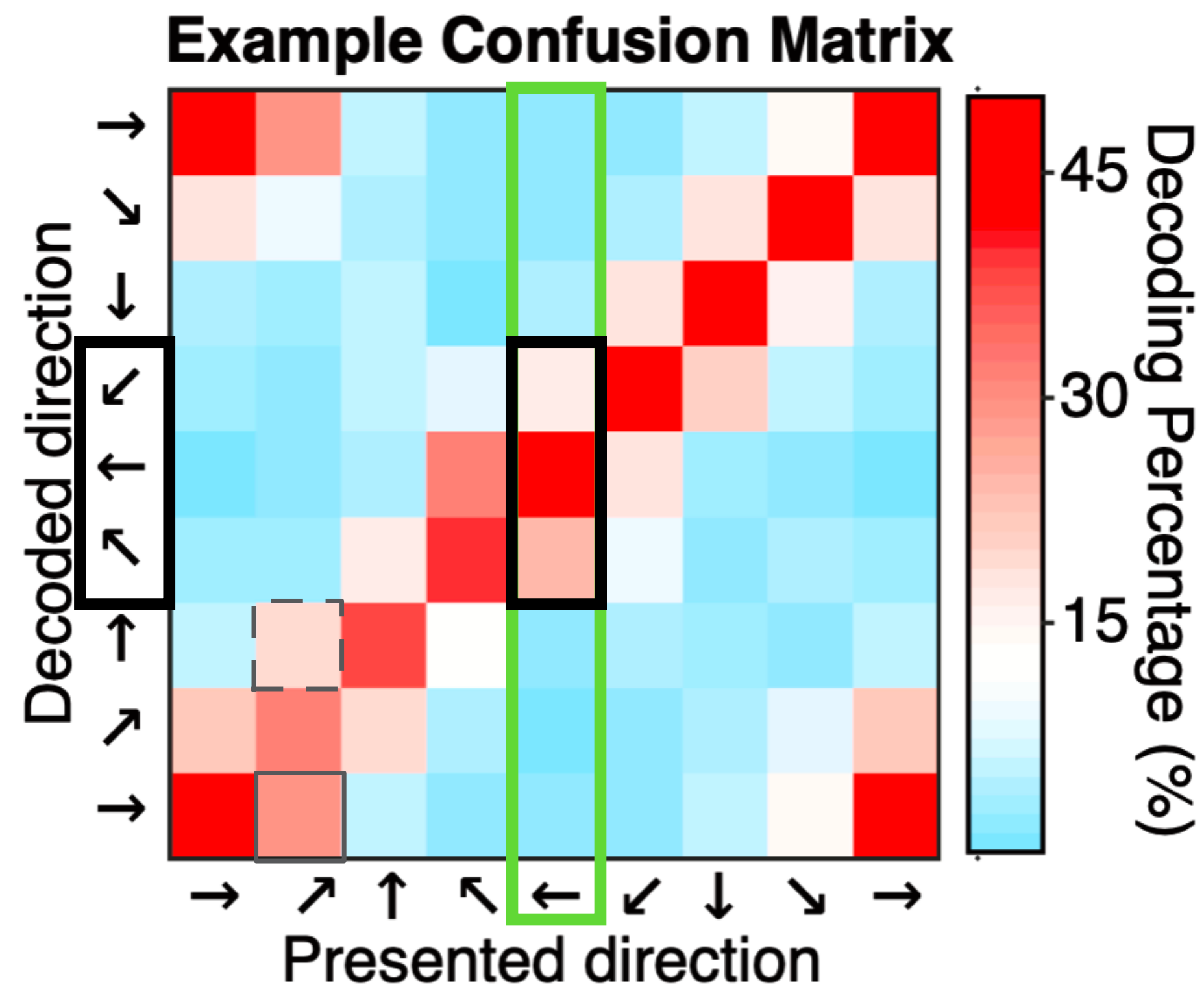
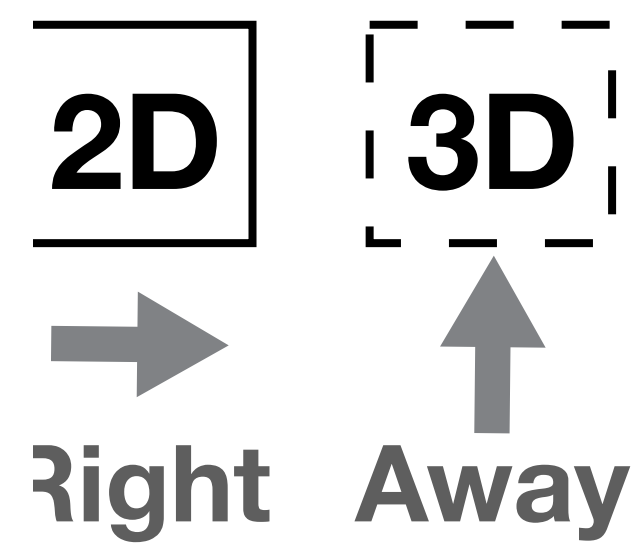
(van Bergen & Jehee, 2021)

