



Is There an Object-Centered Coordinate Map in LOC?

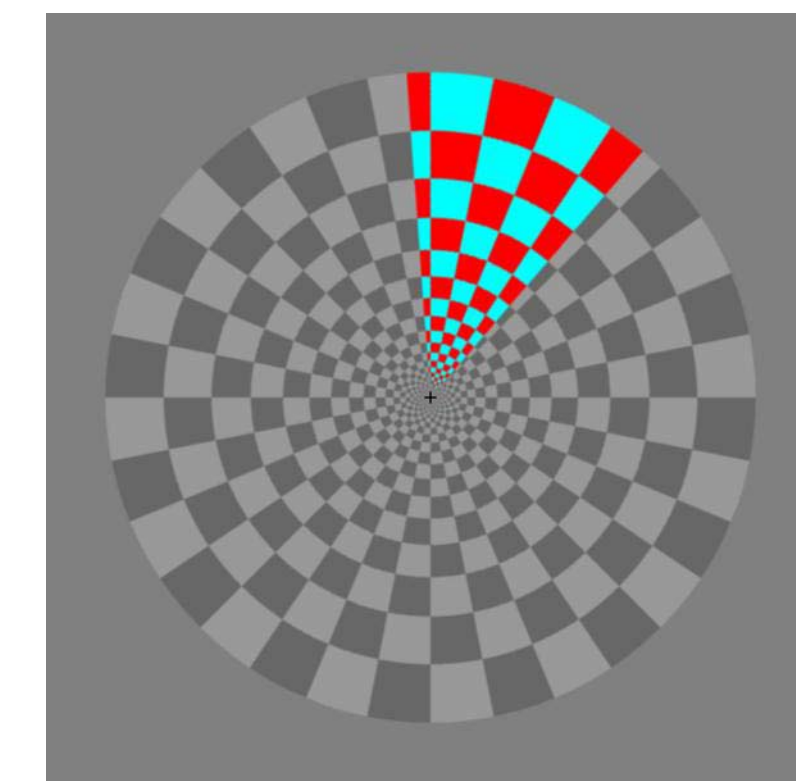
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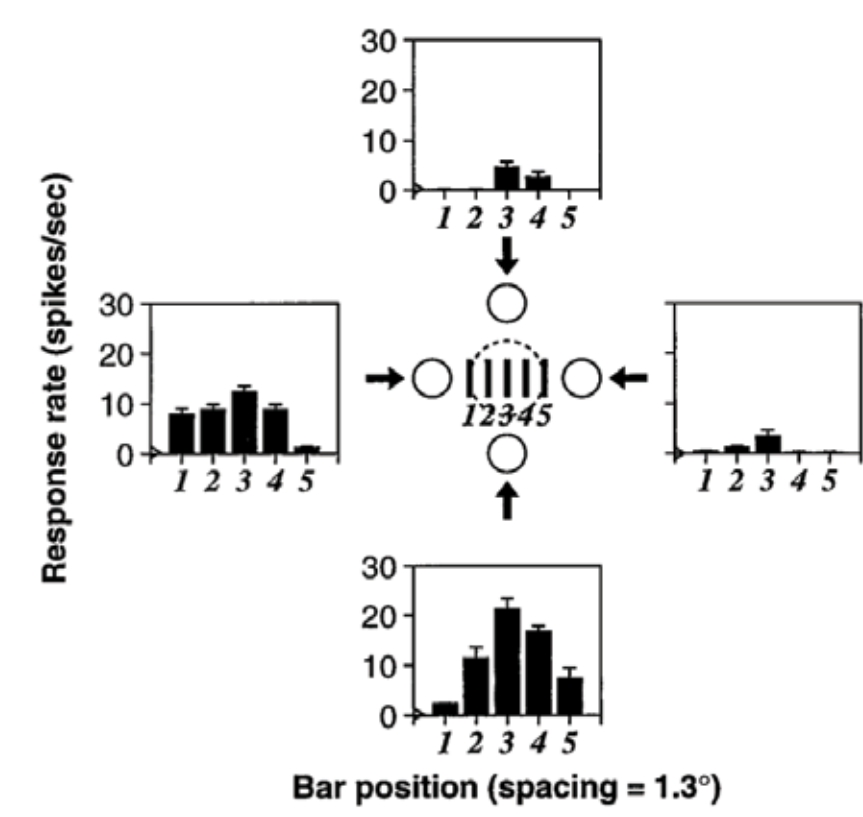


