

Introduction

EEG signal spatial patterns depend on the 3D orientation of the brain regions they originate from, as well as neural activity. This complicates data interpretation because different individuals have different cortical folding patterns. **We investigated how much of the variability in EEG signals can be attributed to the difference in cortical folding patterns of individual brains.**

We used EEG and sMRI data from a study where subjects viewed images of textures that contained rotational symmetry, in a steady-state design (600ms control image → 600ms image with rotational symmetry), allowing the isolation of symmetry responses (odd harmonics) and image update responses (even harmonics) in different frequency components. **We generate individualized forward models to assess the effect of cortical folding in V1, V2, and V3 on the even harmonic spatial pattern, V3, hV4, LOC, and VO1 on the odd harmonic spatial pattern.**

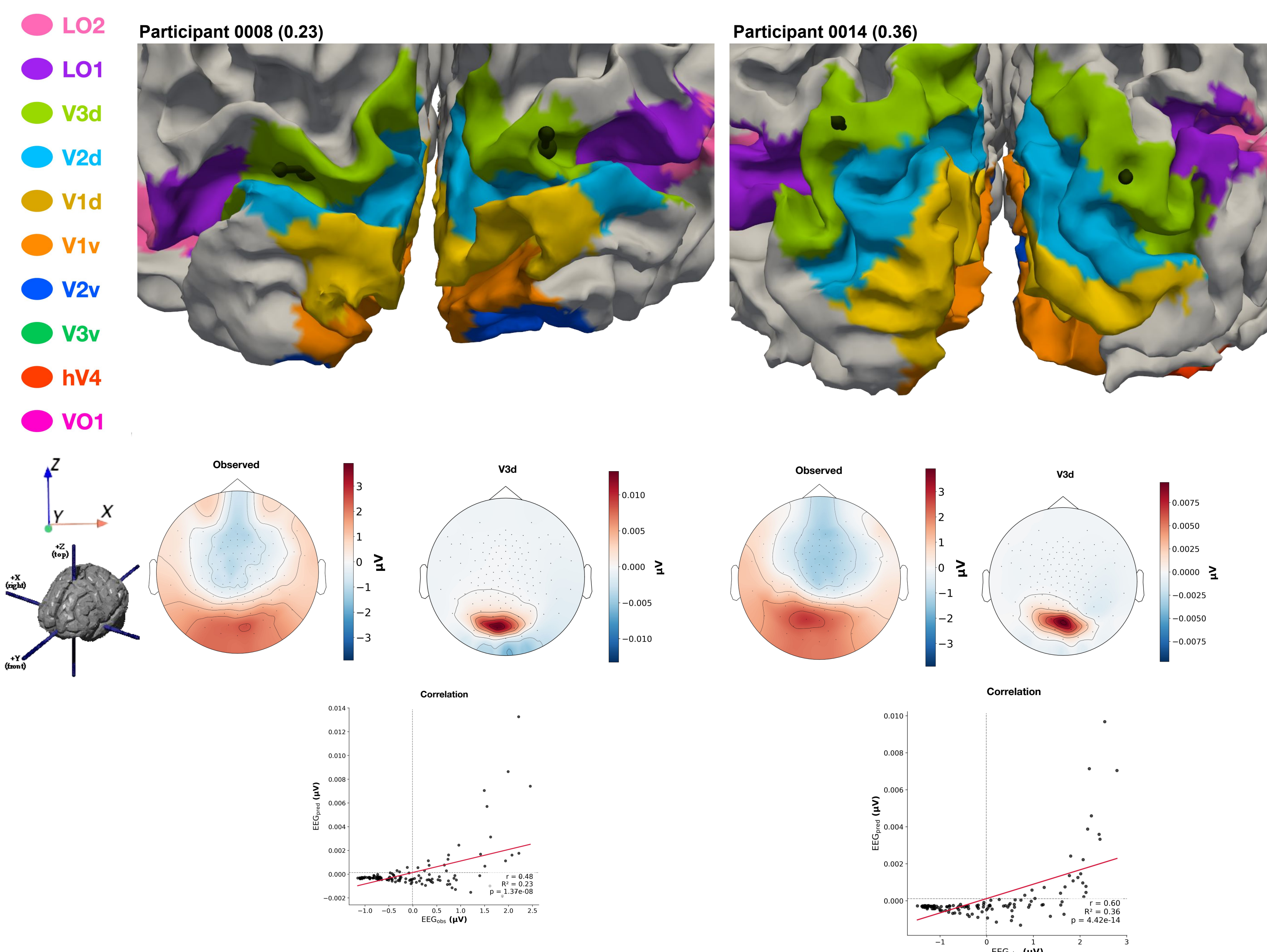
Methods

- Observed Topographic Map:** Generate a topographic map corresponding to the empirical signal.
- Dipole Approximation:** Approximate dipoles using surface normals between the white & pial surface (FreeSurfer) within 0-7 degrees of eccentricity (Benson Atlas) within each ROI (Wang atlas).
- Modelled Topographic Maps:** Generate a forward model for each dipole & dipole combinations isolating the effect of dipole orientation and distance on the EEG spatial pattern.
- Correlation:** Compare the spatial pattern between the empirical and modelled topographic maps (r).