Decoding motion from V1 and hMT

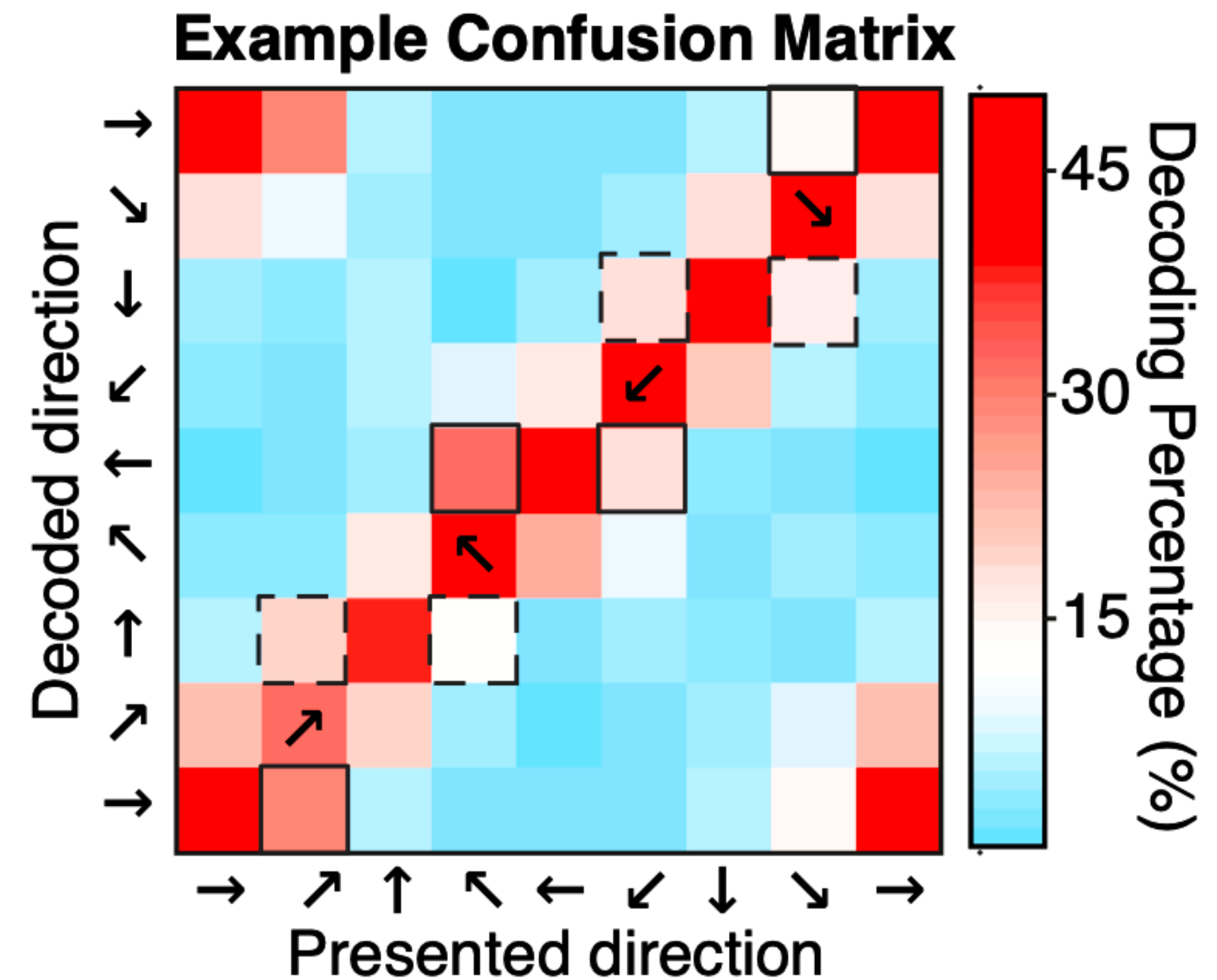
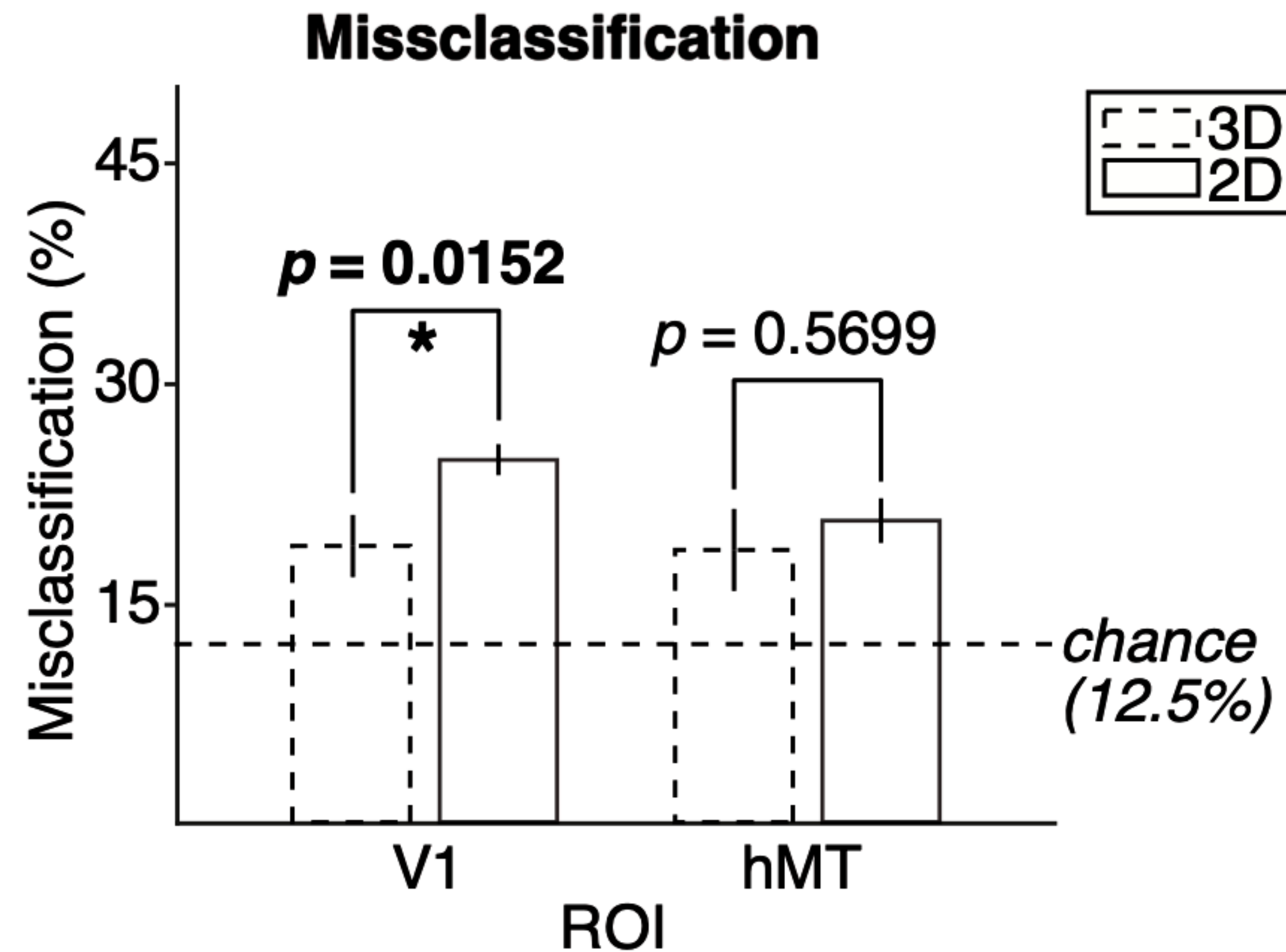


