Mind-wandering and the brain

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Image extracted from: **Kirschner, A., Kam, J. W. Y., Handy, T. C., & Ward, L. M. (2012). Differential synchronization in default and task-specific networks of the human brain. *Frontiers in human neuroscience*, 6.**

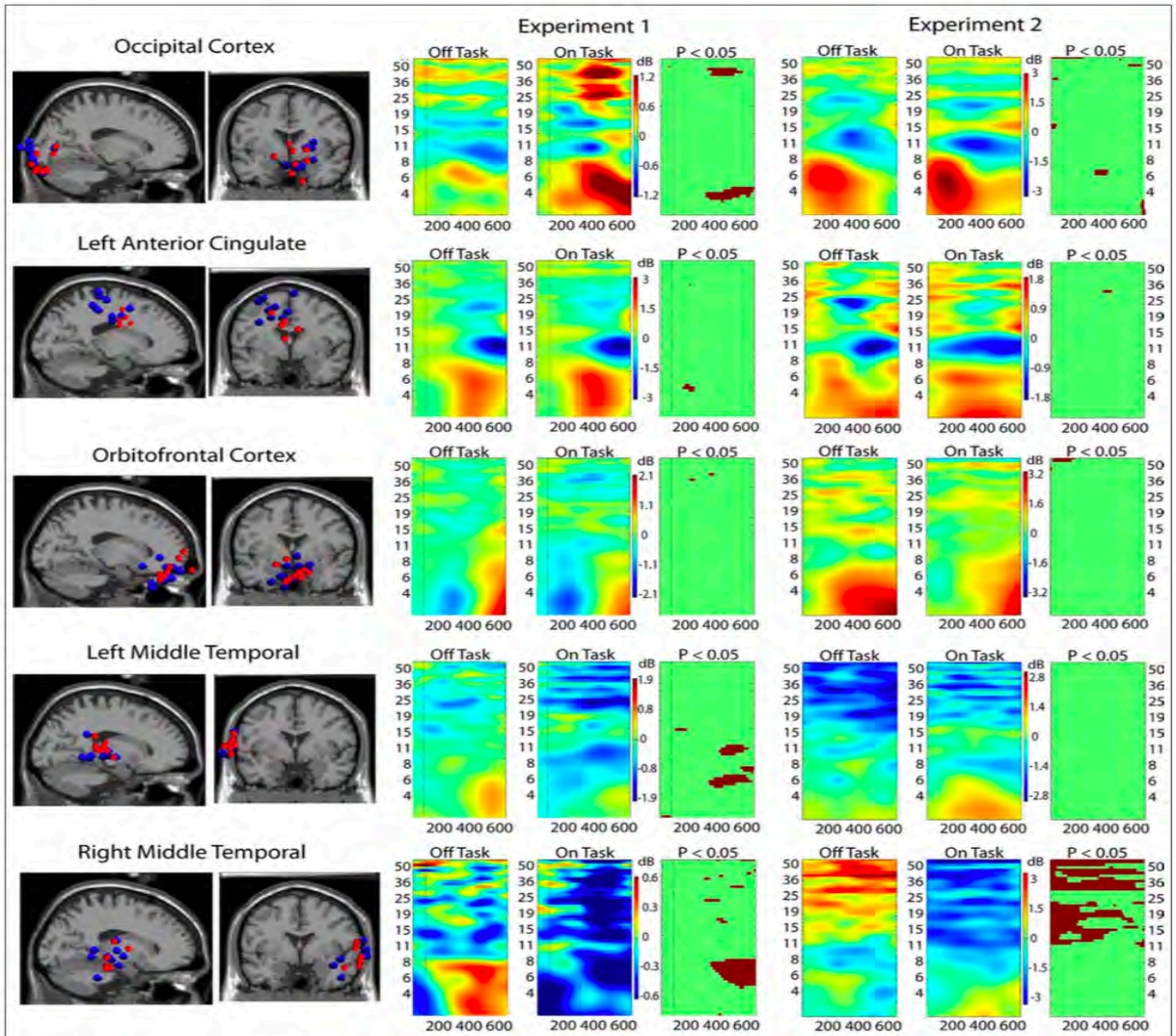

FIGURE 3 | Event-related spectral perturbation (ERSP) results for ICs localized to five critical brain regions. Leftmost columns show the locations in the brain of clusters of ICs from the two experiments: Experiment 1 in red dots and Experiment 2 in blue dots. Rightmost three columns display ERSP results (Off-task and On-task) and the On-task Off-task difference masked at $p = 0.05$ by permutation test.

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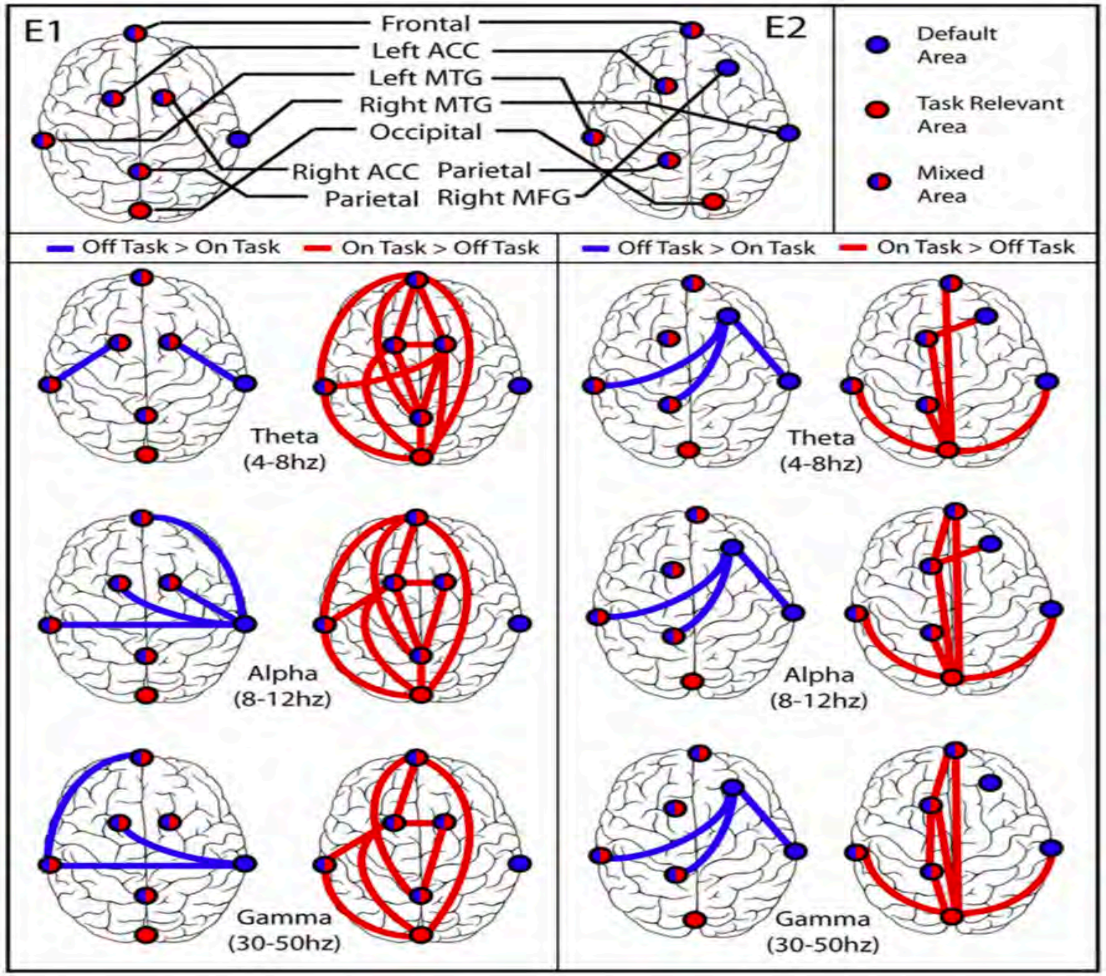


FIGURE 5 | Synchronization between brain regions. (E1) Experiment 1 on left, (E2) Experiment 2 on right. In each part the left column displays blue lines between regions that were more synchronized during off-task epochs (default network), and the right column displays red lines between regions that were more synchronized during on-task epochs. In all but the Experiment 2 off-task > on-task network, lines are displayed only if both the difference between average PLV was significant at $p = 0.001$ in the indicated direction *and* the more significant coherence was also significantly different from zero for most or all of the subjects in the cluster by binomial test at $p = 0.001$. The off-task network in Experiment 2 passed only the first of these criteria.

Image extracted from: **Baird, B., Smallwood, J., Lutz, A., & Schooler, J. W. (2014). The decoupled mind: mind-wandering disrupts cortical phase-locking to perceptual events. *Journal of Cognitive Neuroscience*.**