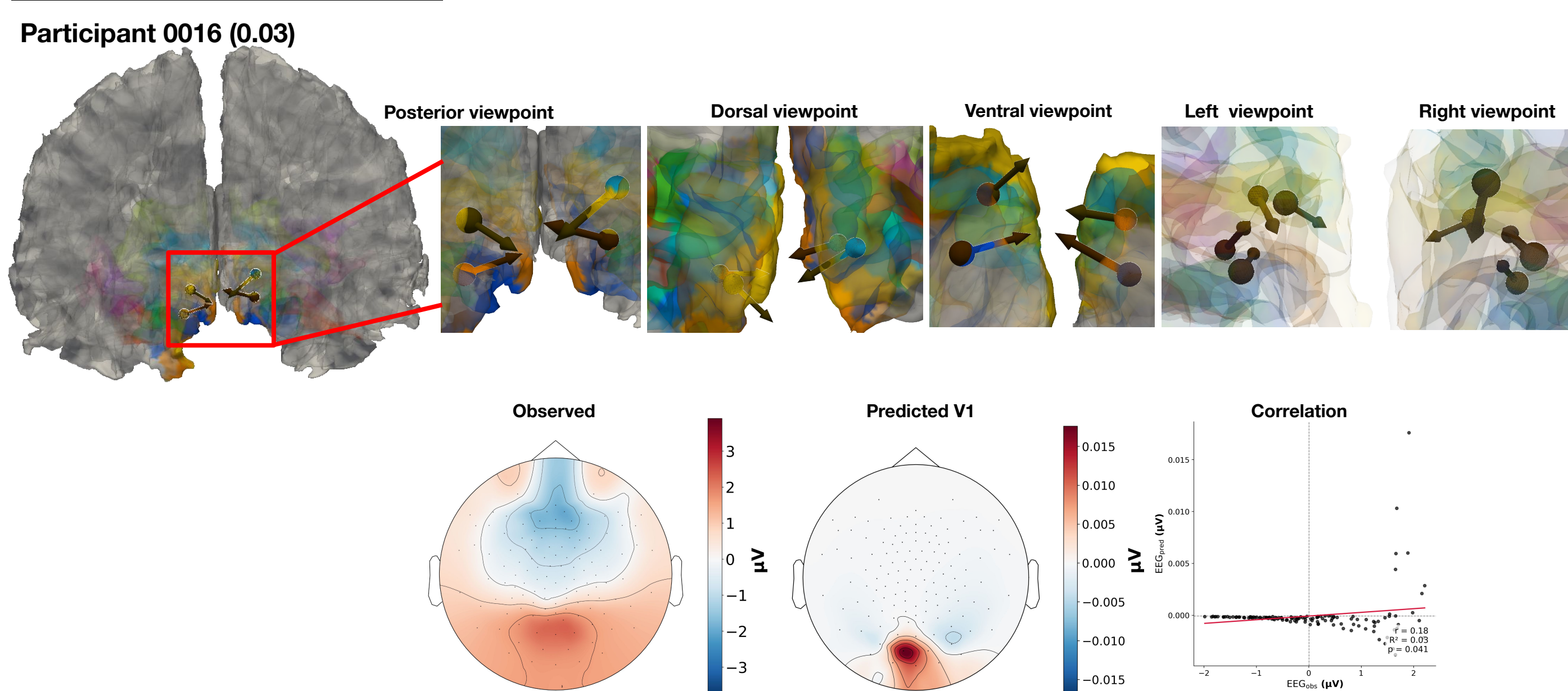
Results

Even Harmonics

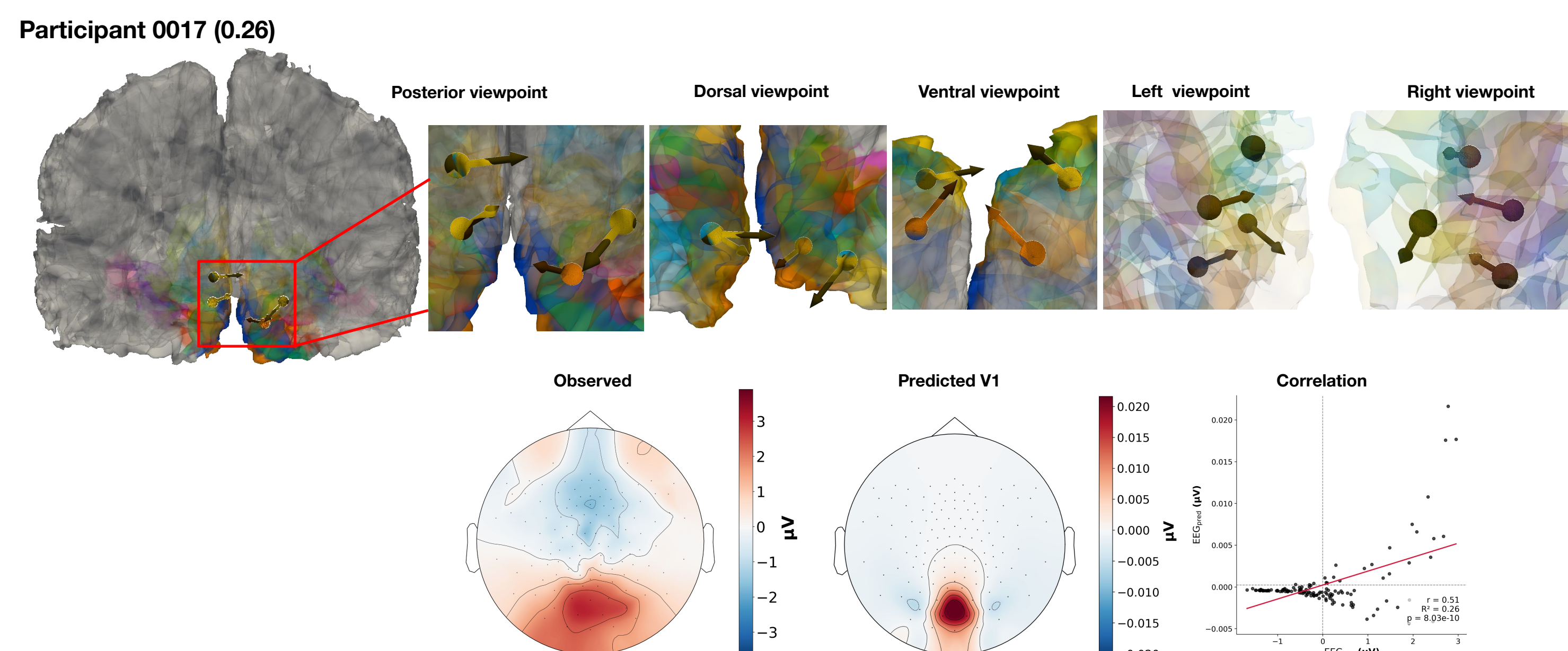