**V1 and hMT have the same decoding accuracy —
Does this mean that they have the same representation?**

Decoding errors are systematically distributed

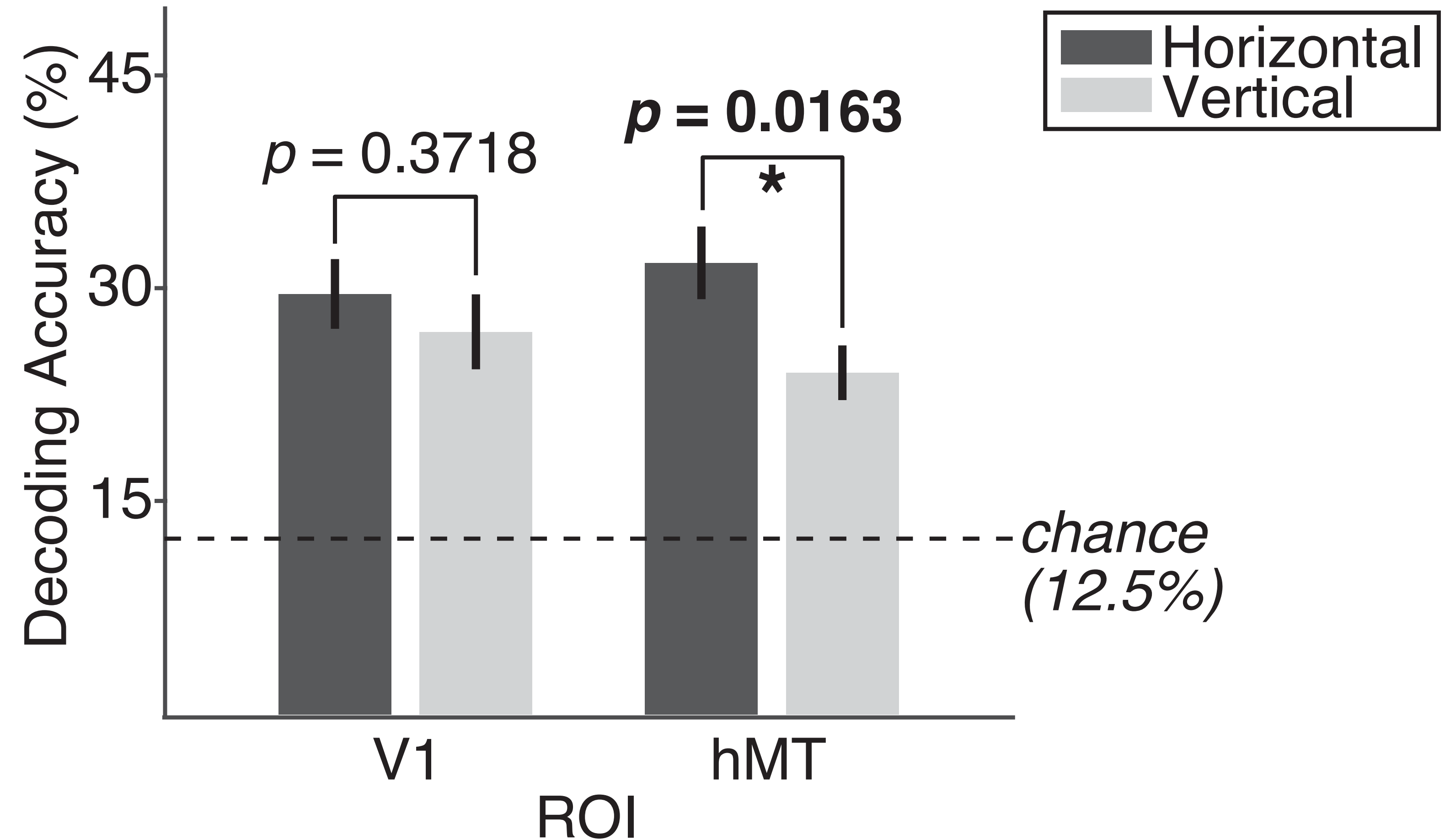
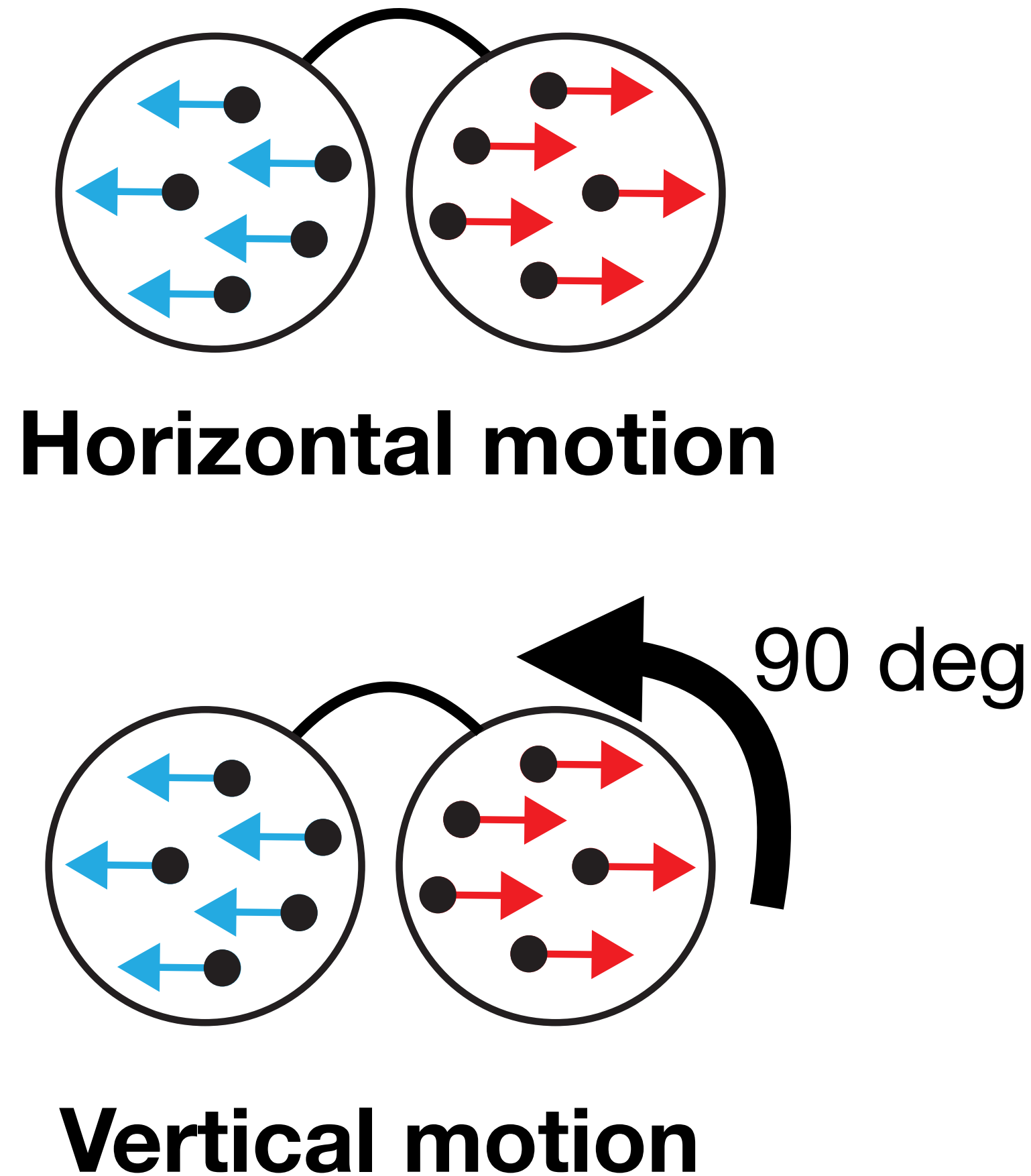