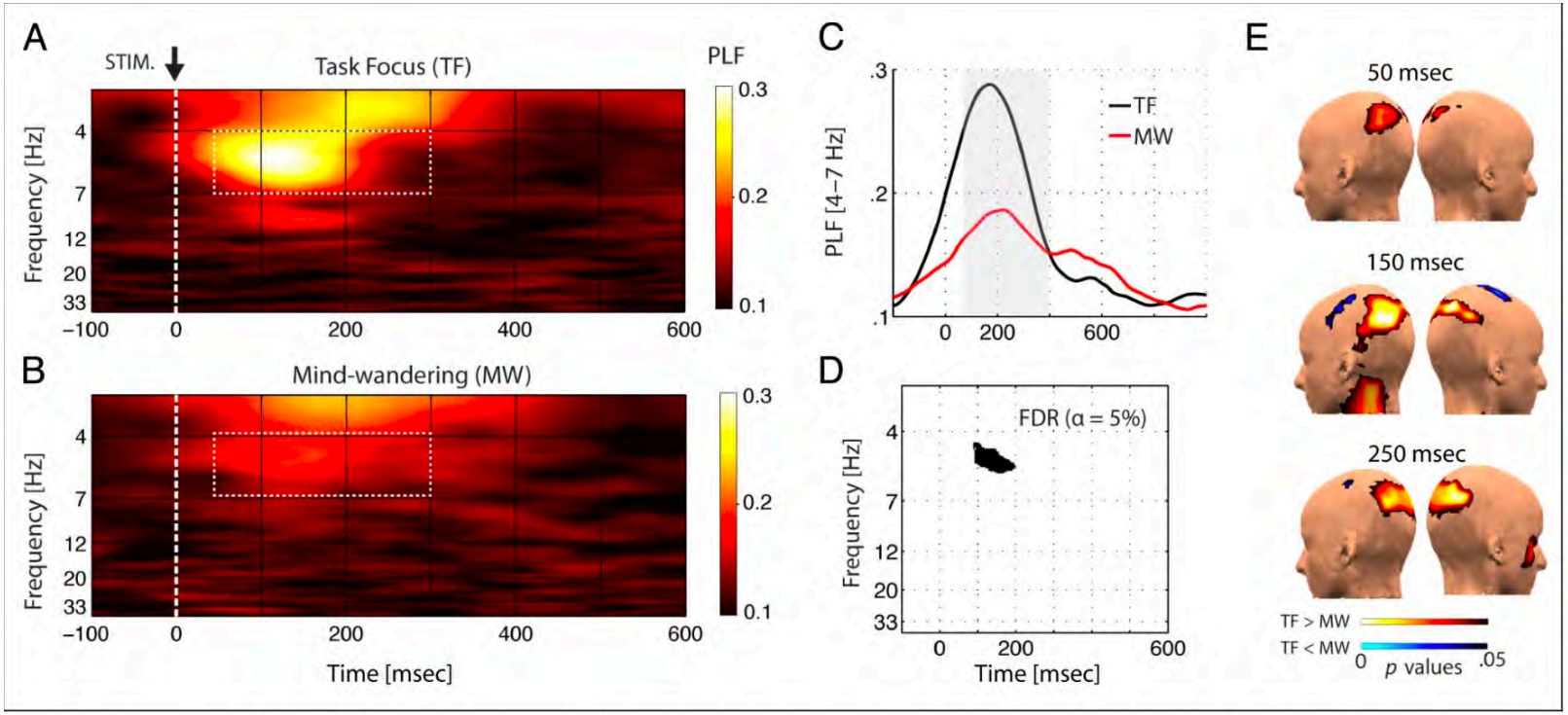
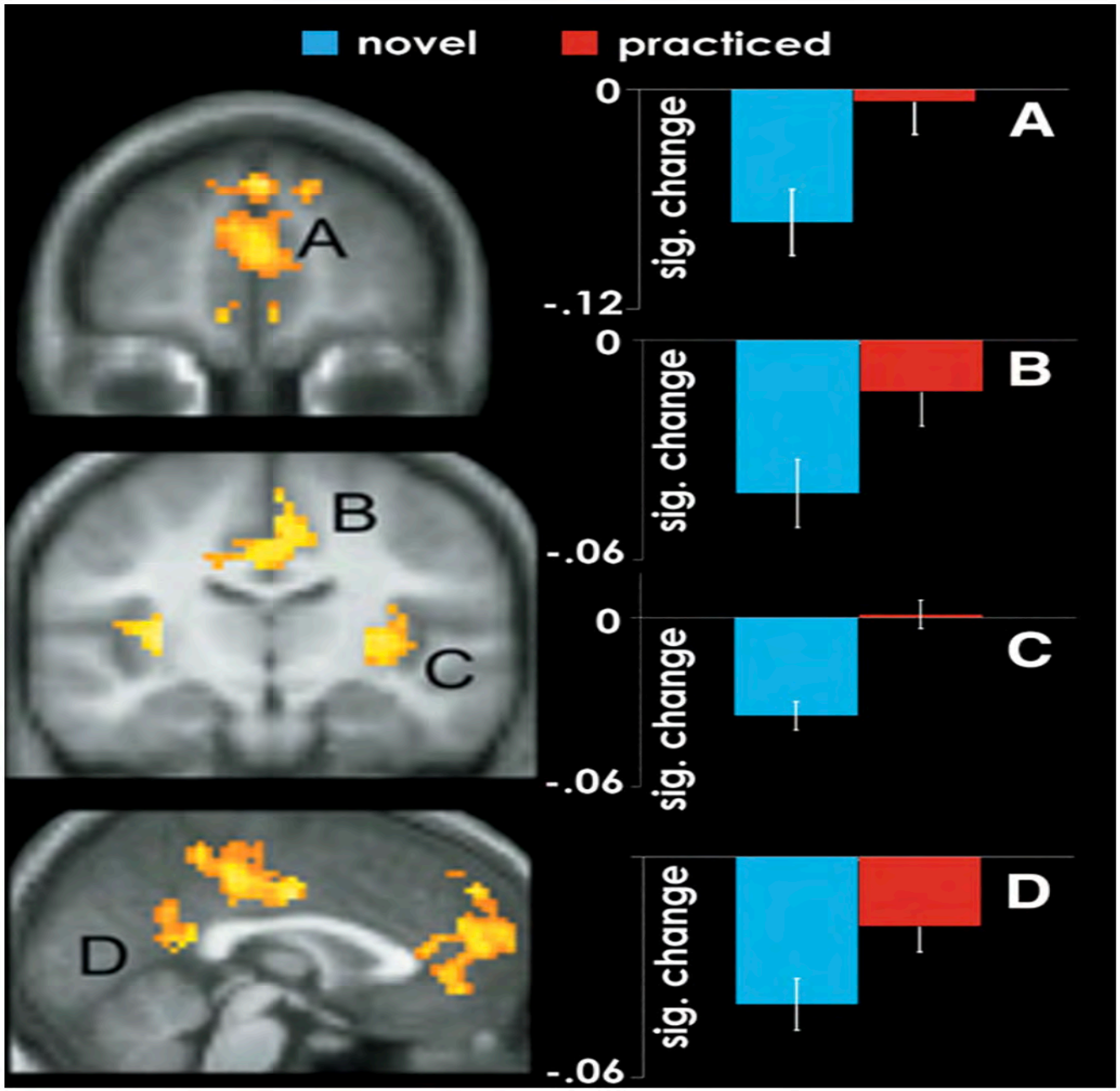
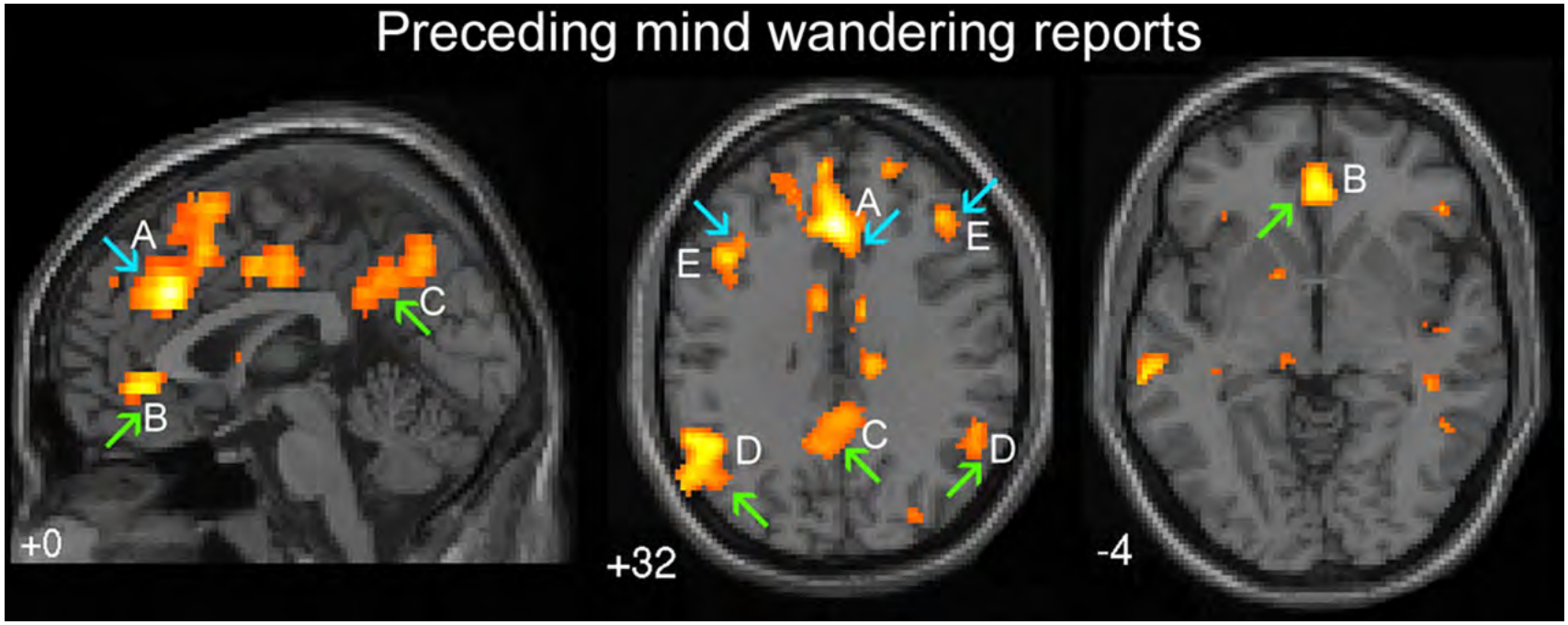


Figure 3. Phase-locking factor (PLF). Group-averaged PLF values for (A) task focus (TF) and (B) mind-wandering (MW) over the parietal scalp region are shown for 2–35 Hz and 100 msec before to 600 msec after stimulus onset (dashed white line $t = 0$). Diminished phase synchronization of the trial-to-trial brain response to visual stimuli was found during periods of mind-wandering compared with task focus for oscillations within the theta-band in 50–150 and 150–300 msec poststimulus time windows (dotted white boxes). (C) Time course of the average parietal theta-band (4–7 Hz) PLF for task focus and mind-wandering states showing a significant interaction between conditions (gray background indicates significant time windows ($p < .01$). (D) Significant time–frequency pixels over parietal scalp site (FDR-corrected, $\alpha = .05$) contrasting mind-wandering and task focus for every point in time–frequency space (200 time points × 200 frequencies × 4 scalp regions). (E) Topography of the increase in theta-band (4–7 Hz) PLF during task focus compared with mind-wandering states at 50, 150, and 250 msec.

Image extracted from: **Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007). Wandering minds: the default network and stimulus-independent thought. *Science*, *315*(5810), 393-395.**

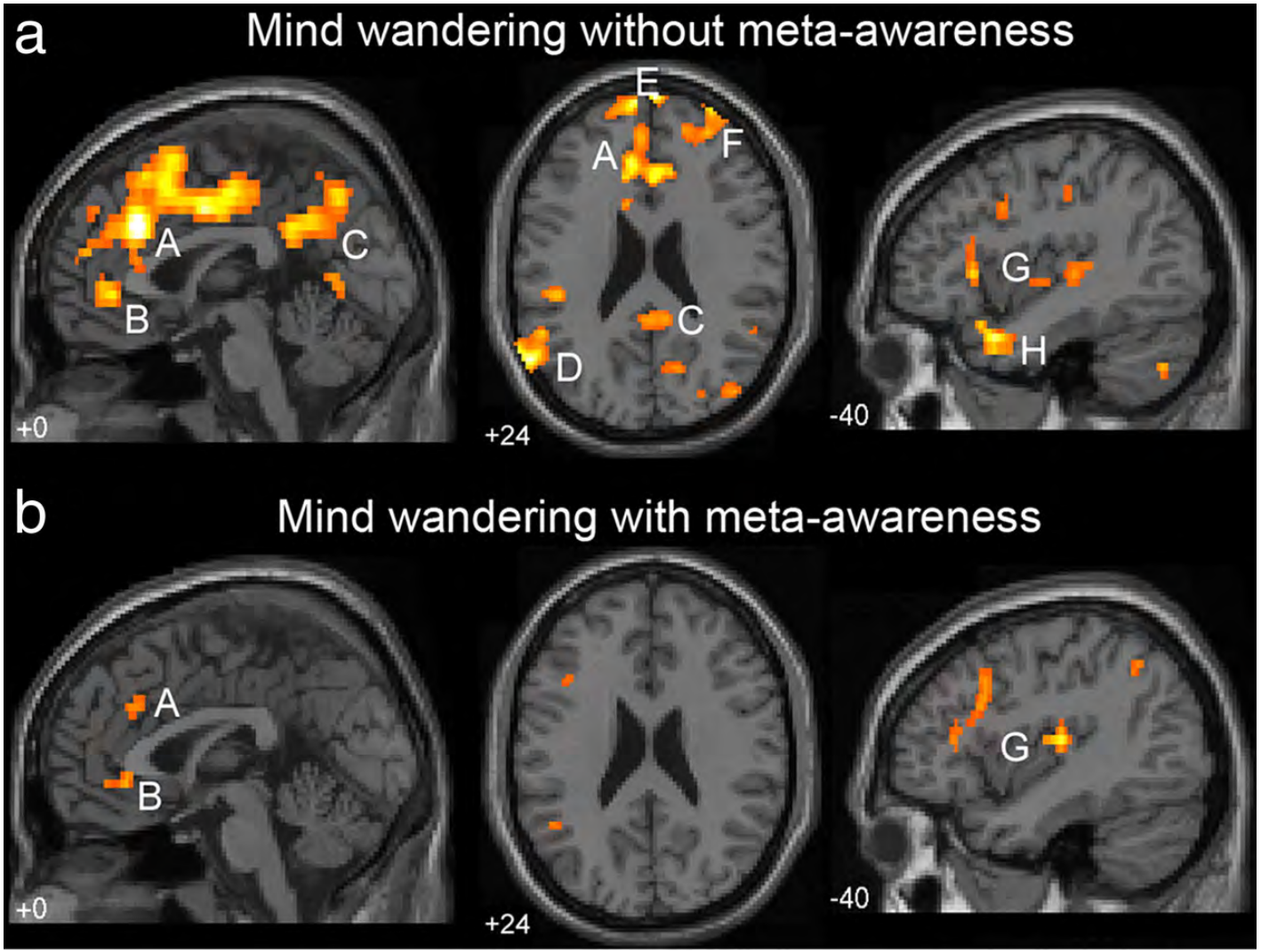


Activations preceding reports of mind wandering (intervals prior to off-task versus on-task probes).



Kalina Christoff et al. PNAS 2009;106:8719-8724

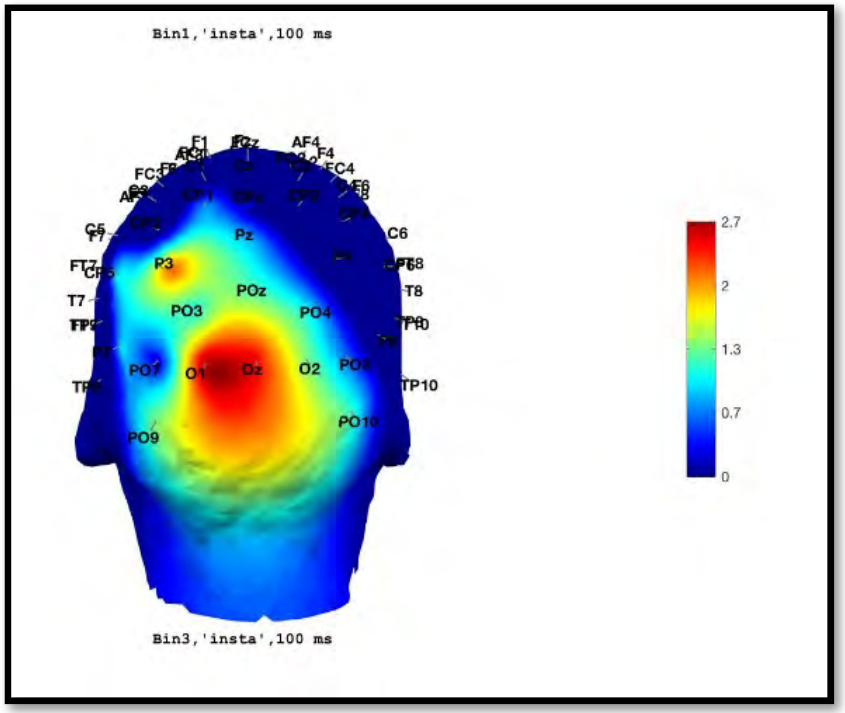
Mind wandering in the absence (a) and presence (b) of meta-awareness.