Background

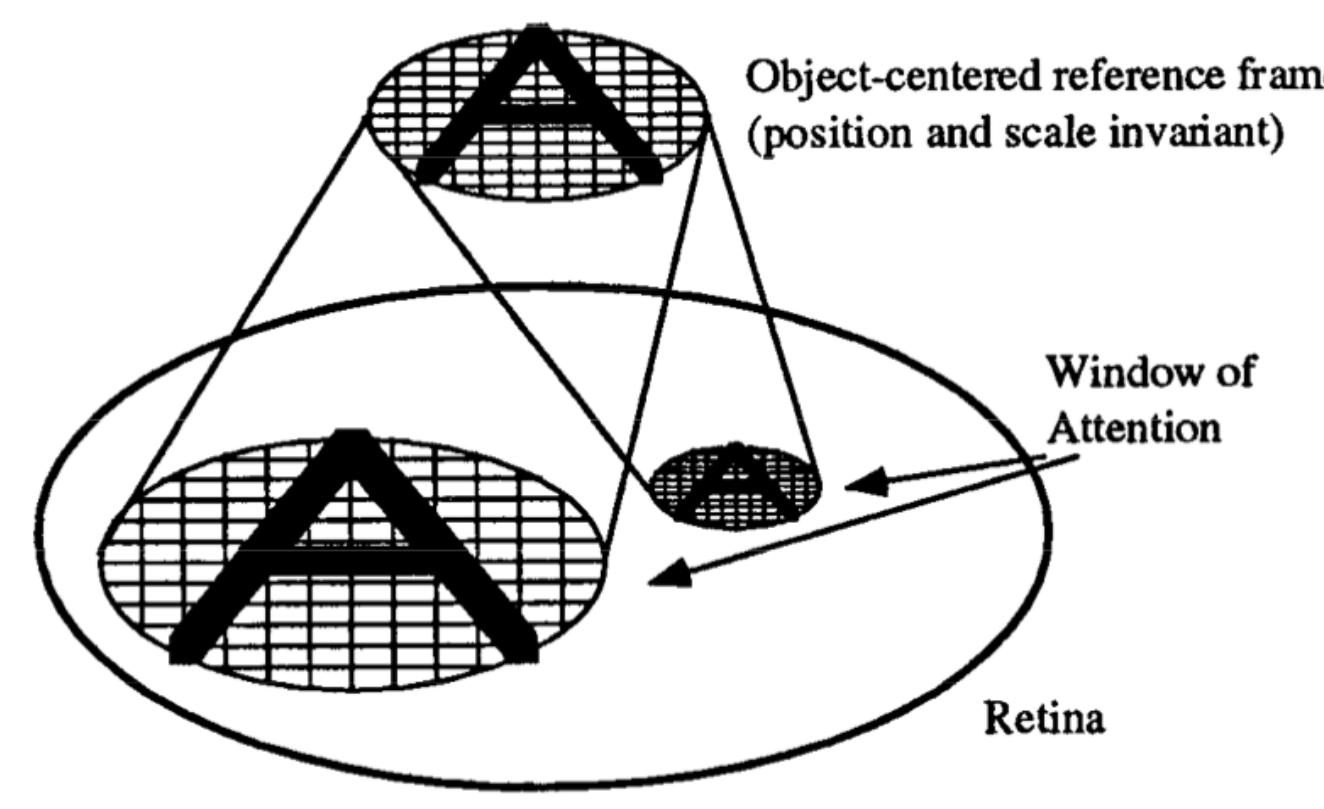
- Several studies* have shown evidence for object-centered tuning in macaque V4 and IT, as well as human LOC
- Other studies** have shown that attention can change receptive field properties.
- Computational models of “shifter circuits” explicitly predict a transformation of the coordinate system of the visual representation from absolute to object-centered space.
- Standard retinotopic paradigms confound object-centered position and retina-centered position.
- Could there be an object-centered map in LOC?



Standard retinotopic mapping stimulus. The wedge occupies both a retinotopic and object-centered position.



Attention shifting receptive fields in V4. (Connor et al., 1997)

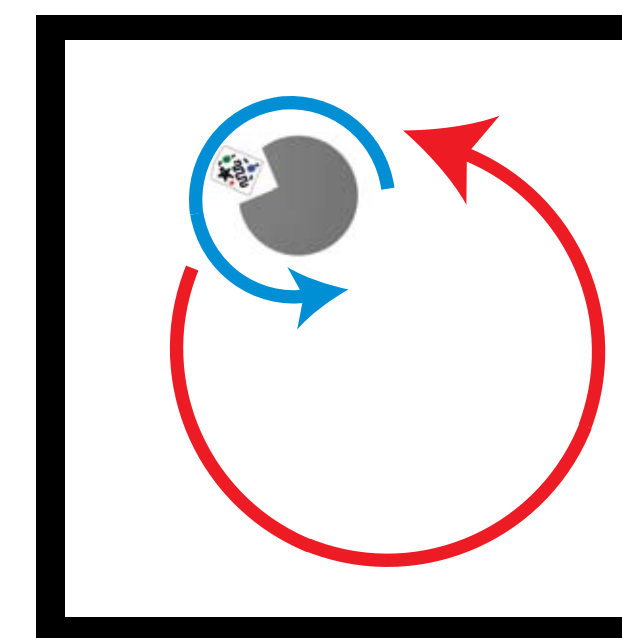


Olshausen and Andersen's shifter-circuit model (1993)

Methods

- In each of three experiments, fixating subjects viewed one of three types of stimuli appearing in the periphery.
- Subjects attended to a particular object- (or scene-) centered location on the stimulus. The attended spot rotated around the stimulus at a particular frequency as the whole stimulus rotated around the screen at a different frequency.
- We assessed response modulation at each of the two frequencies by lagged correlation and Fourier analysis.