Decoding errors are systematically distributed



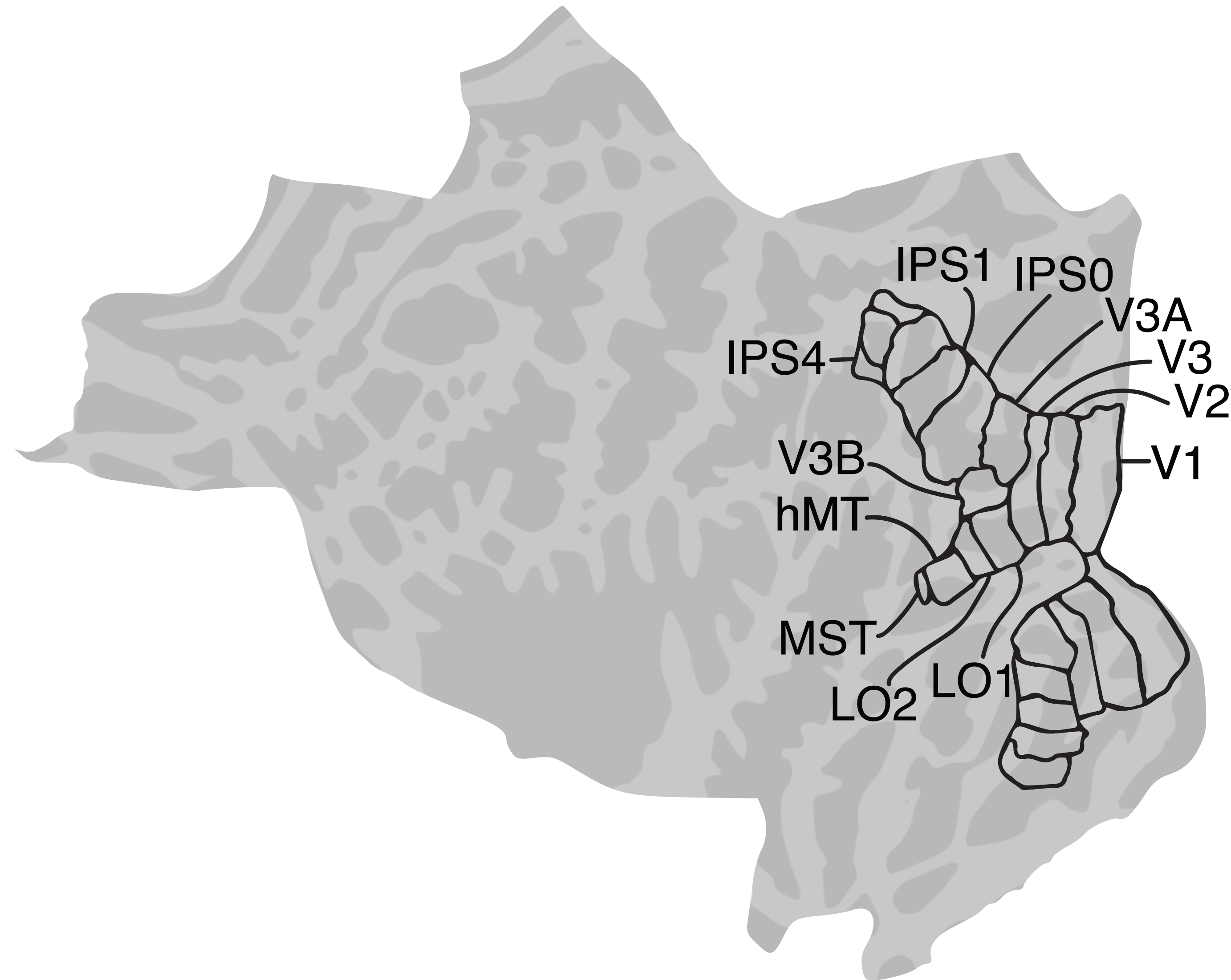
V1 has a strong bias towards 2D components.
hMT has no bias towards either the 2D or 3D components.