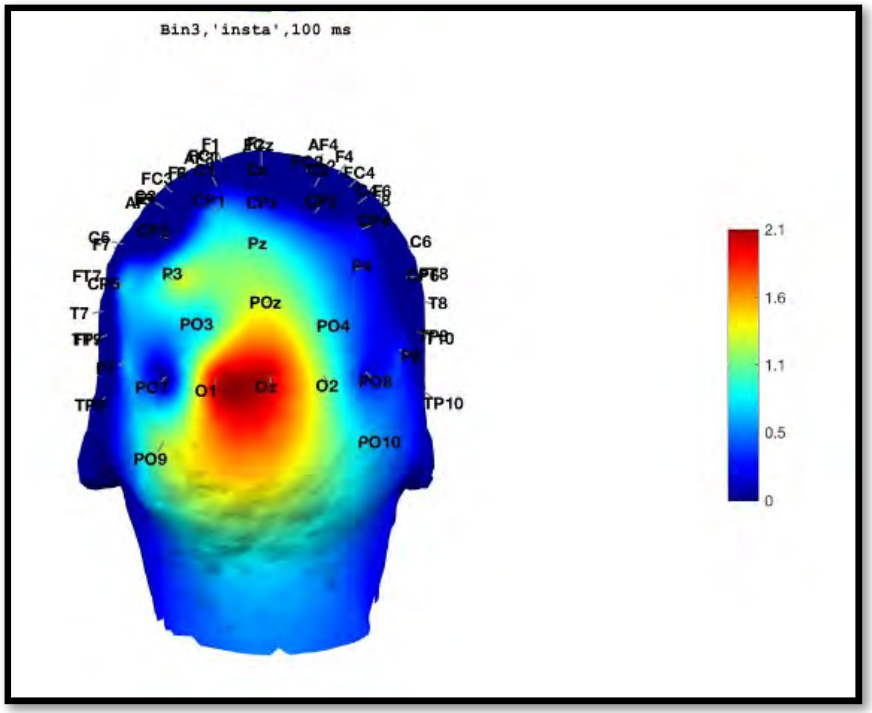
Kalina Christoff et al. PNAS 2009;106:8719-8724

Early visual processing of no-go stimuli in adults with ADHD and controls

Controls
100 ms post no-go stimuli

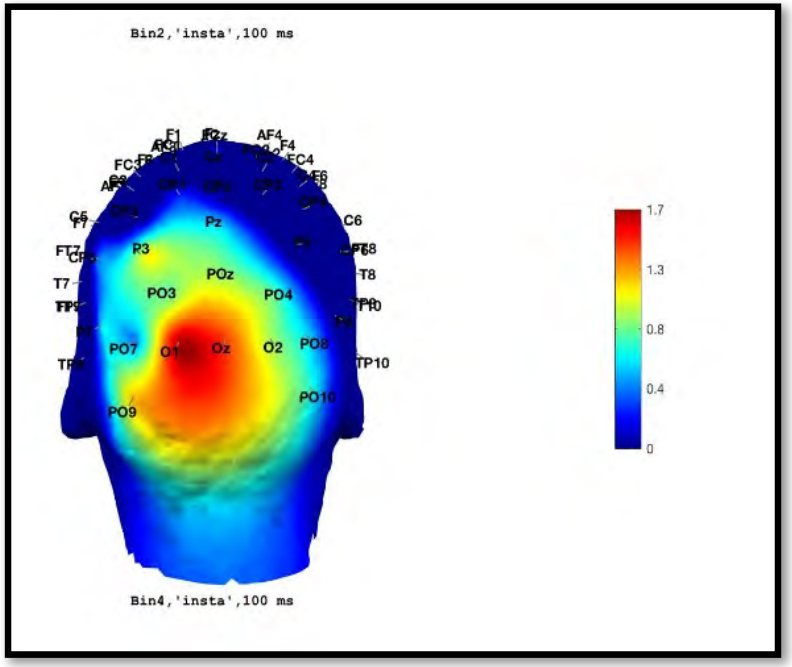


ADHD
100 ms post no-go stimuli



Early visual processing of go stimuli in adults with ADHD and controls

Controls
100 ms post go stimuli



ADHD
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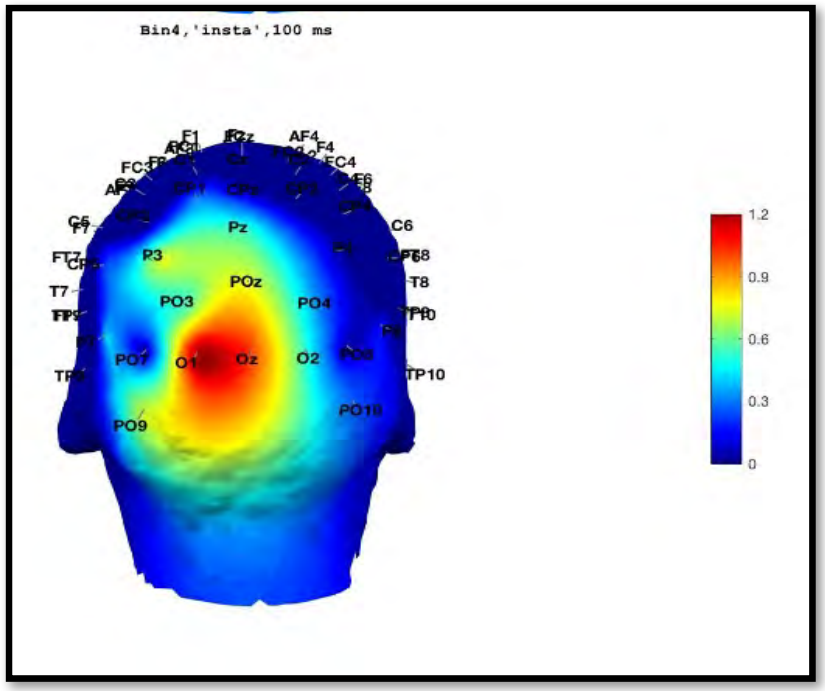
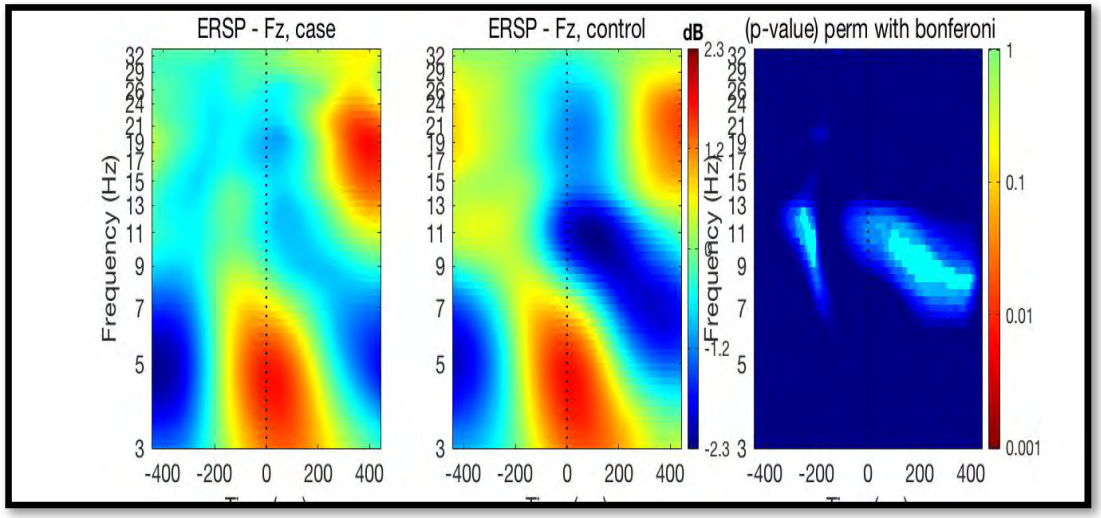