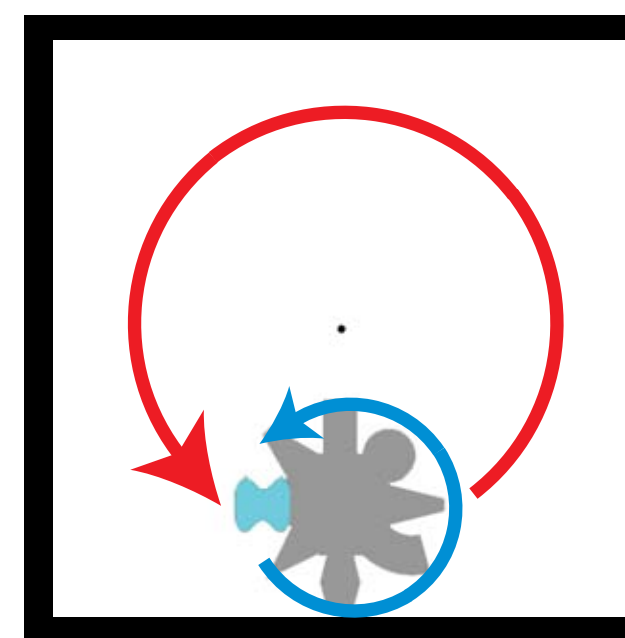
Experiment 1



- 4 **Screen** rotations per run (72s each)
- 9 **Object** rotations per run (32s each)
- Stimuli appeared once per second

Task: Subjects pressed a response key if the outer contour of the puzzle piece did NOT match the cutout in the shape (as shown here).

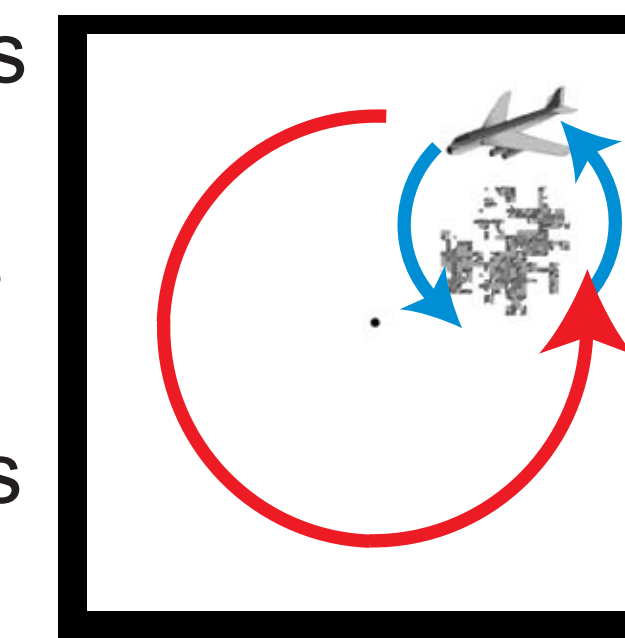
Experiment 2



- 12 **Screen** rotations per run (32s each)
- 16 **Object** rotations per run (24s each)
- Boundary elements changed at 2 Hz

Task: Subjects performed a one-back matching task on the color-highlighted boundary element, indicating match or non-match on cued trials

Experiment 3



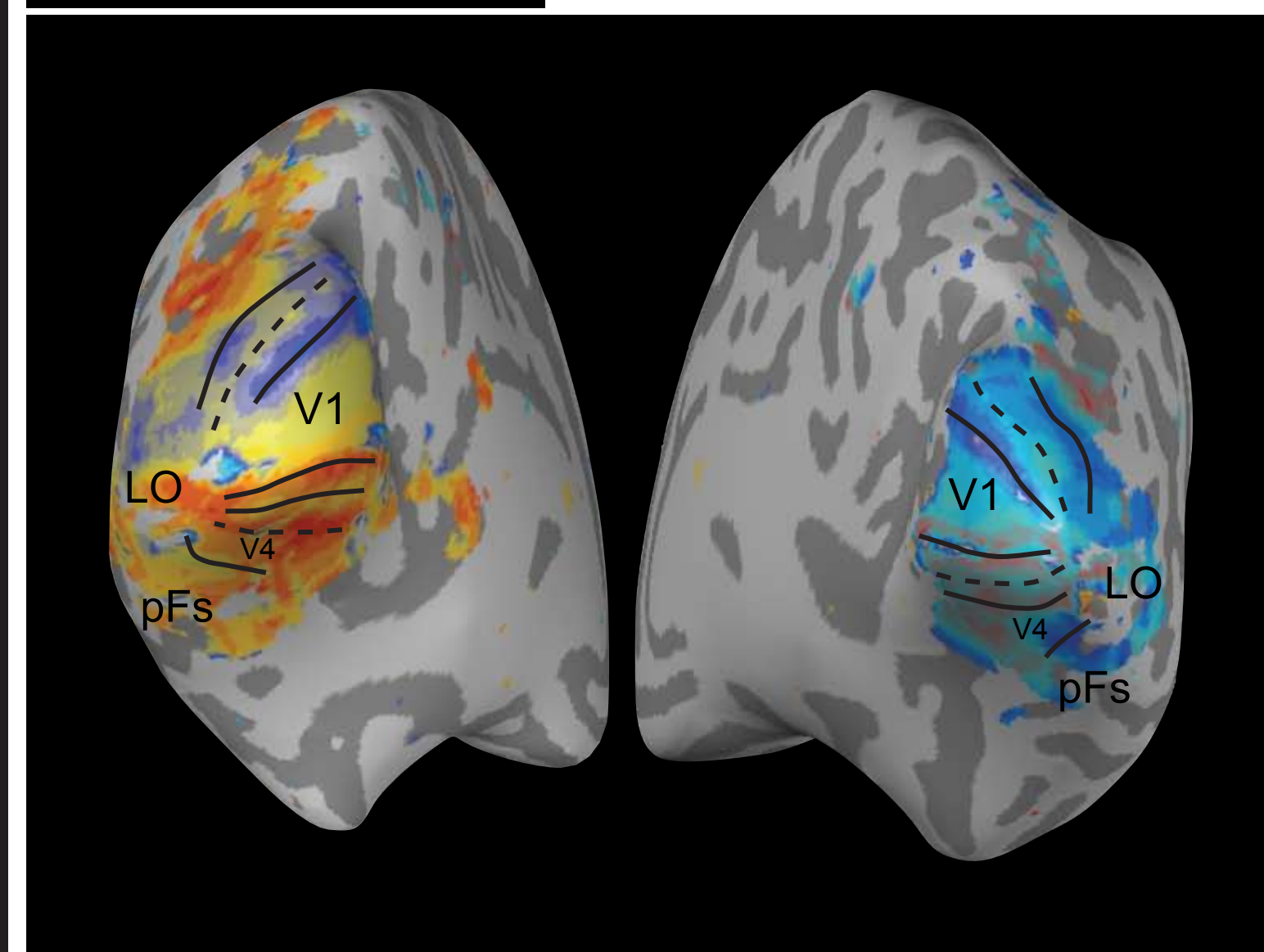
- 12 **Screen** rotations per run (32s each)
- 16 **Object** rotations per run (24s each)
- Both shapes changed at 2 Hz