Control experiment: Vertical motion condition



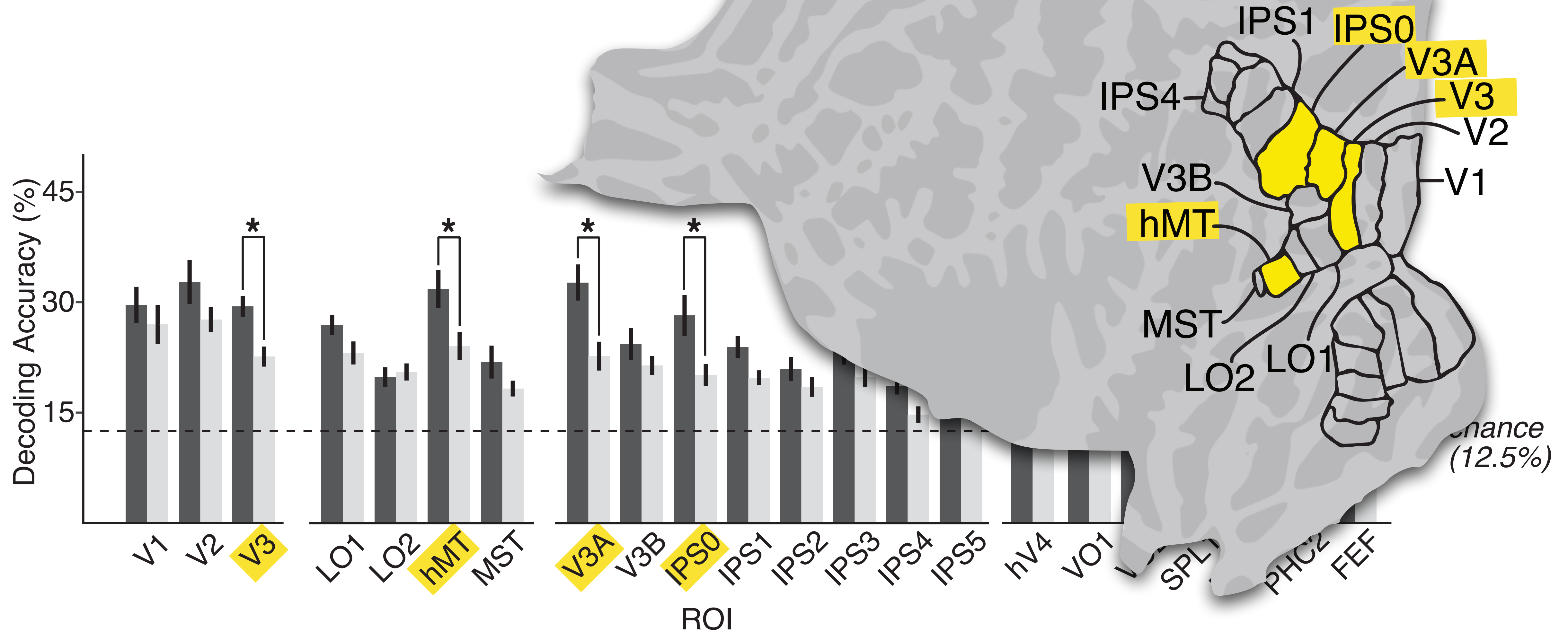
V1 decodes vertical and horizontal conditions **equally well**.
hMT showed a significant **reduction** in decoding accuracy in vertical compared to horizontal condition.

Exploring beyond V1 and hMT



(Wang et al., 2014)