Differential V3d Contribution



Lesser V1 Representation

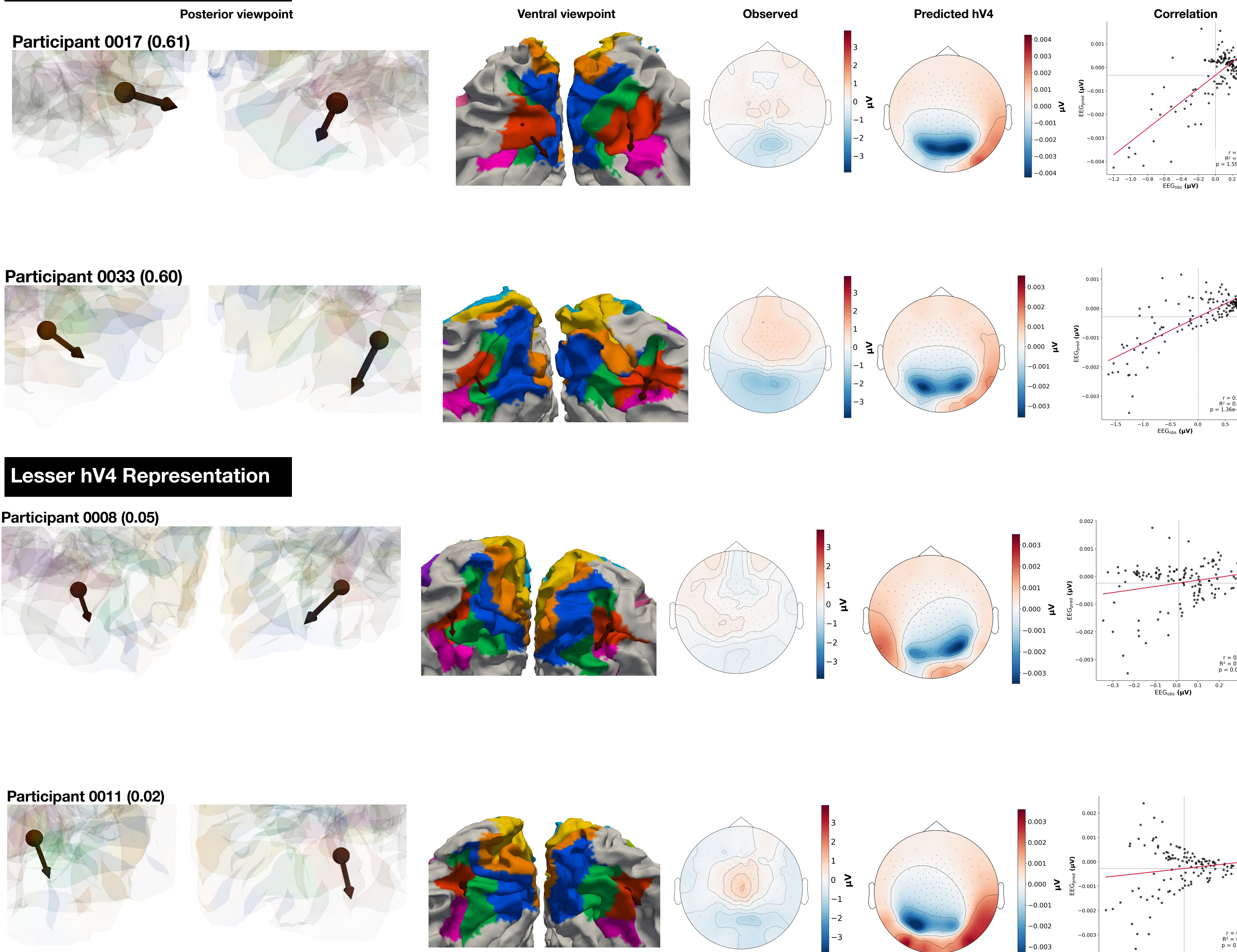