Task: Subjects performed a matching task on the two images (periodically a scrambled image would appear in the object stream or vice-versa).

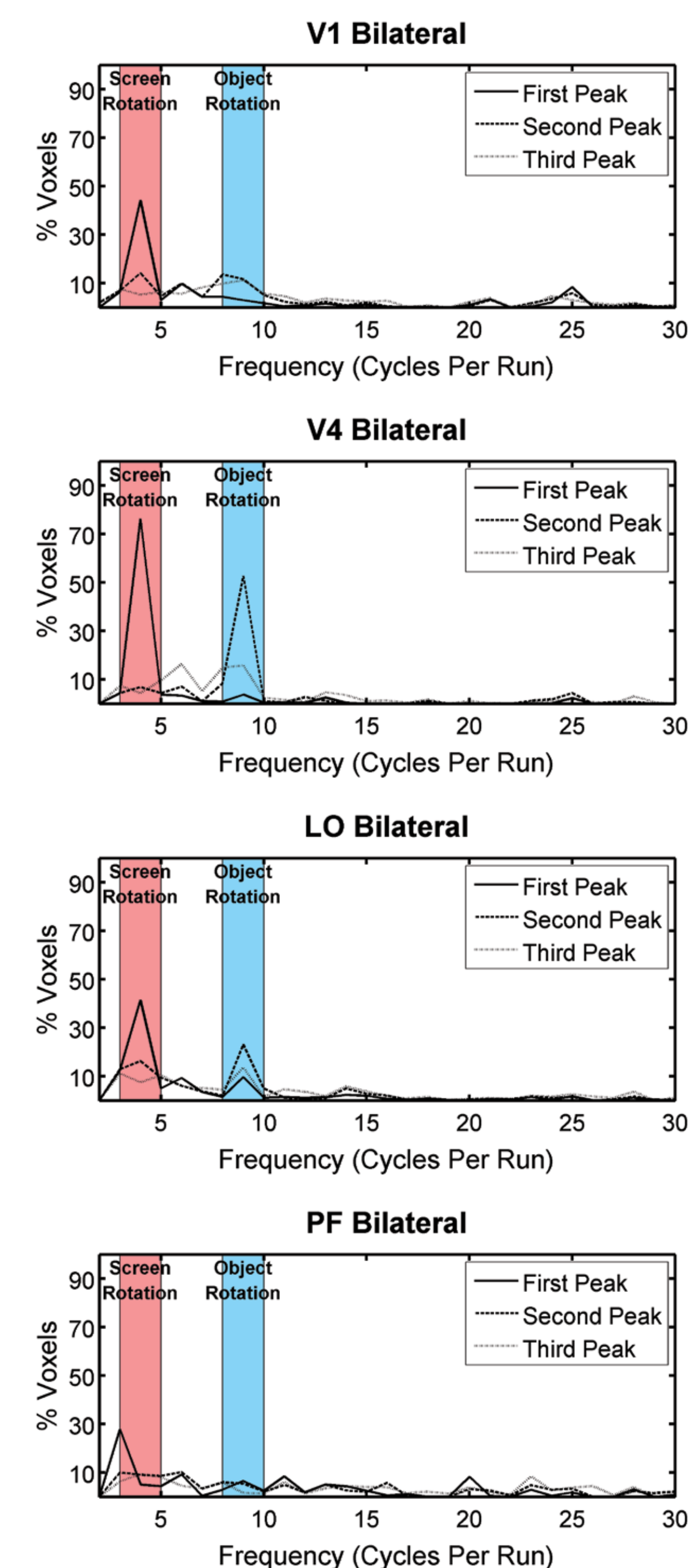
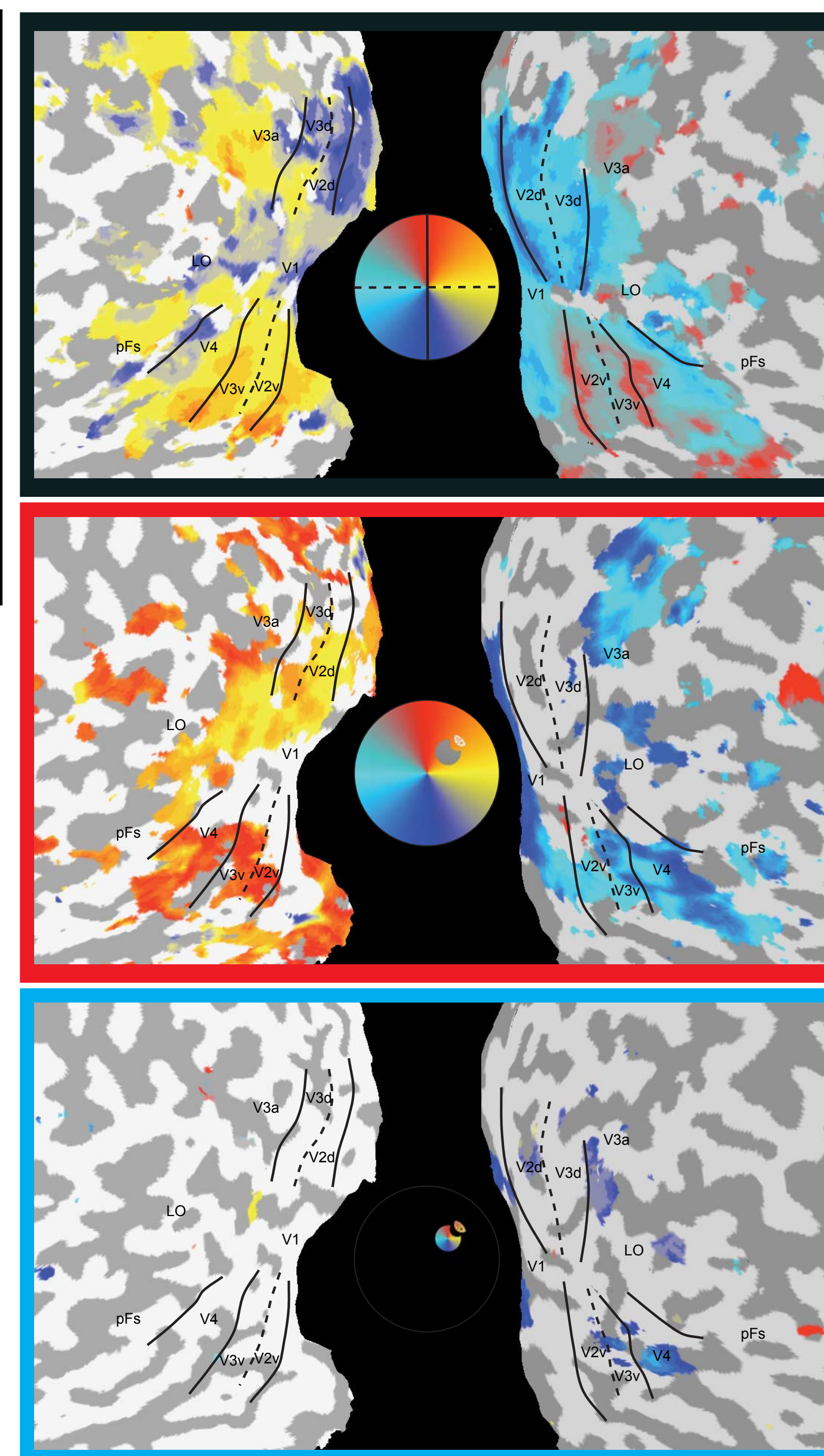
Conclusions