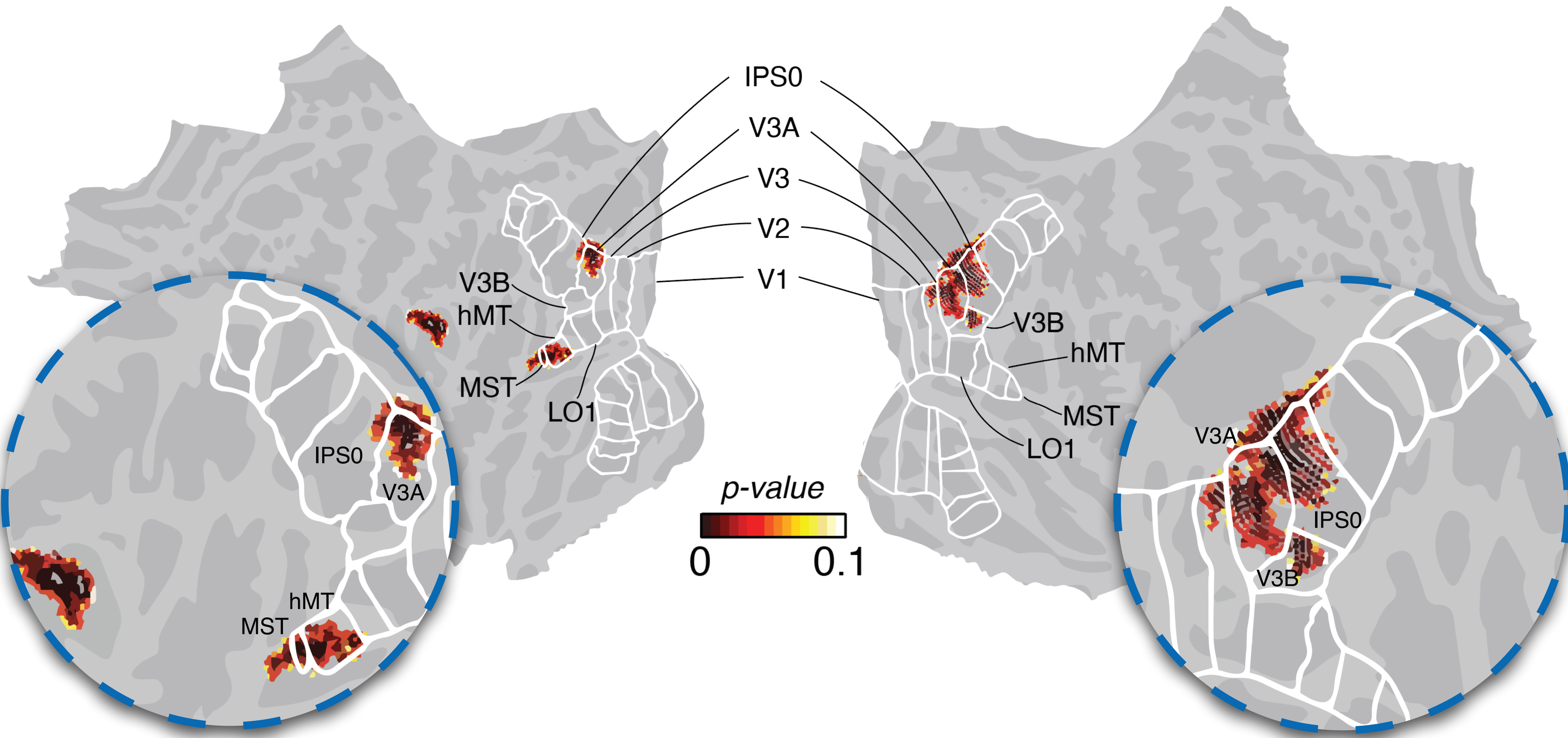
V3, V3A, IPS0 behaved similarly to hMT



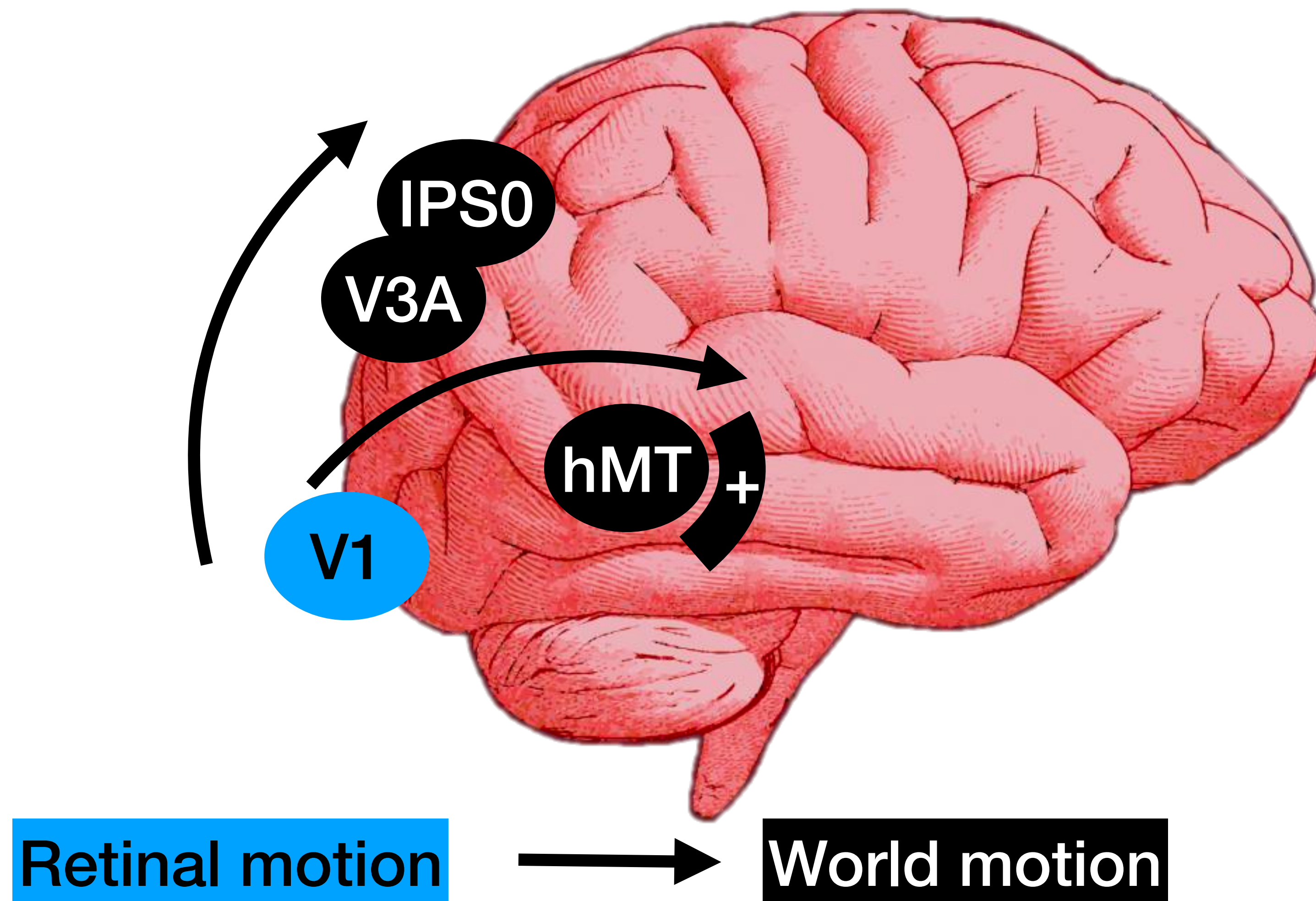
Searchlight: Looking across the whole brain