Greater V1 Representation

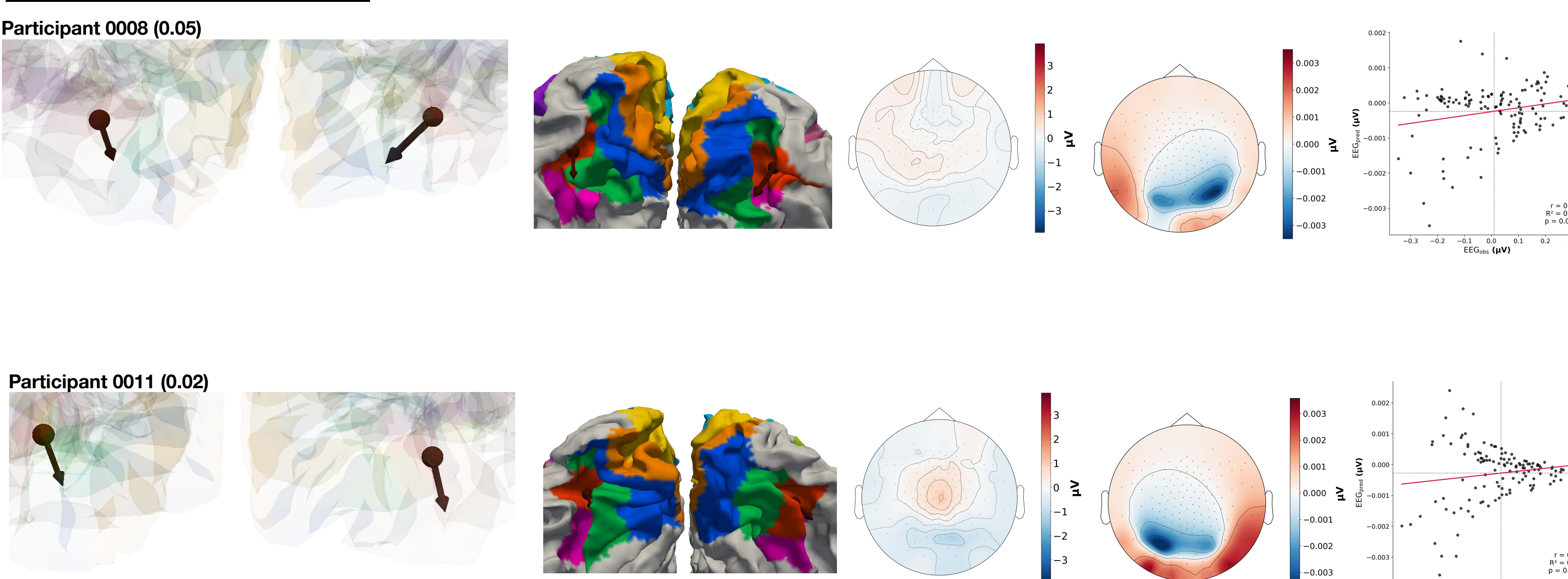