- There is no millimeter-scale object-centered coordinate map in LOC.
- The vast majority of the voxels, in all subjects, showed stronger modulation to changes in absolute (screen) position than object-centered position.
- Thus it is likely that the circuits that mediate object-centered coding are smaller than the scale of MRI voxels.
- Consistent with other results showing sensitivity to object-centered position in V4 and LOC, a secondary modulation of activity, i.e., a second peak in the Fourier spectrum at the frequency of the object-centered rotation, was observed in ~20% of the voxels in V4 and LO in experiments 1 and 2.
- A productive direction for future work would be to determine whether the object-centered location of attention could be read out of higher-level visual areas using multi-voxel classifiers, the same way orientation can be read out of earlier visual areas.

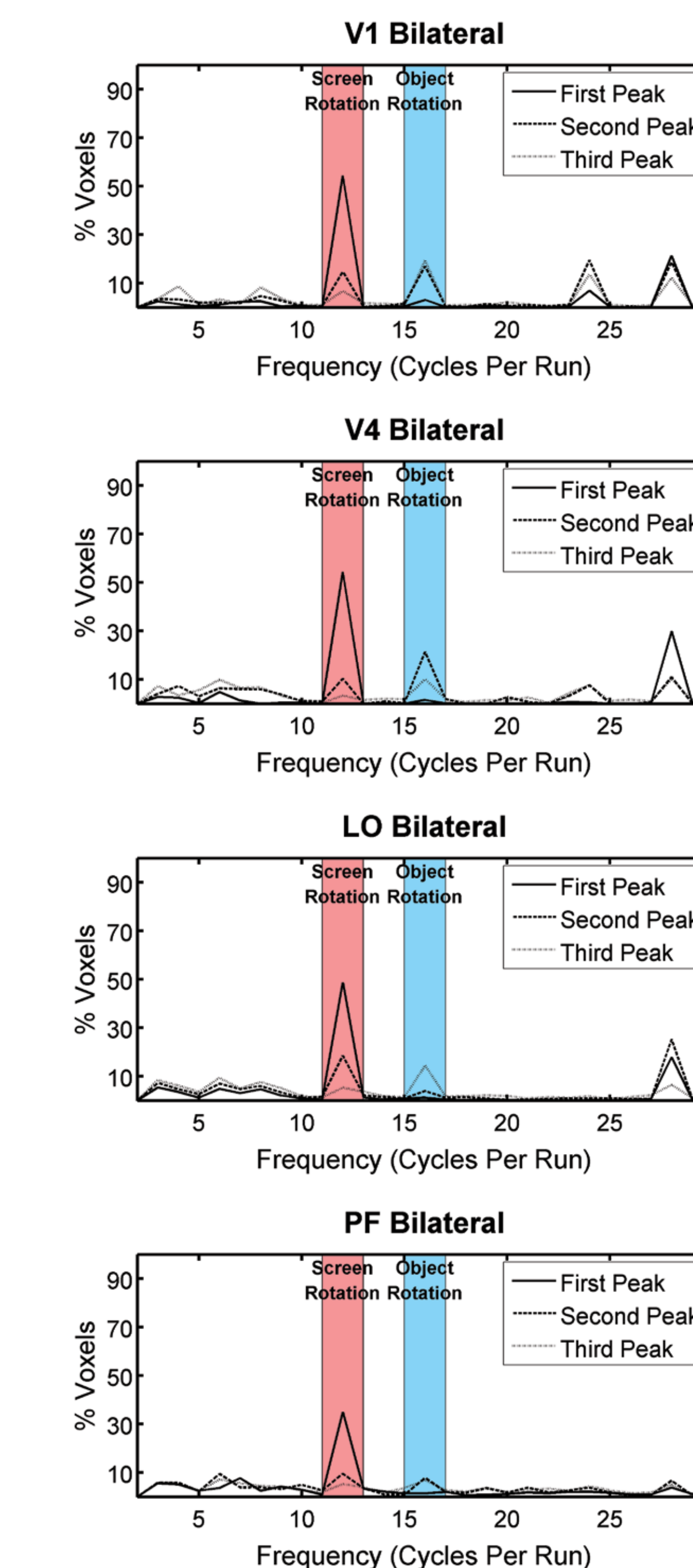
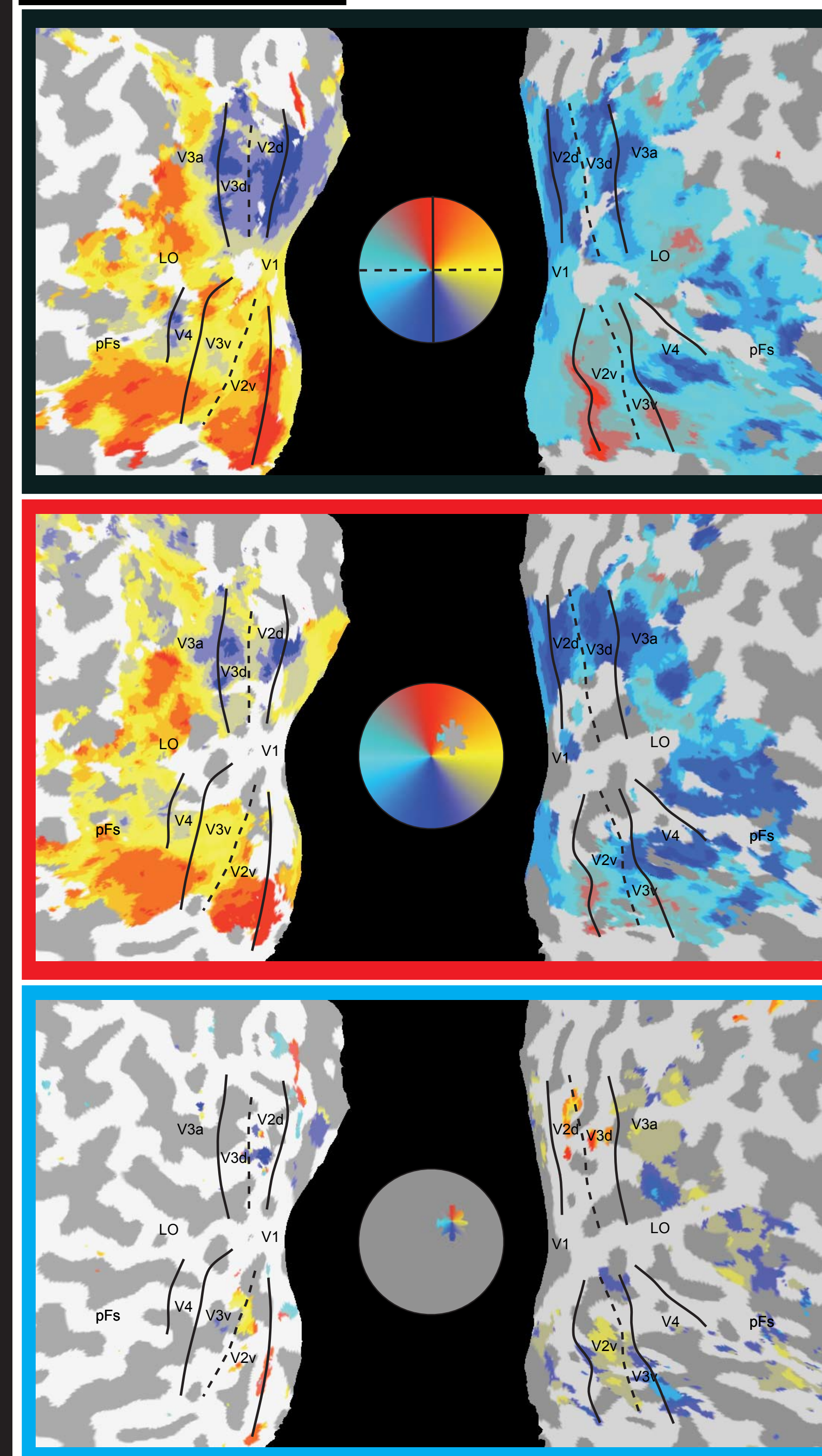
Results - Experiment 1 Within-Object Puzzle Piece n=1