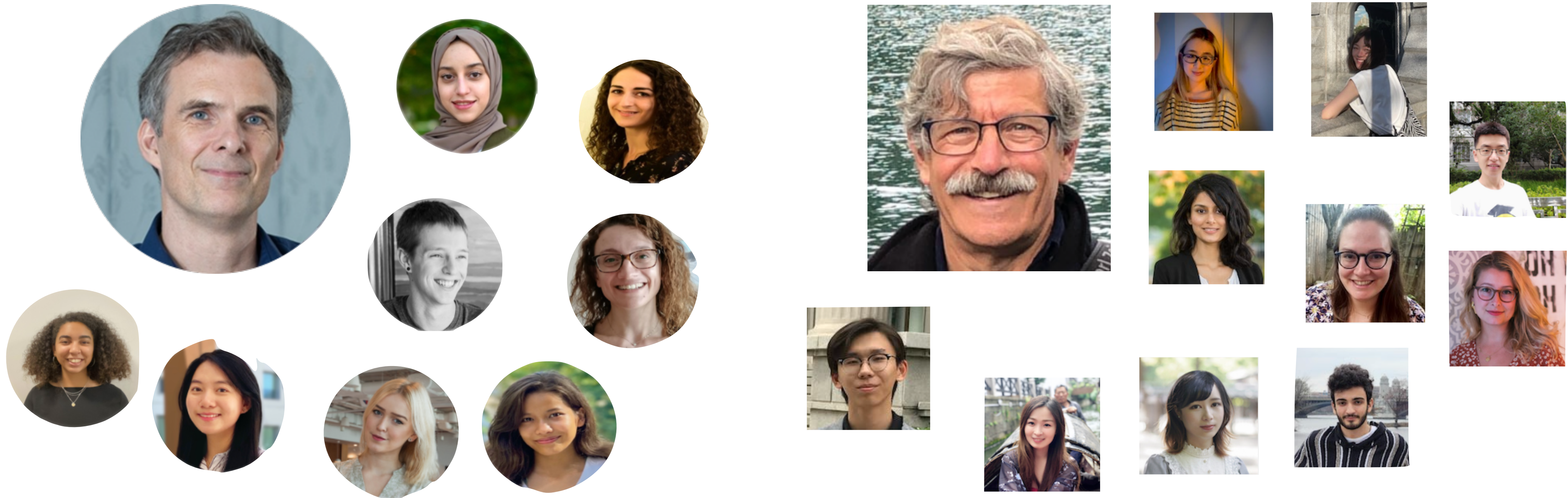
Significant clusters that show greater representation of **world motion** over retinal motion