Event-related spectral perturbations(ESRP) following the response

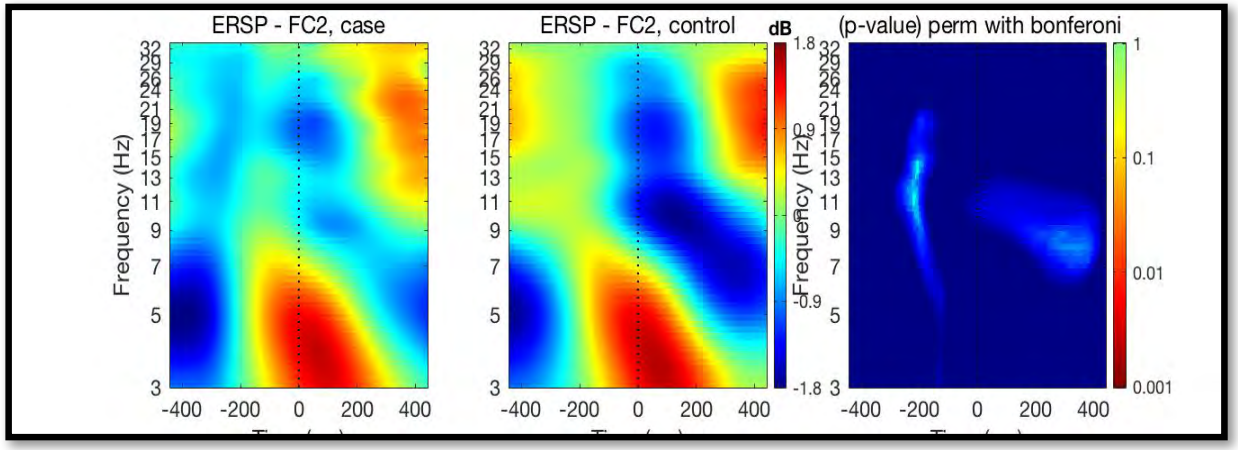
ERSP at Fz

Case Control Case-control difference



ERSP at FC2

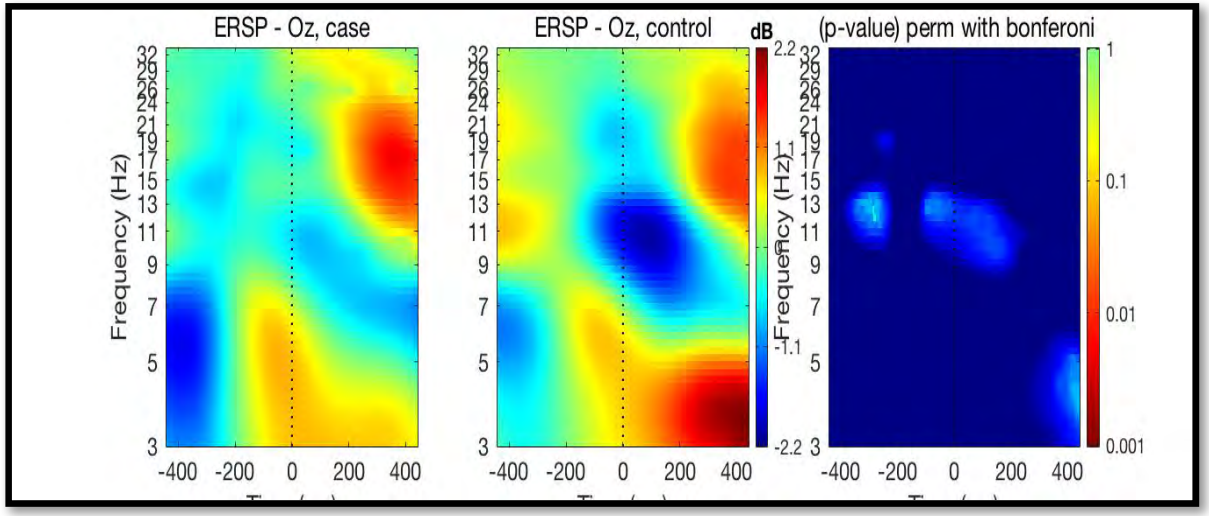
Case Control Case-control difference



Event-related spectral perturbations(ESRP) following the response

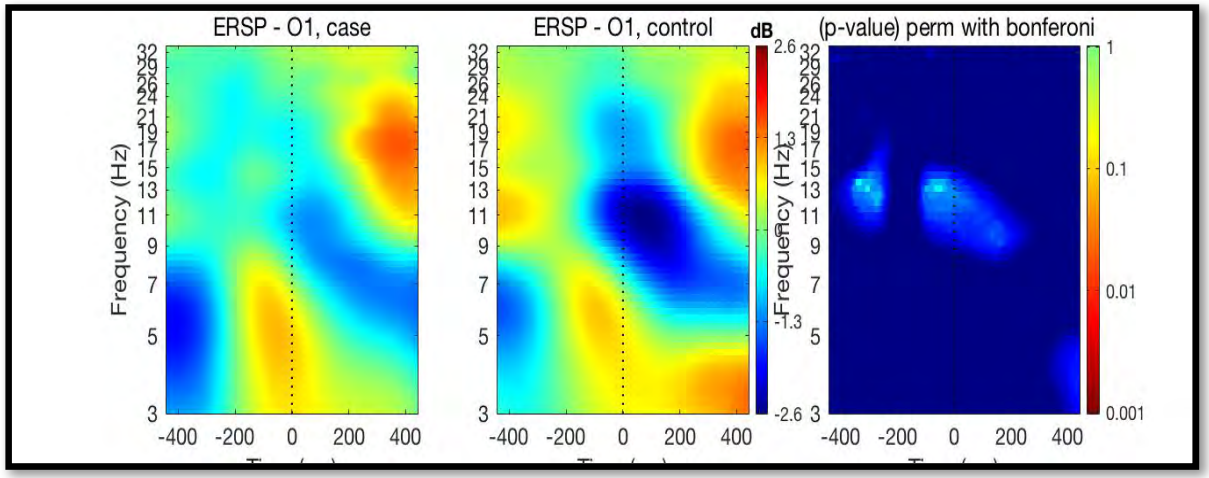
ERSP at Oz

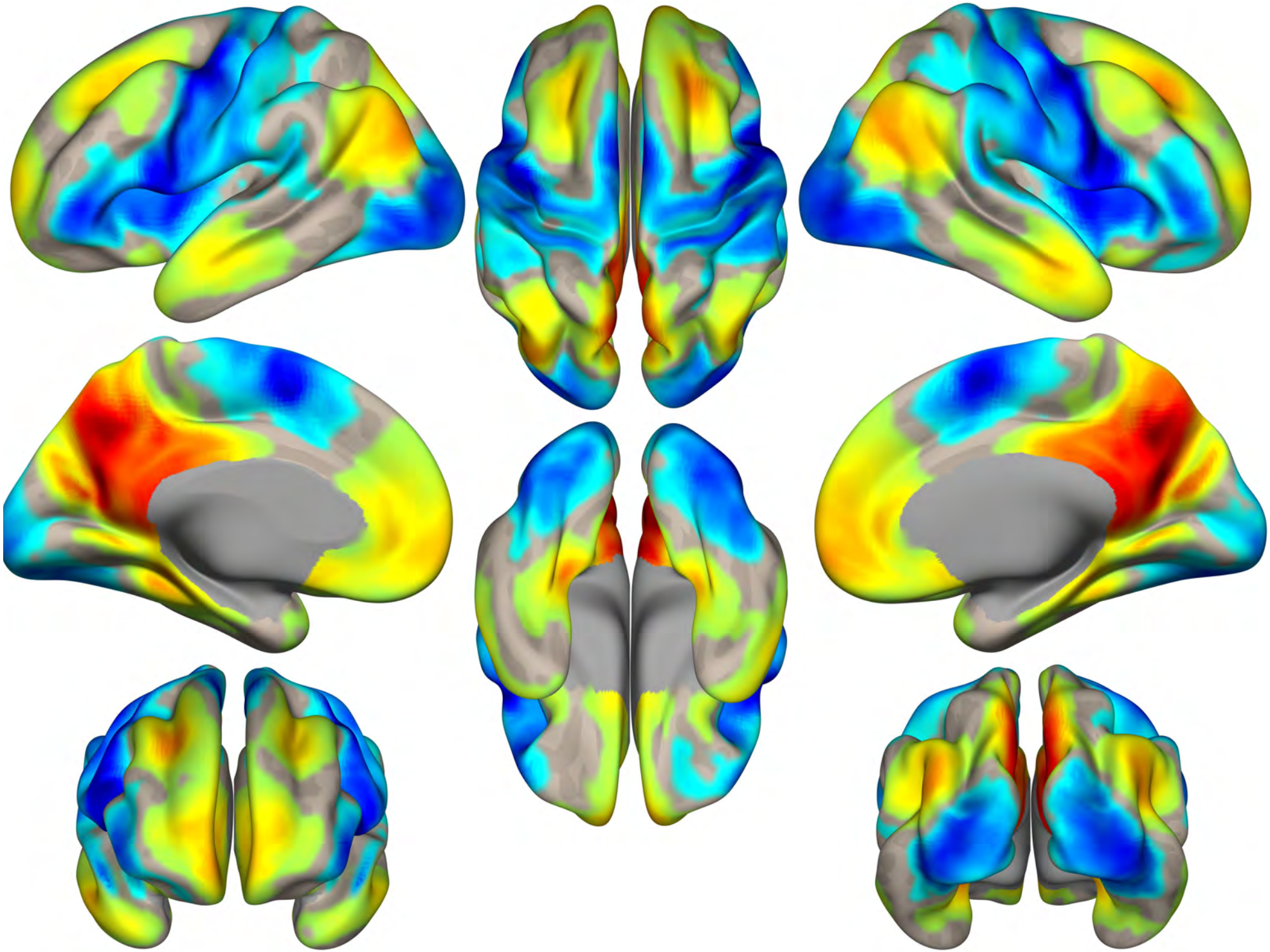
Case Control Case-control difference

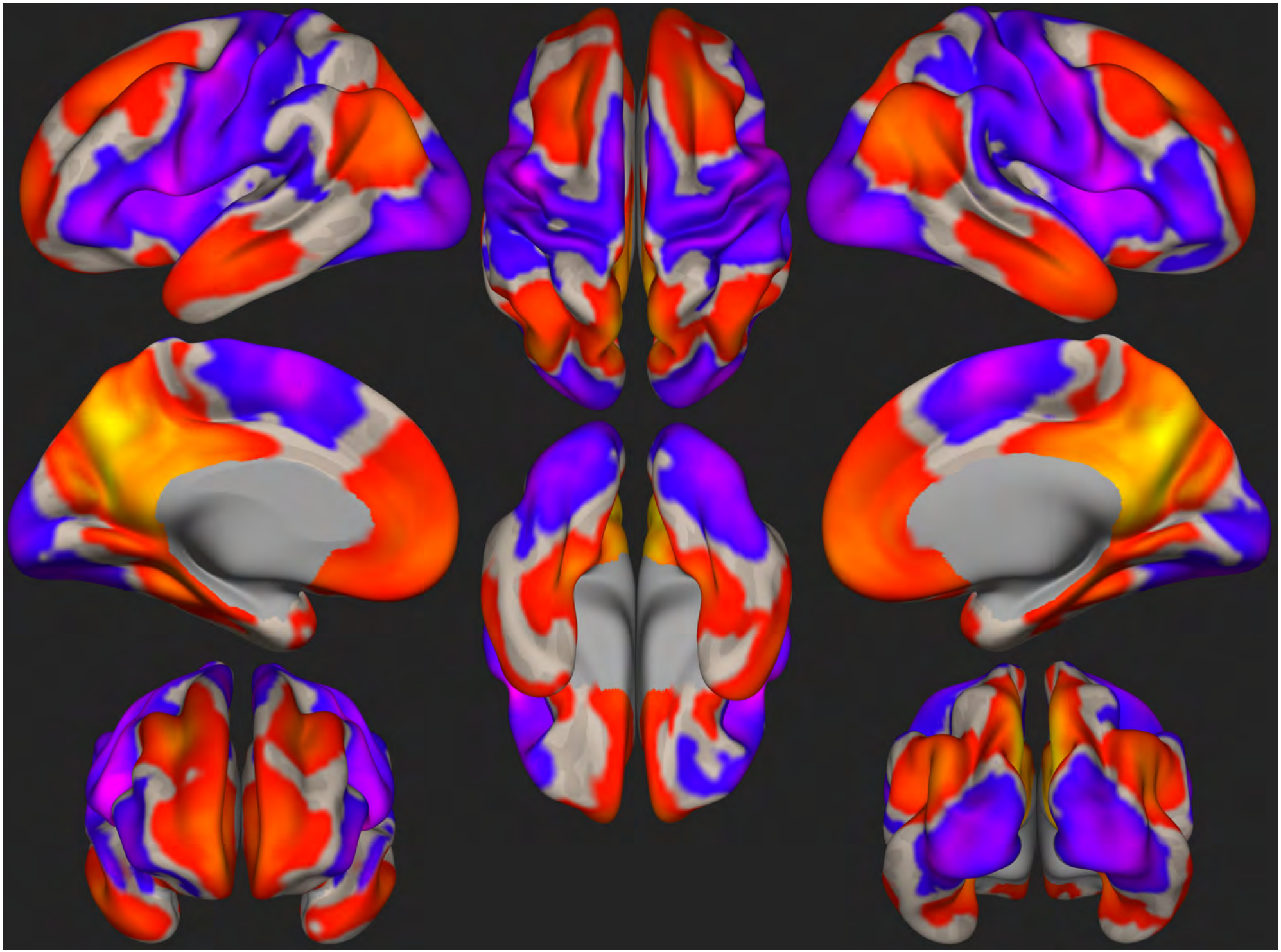


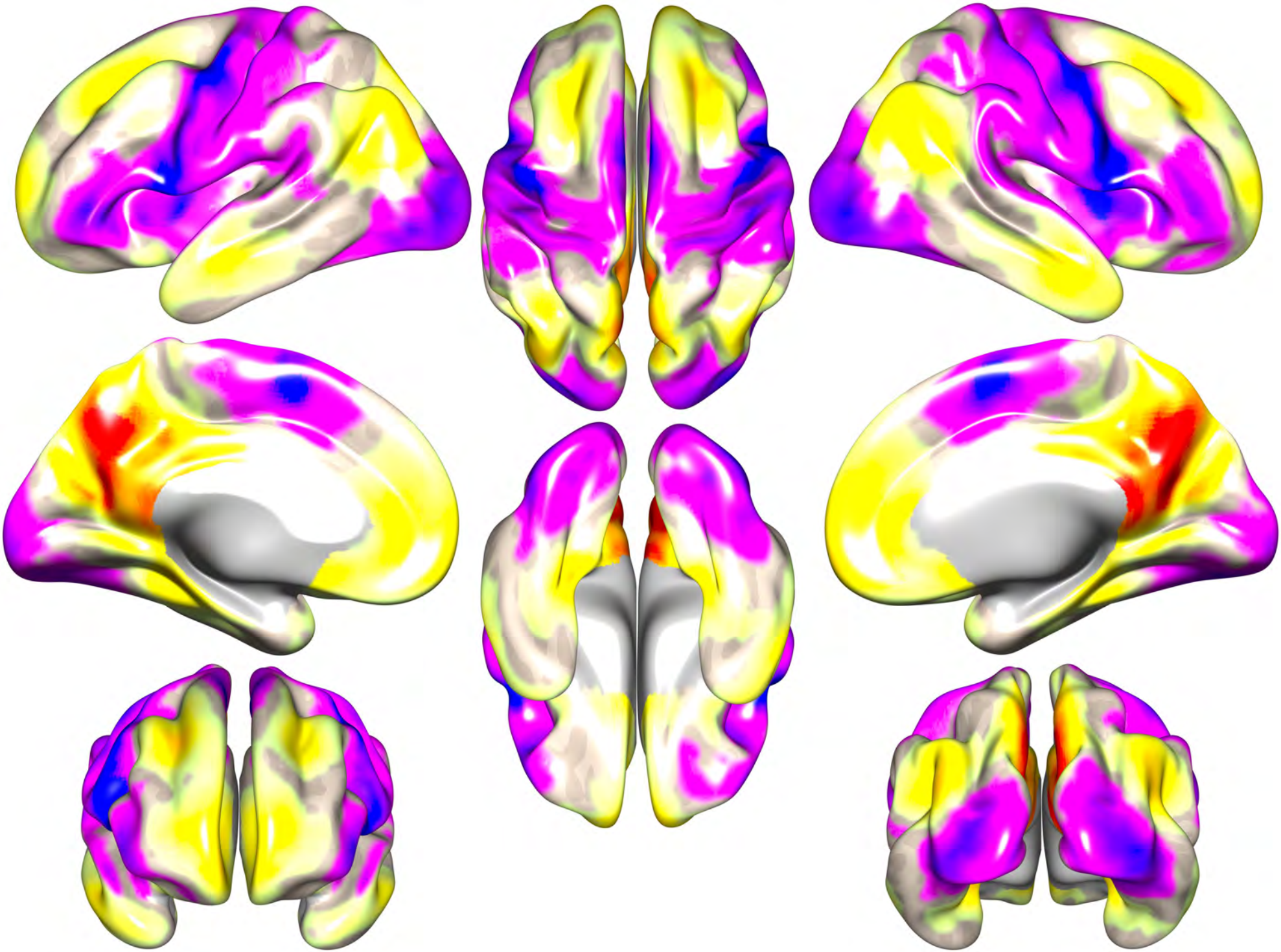