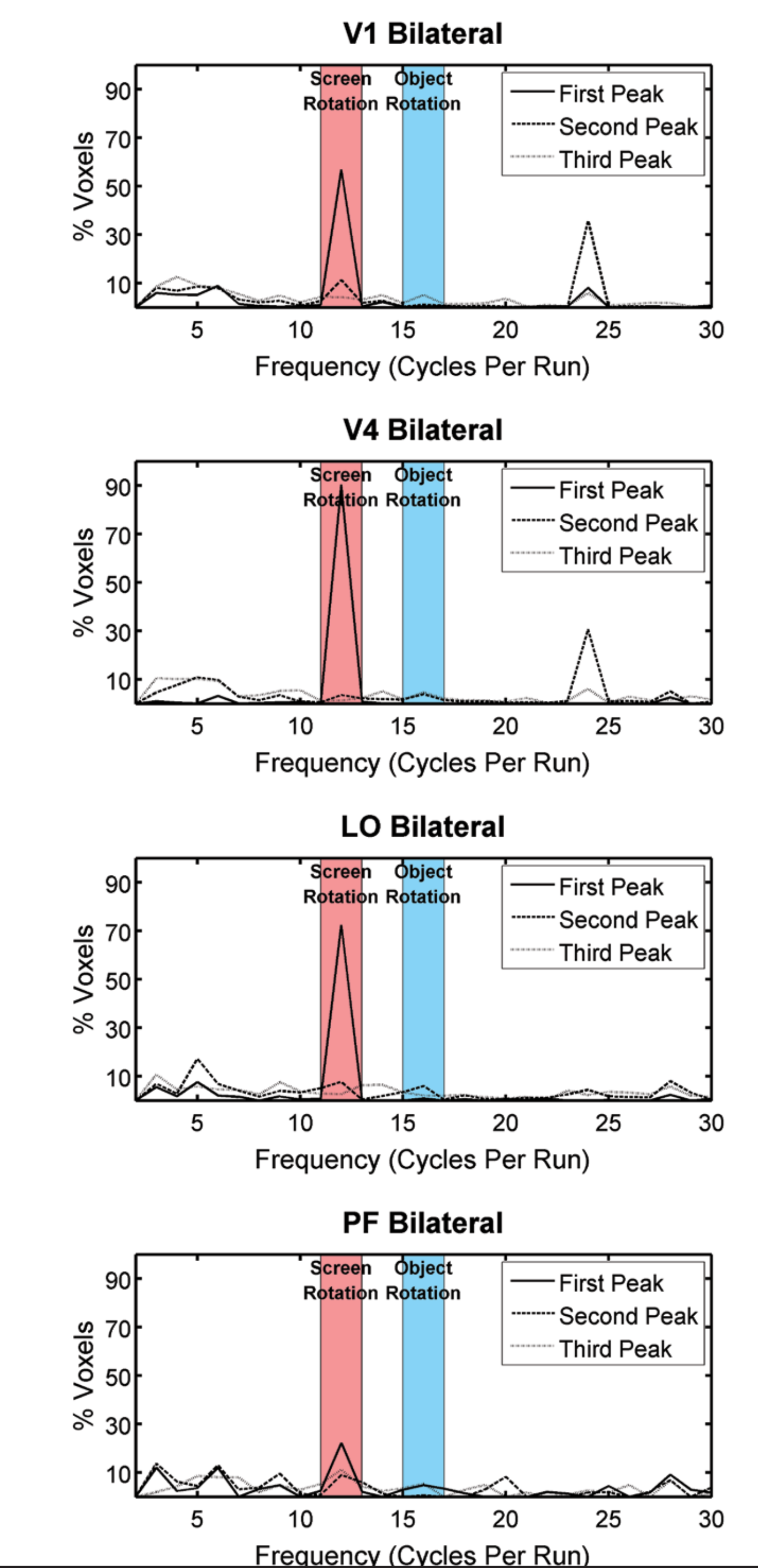
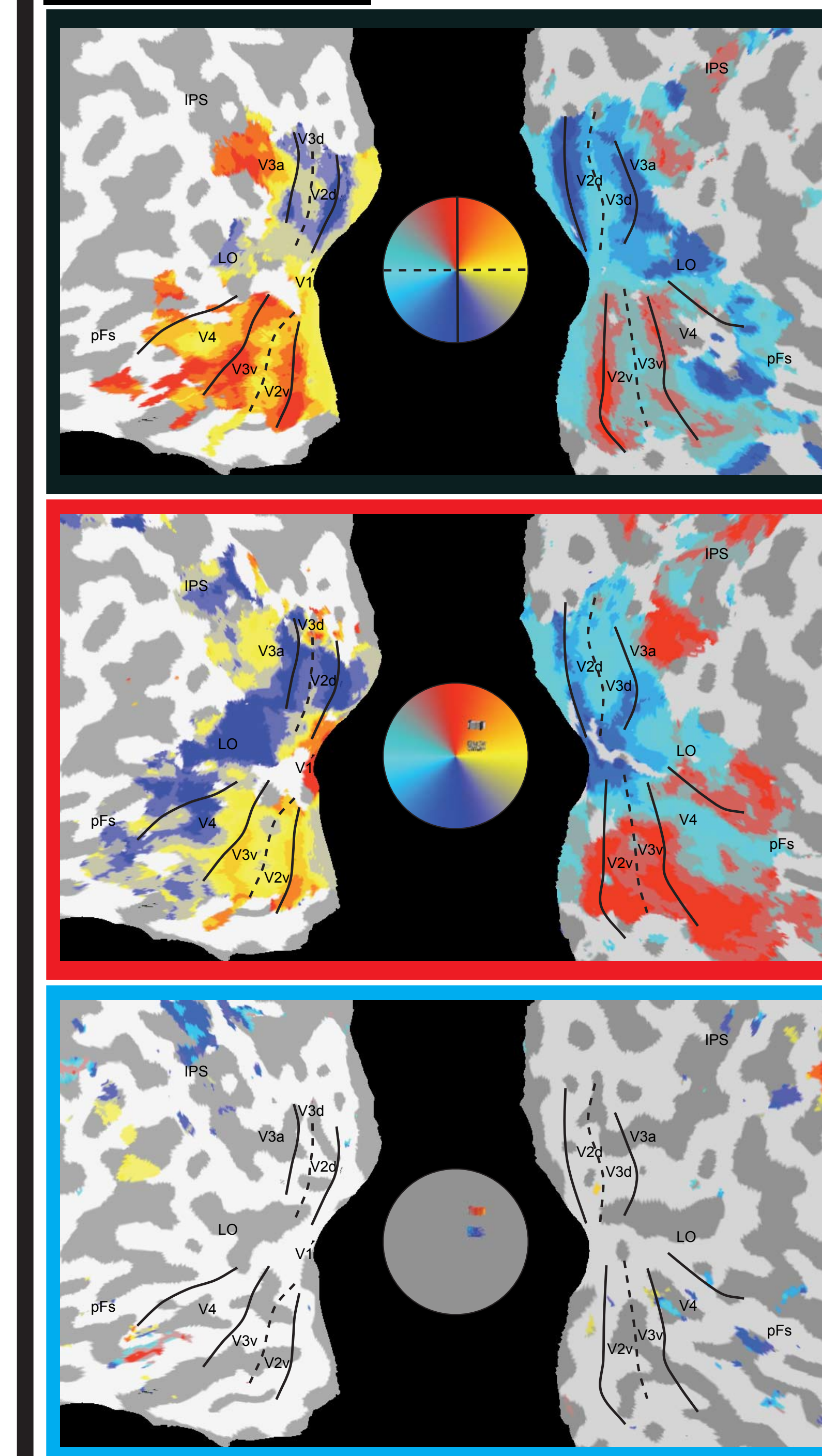
The number of voxels with a **First**, **Second**, or **Third** peak in the Fourier magnitude spectrum at each frequency was counted for four different regions of interest (V1, V4, LO, and pFs)