Conclusion



Acknowledgement



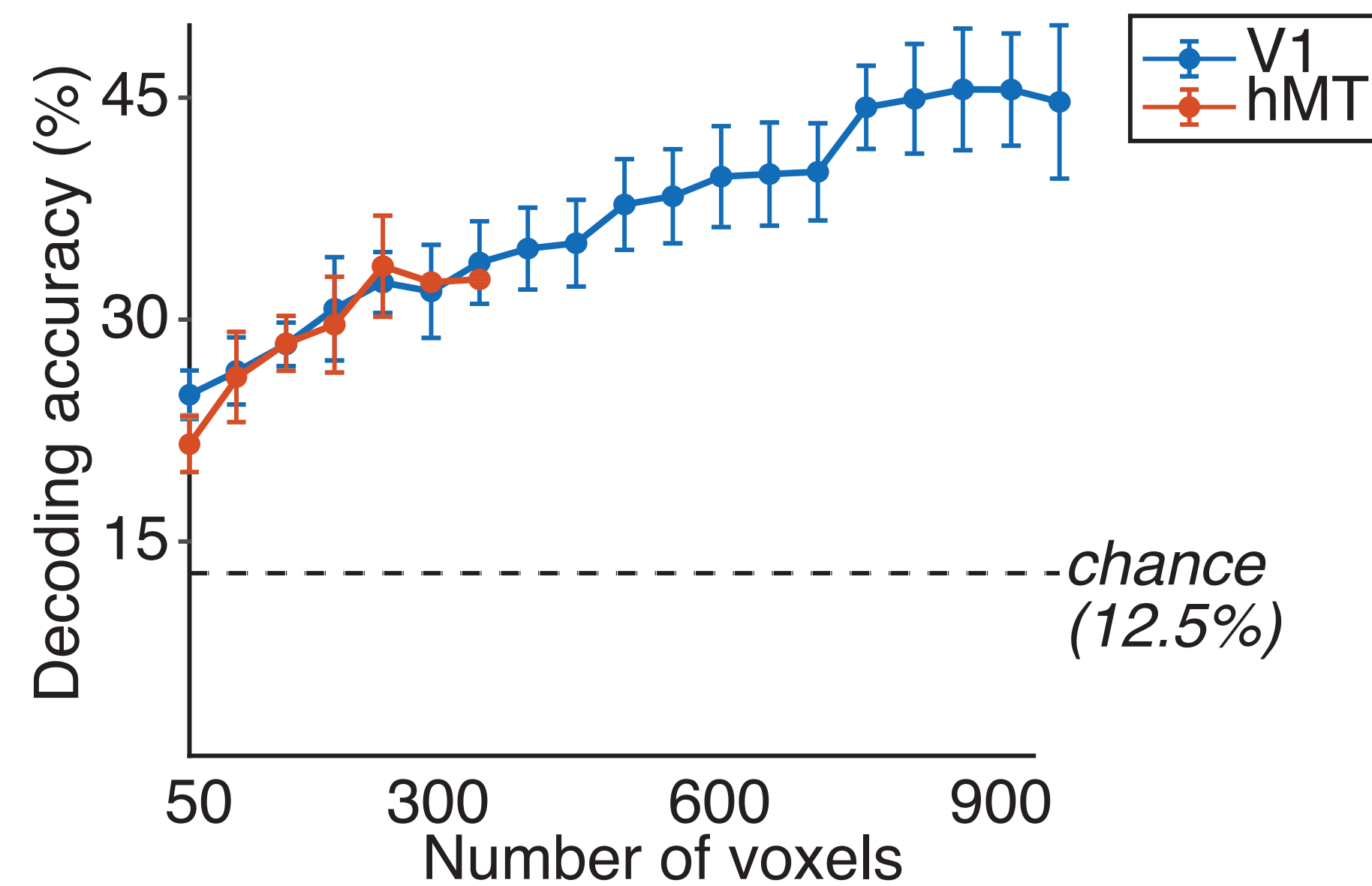
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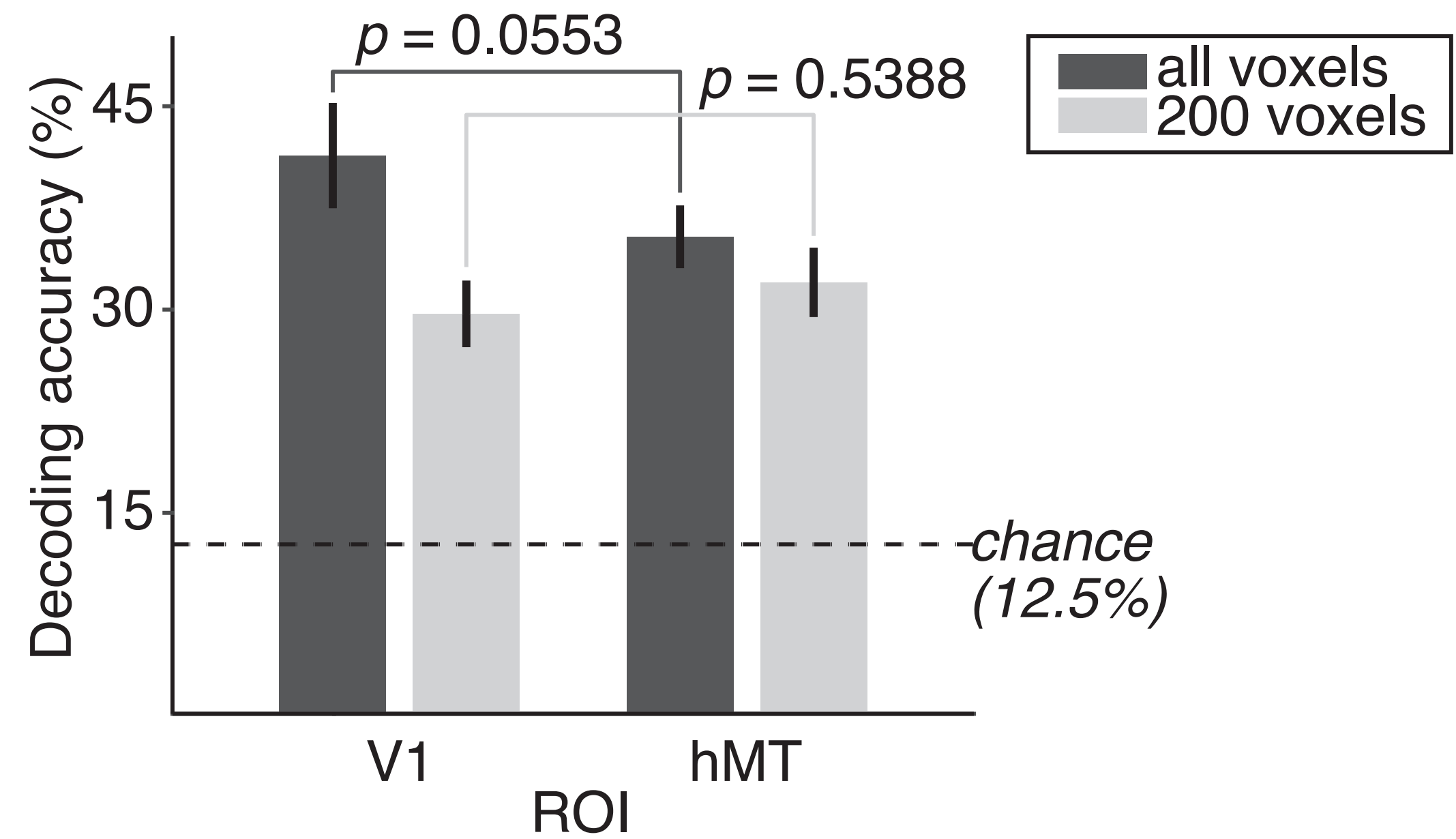
Email: pw1246@nyu.edu



**Decoding Accuracy as a
Function of Number of Voxels**



**Decoding Accuracy
(all voxels vs. 200 voxels)**



Motion direction preference map