ERSP at O1

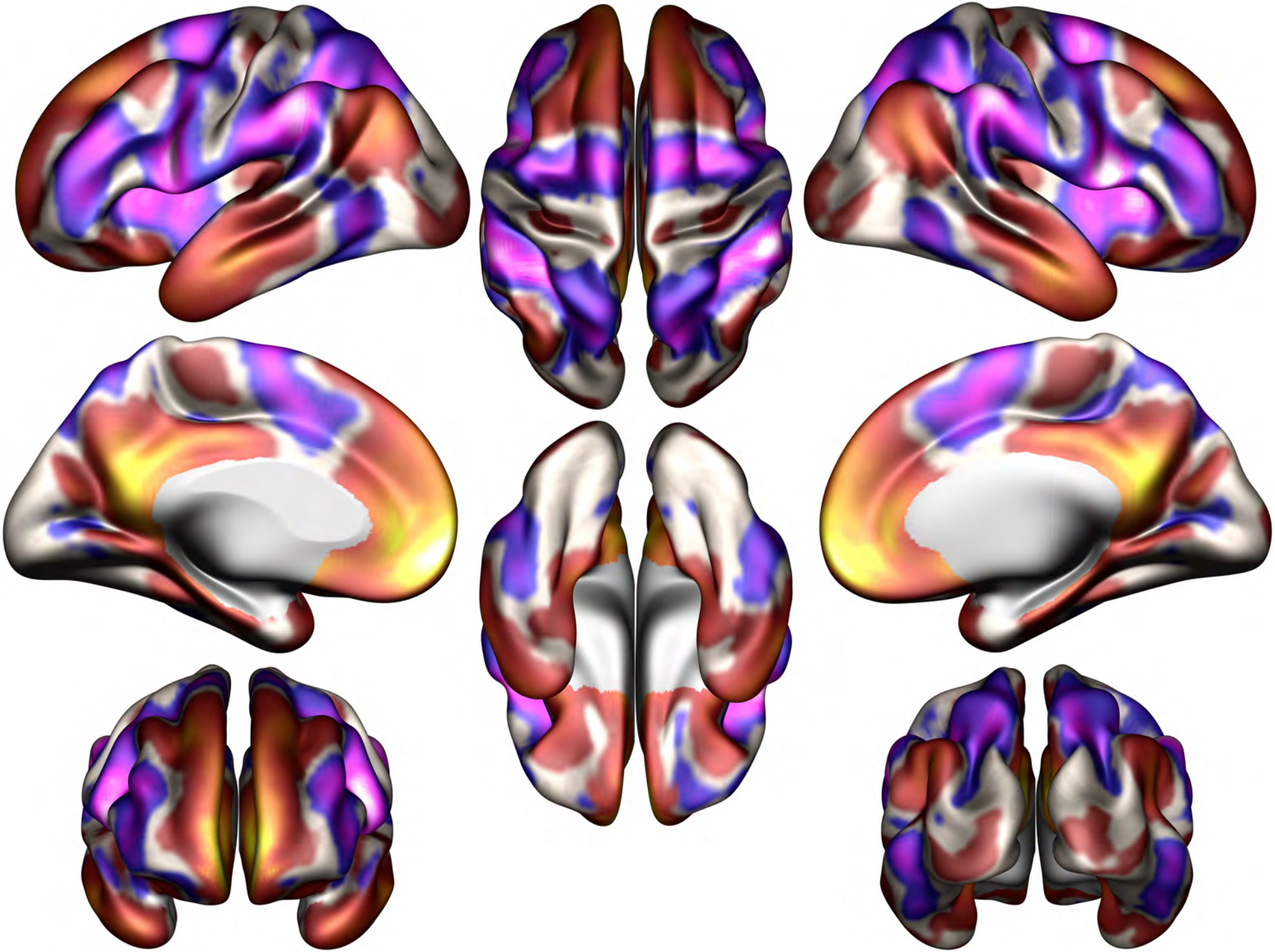
Case Control Case-control difference

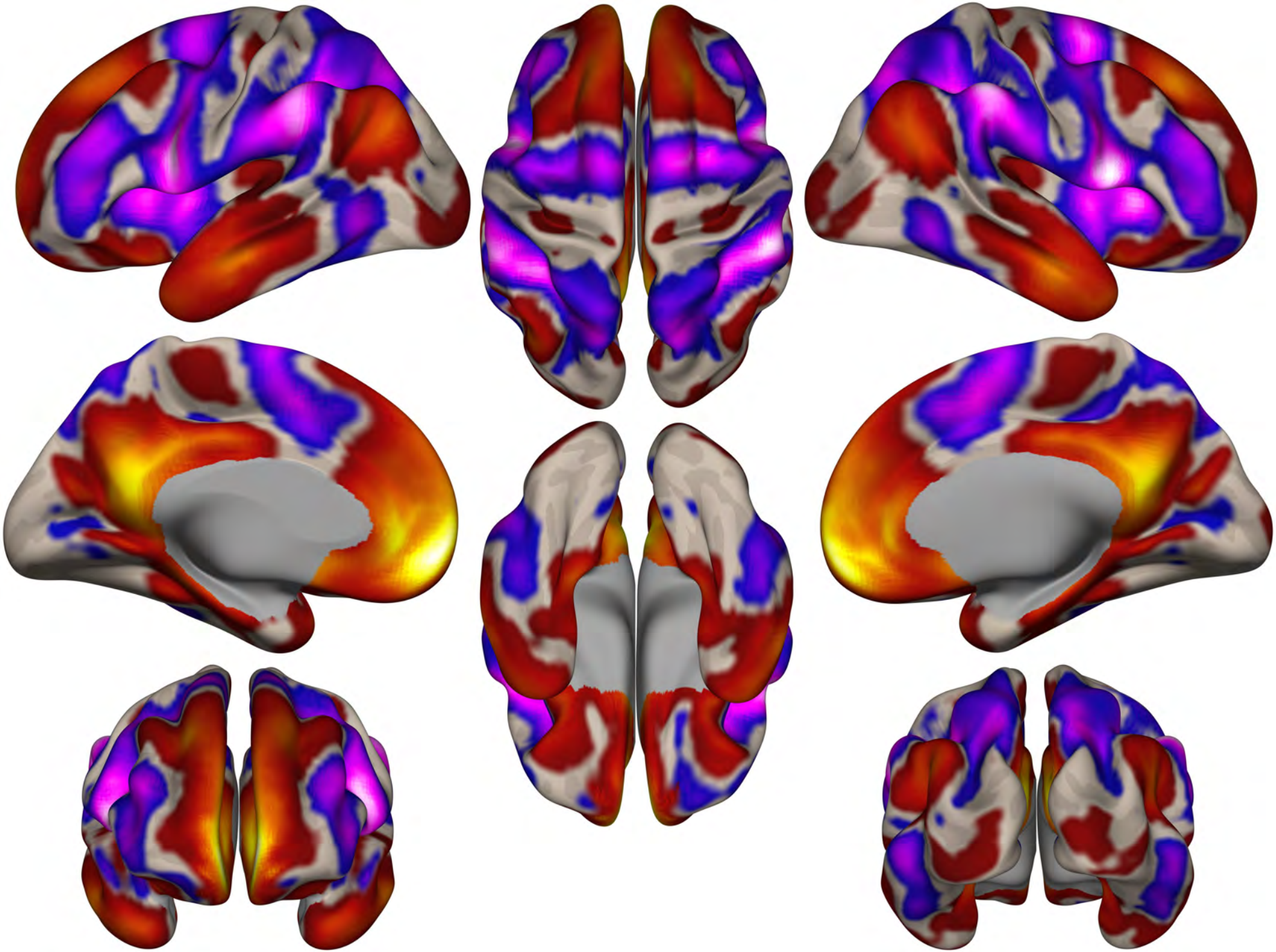


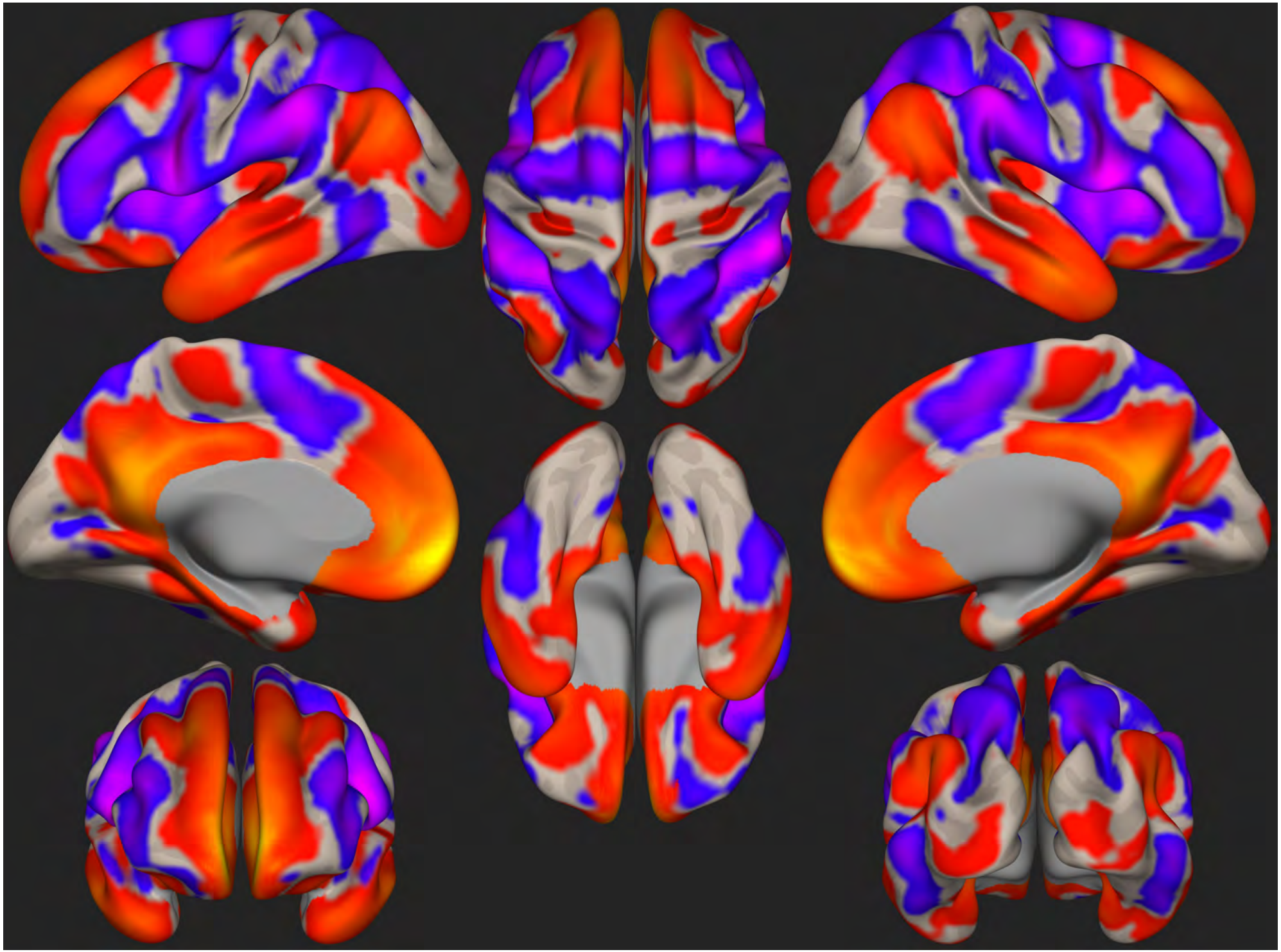


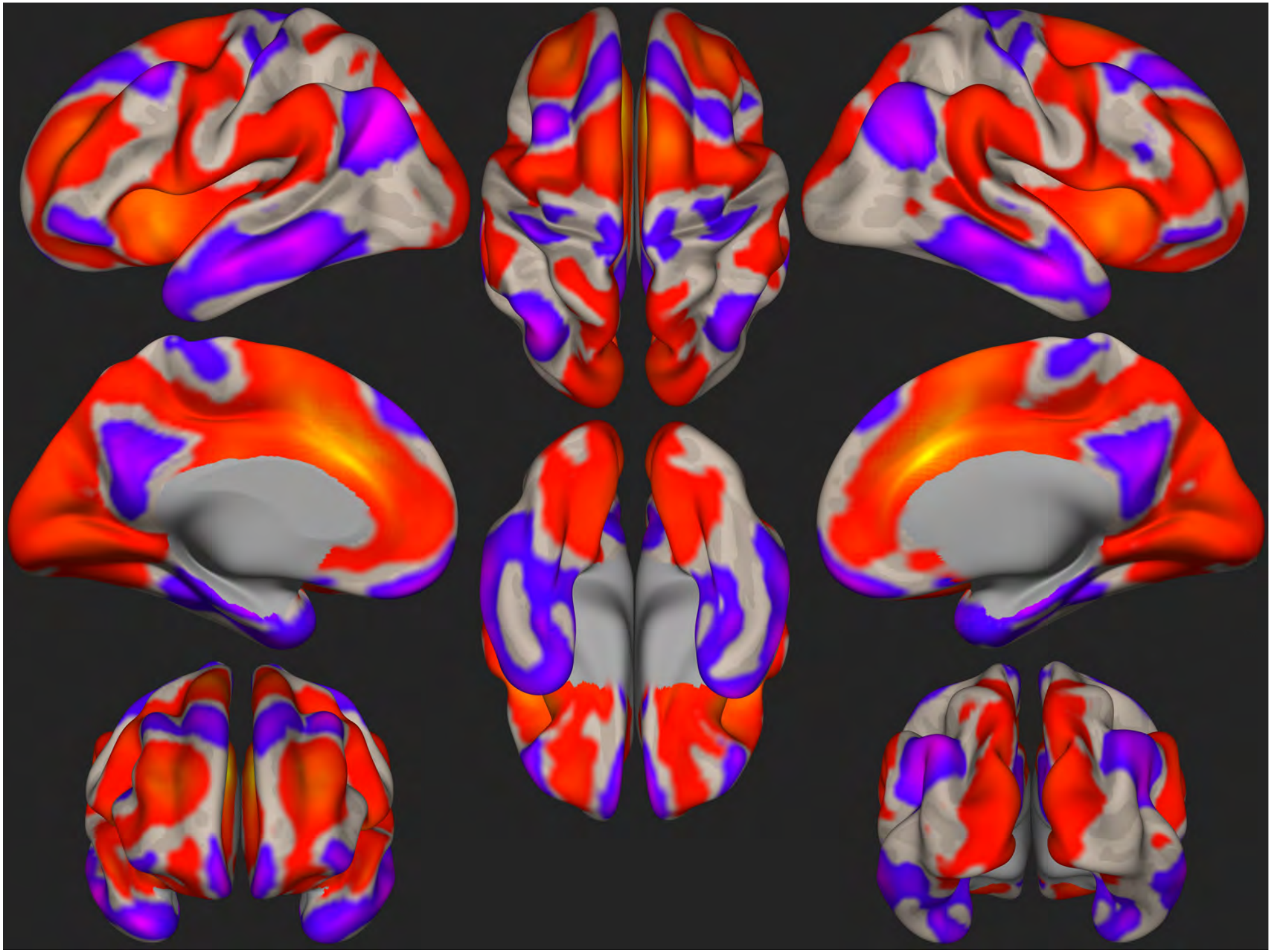


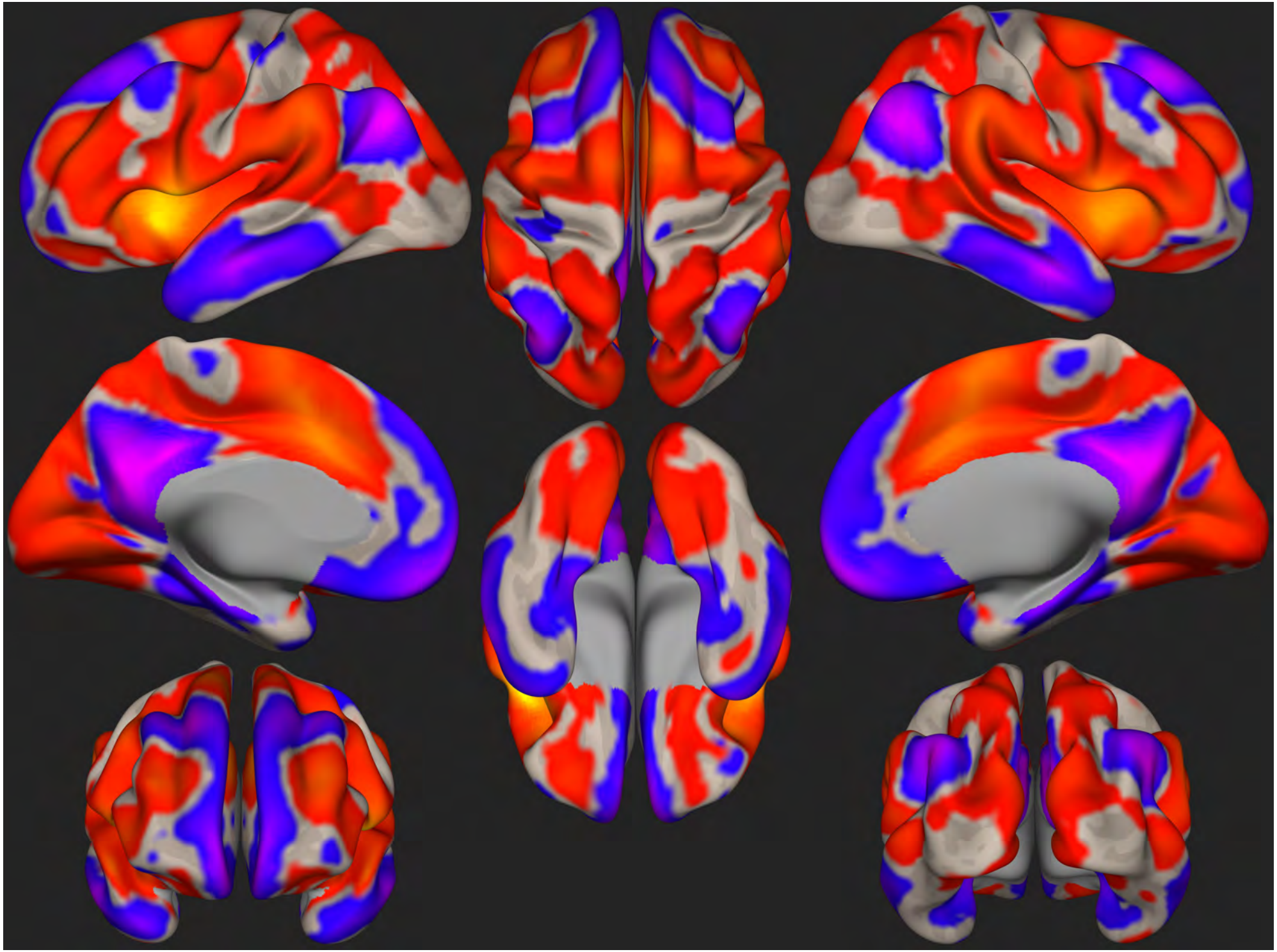


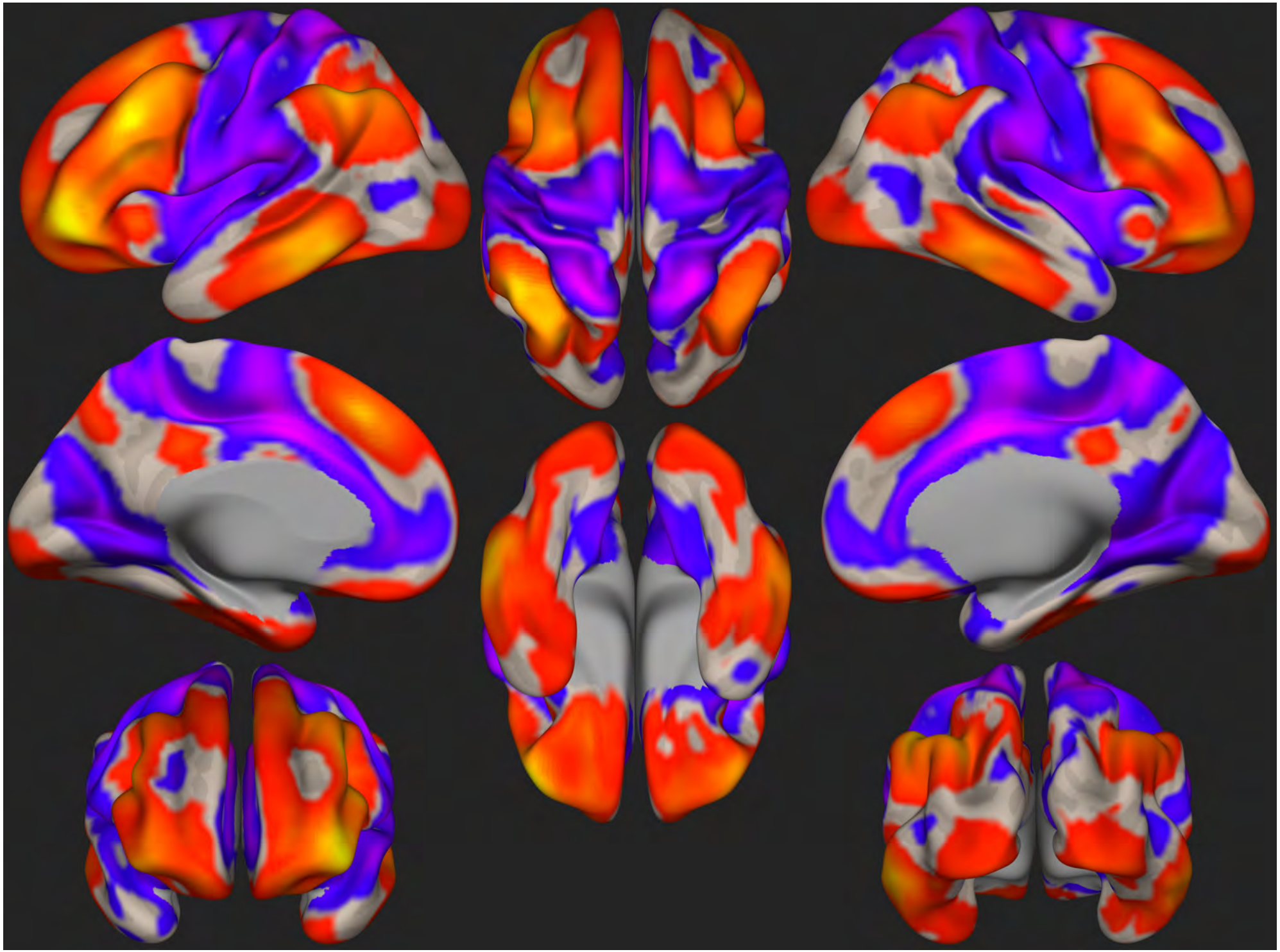


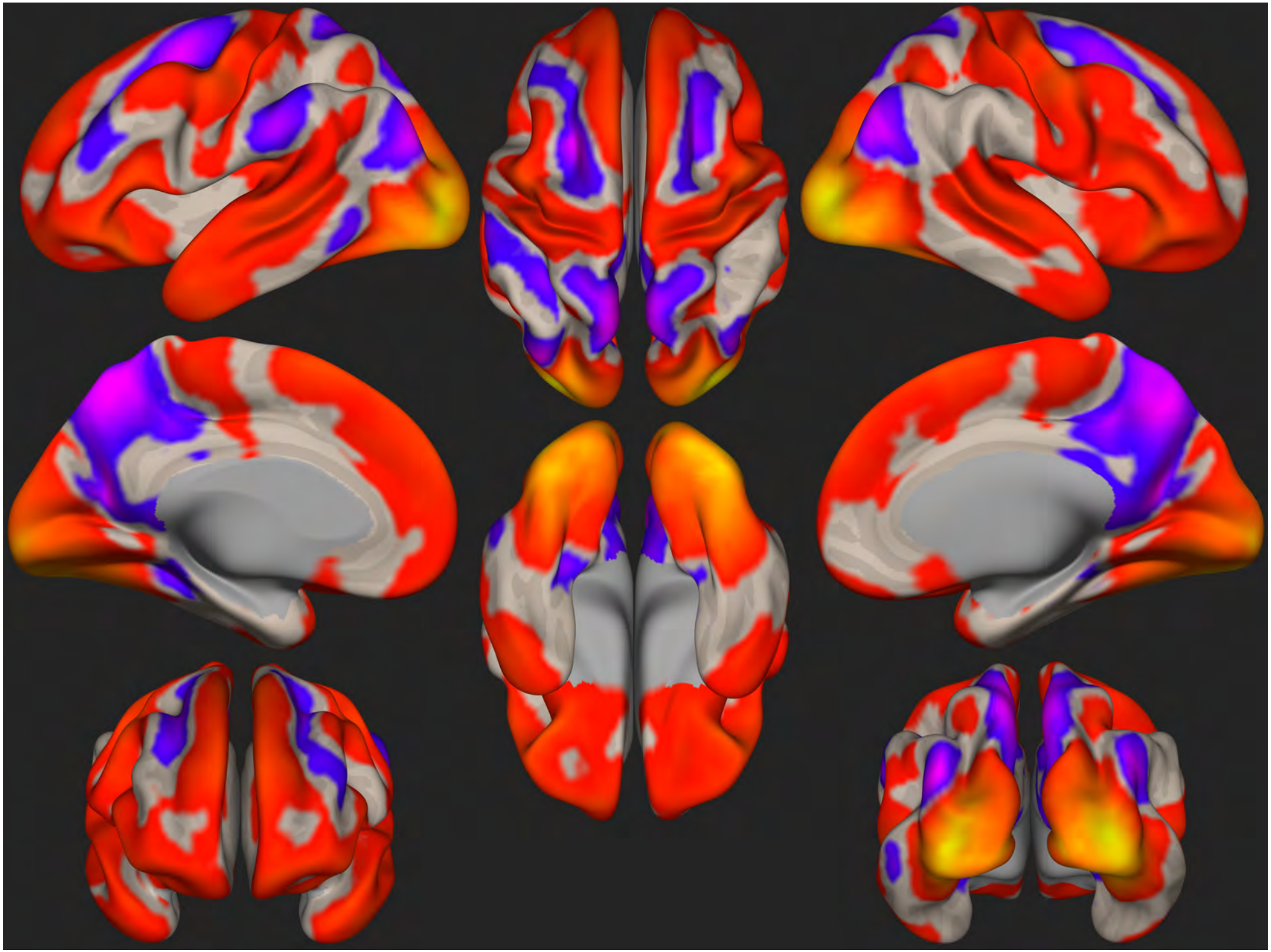


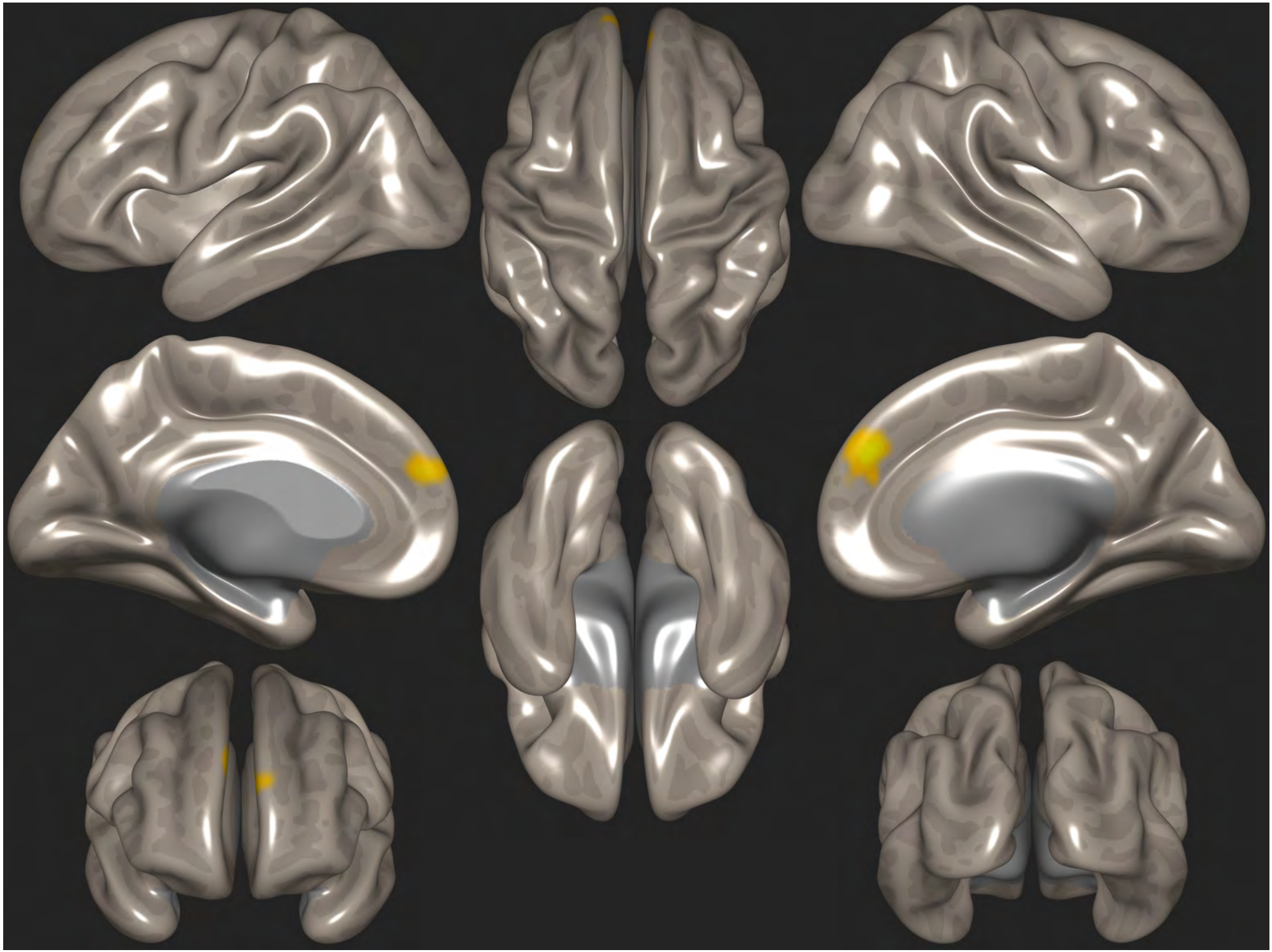


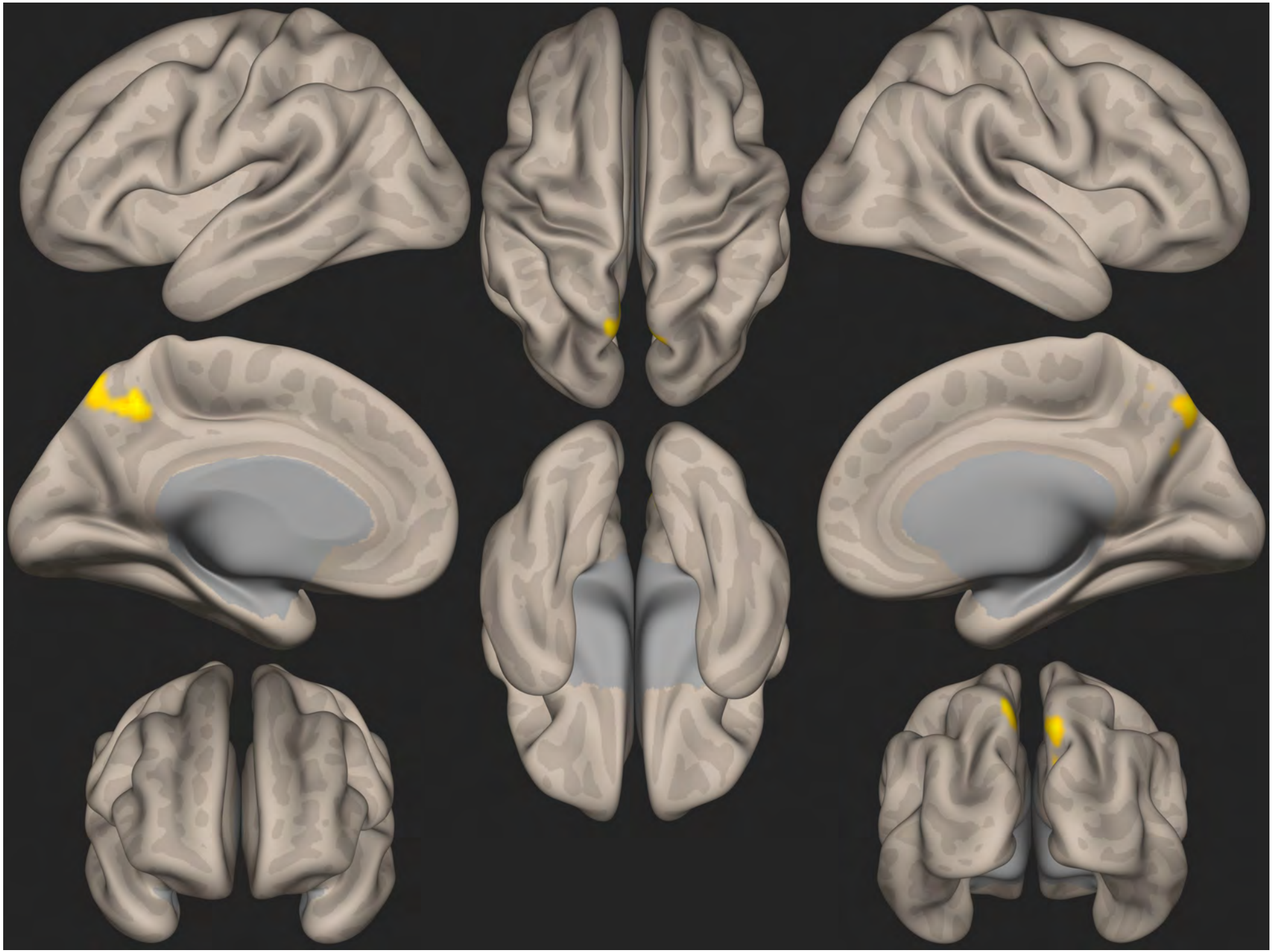


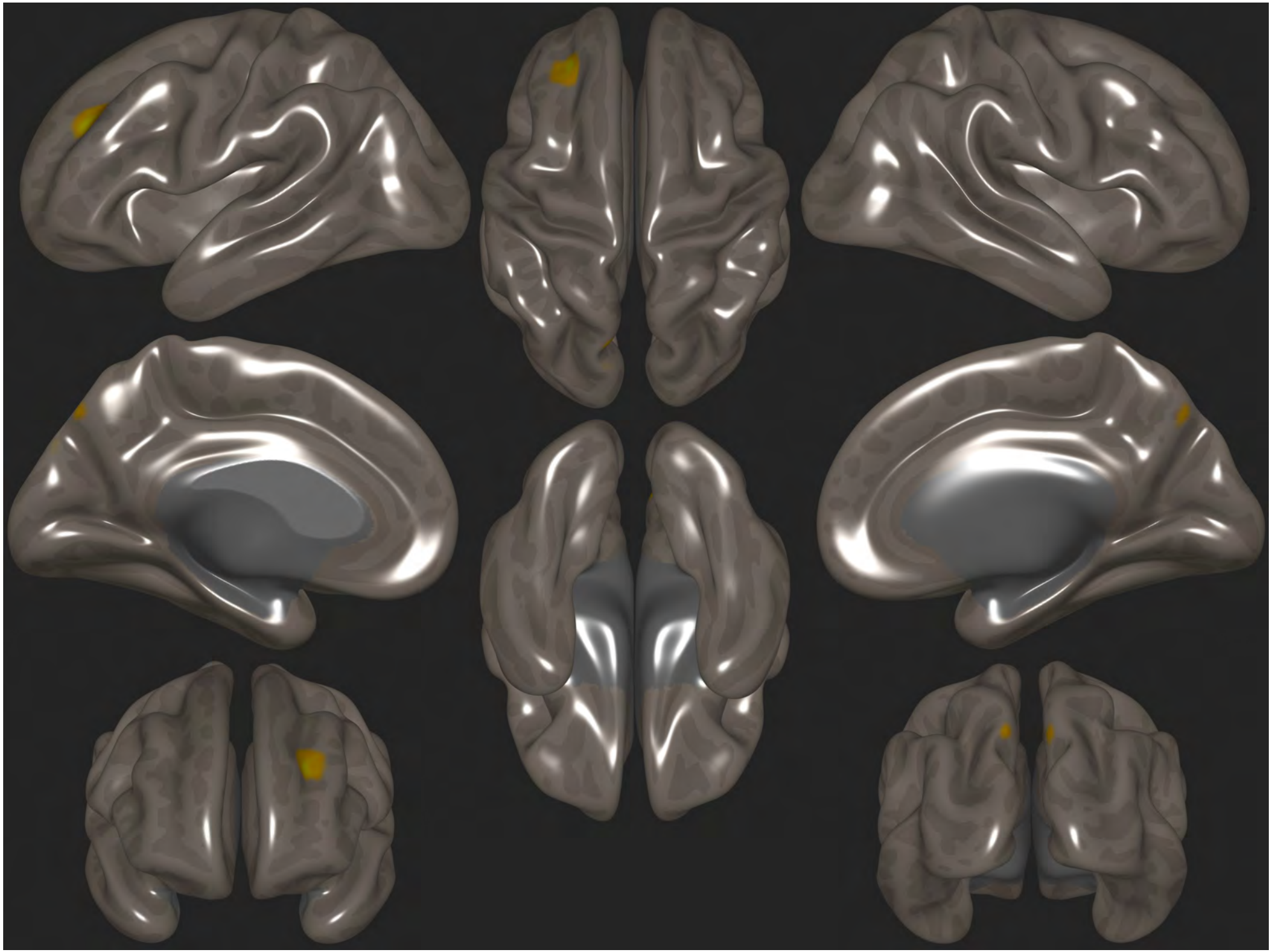


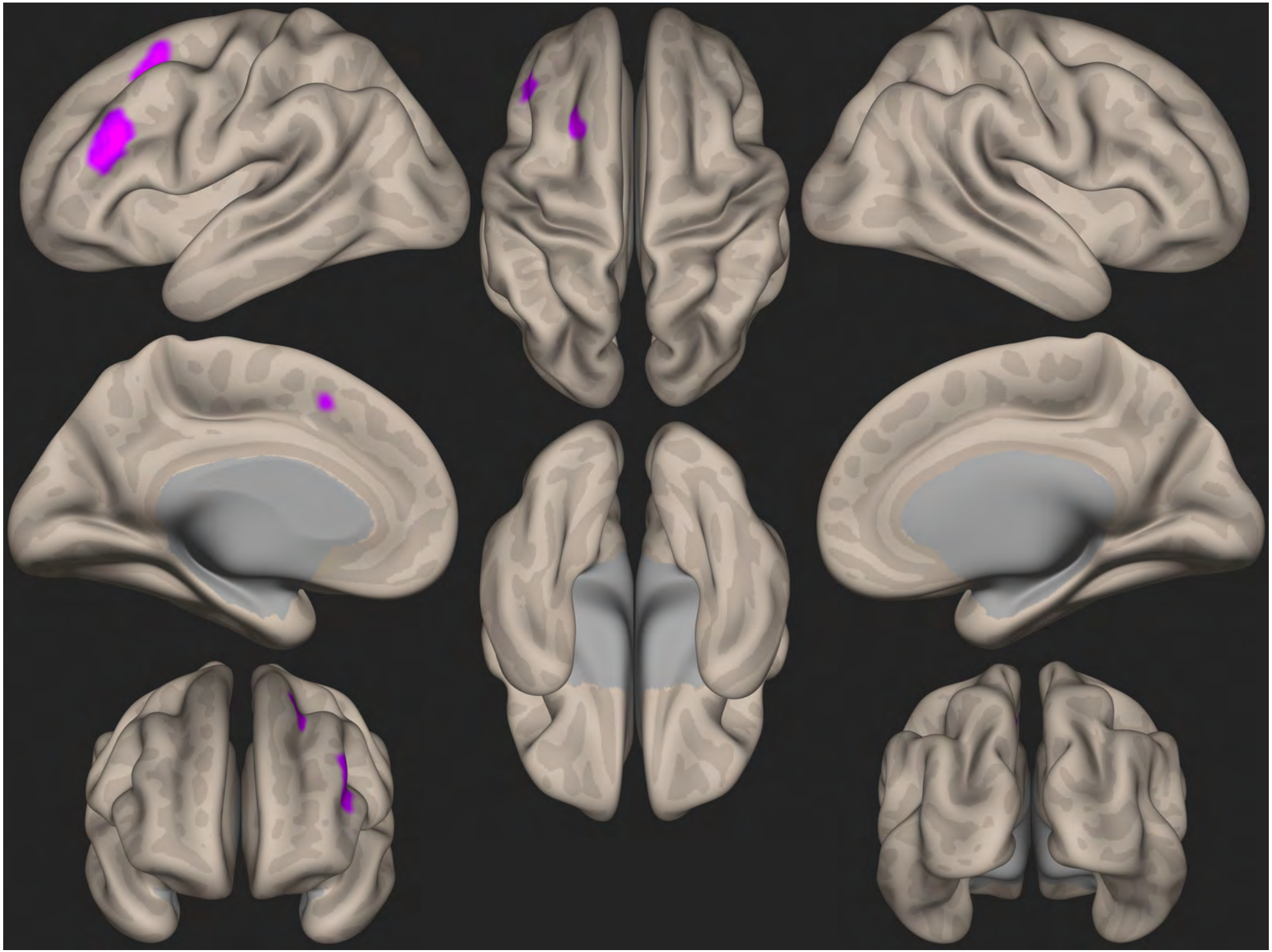