Results - Experiment 2 Within-Object Border Shape n=2



Results - Experiment 3 Between-Object Relations n=2



* McKyton, A., & Zohary, E. (2007). Beyond retinotopic mapping: the spatial representation of objects in the human lateral occipital complex. *Cereb Cortex*, 17(5), 1164-1172.; Yamane, Y., Tsunoda, K., Matsumoto, M., Phillips, A. N., & Tanifuji, M. (2006). Representation of the spatial relationship among object parts by neurons in macaque inferotemporal cortex. *J Neurophysiol*, 96(6), 3147-3156.; Comitteri, G., Galati, G., Paradis, A. L., Pizzamiglio, L., Berthoz, A., & LeBihan, D. (2004). Reference frames for spatial cognition: different brain areas are involved in viewer-, object-, and landmark-centered judgments about object location. *J Cogn Neurosci*, 16(9), 1517-1535. ** Connor, C. E., Preddie, D. C., Gallant, J. L., & Van Essen, D. C. (1997). Spatial attention effects in macaque area V4. *J Neurosci*, 17(9), 3201-3214.; Womelsdorf, T., Anton-Erxleben, K., Pieper, F., & Treue, S. (2006). Dynamic shifts of visual receptive fields in cortical area MT by spatial attention. *Nat Neurosci*, 9(9), 1156-1160. Olshausen, B. A., Anderson, C. H., & Van Essen, D. C. (1993). A neurobiological model of visual attention and invariant pattern recognition based on dynamic routing of information. *J Neurosci*, 13(11), 4700-4719.