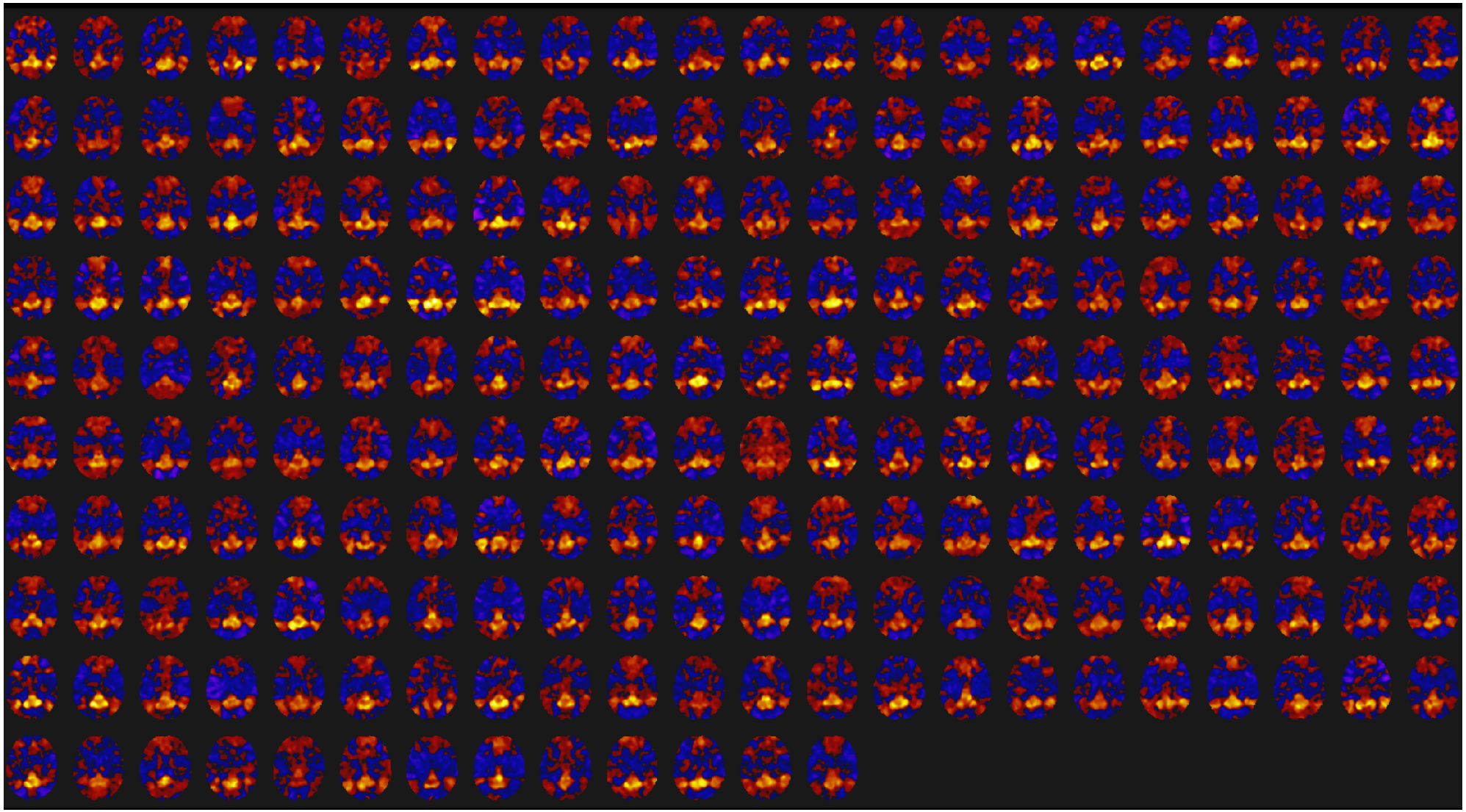


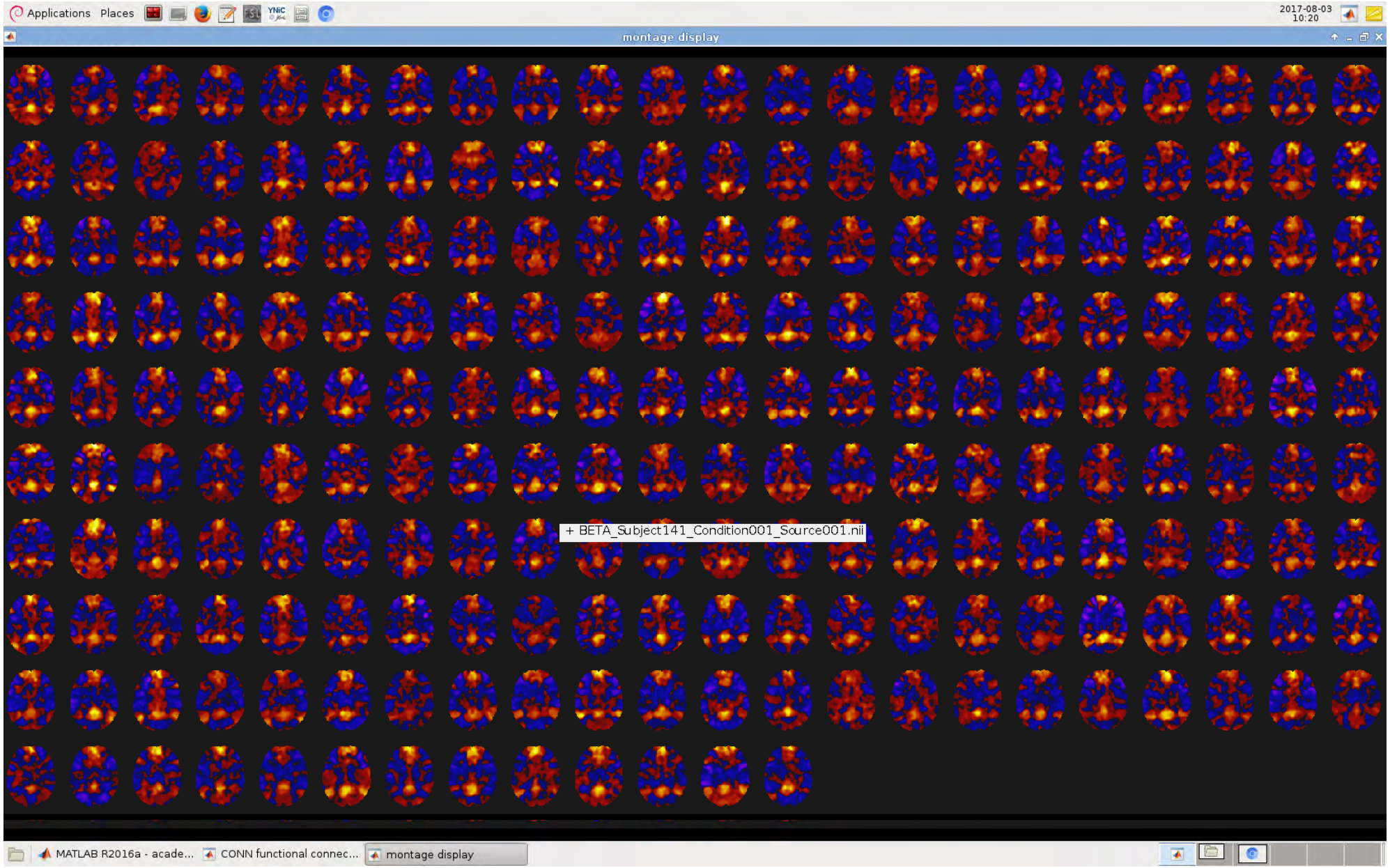








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Summary

- Mind-wandering is associated with the default mode network (both connectivity and activation analyses show it).
- Different types of mind-wandering generate different types of brain activation and connectivity.
- The creative mind-wandering in vivid images is strongly linked to connectivity within the default mode network.
- Whereas the deliberate (controlled and about personal goals) mind-wandering is linked to the greater connectivity between the salience network and the default mode network (potentially it means that the brain transitions in a more efficient way from the attending to the external world to mind-wandering-> We do not know yet).

Final points

- I have selected the most prominent (brain-related) findings in the literature as well as my own.
- Please, also include Dr Deniz Vatansever (University of York) and his supervisor, Dr Jonny Smallwood (Reader, University of York), Memory and Cognition Lab, Department of Psychology in the acknowledgements. I worked with Dr Vatansever to generate the brain images.
- It is also essential to give credit to all the authors I have extracted the images from.
- We have found something very interesting in relation to ADHD and mind-wandering. We have not published it yet, but we can discuss it at some point.
- From slide 12 to 27, the images represent resting functional connectivity, seed to region of interest connectivity analyses.