Odd Harmonics

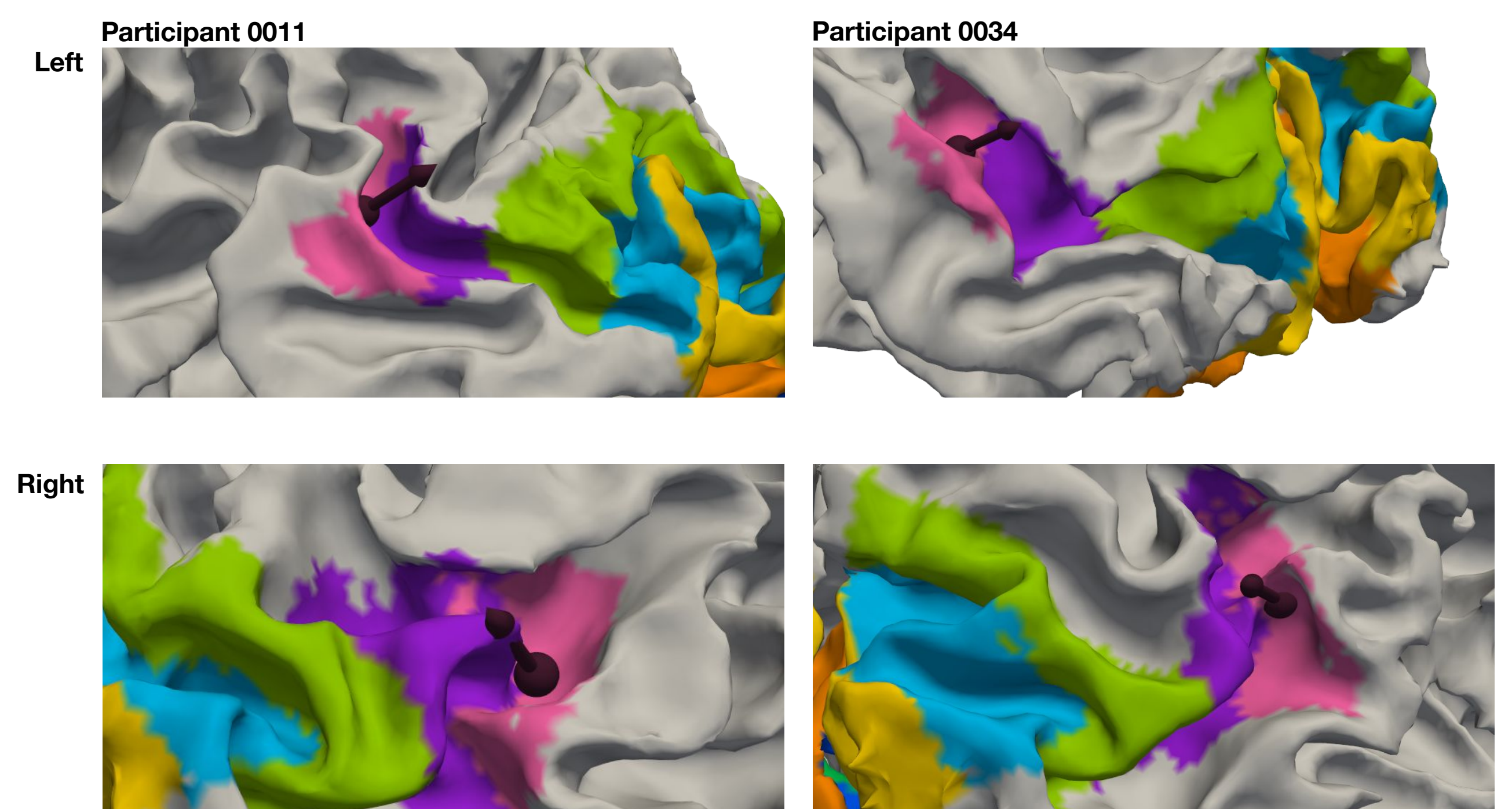
Greater hV4 Representation



Lesser hV4 Representation



LOC Morphology



References

- Herrera, B., Westerberg, J. A., Schall, M. S., Maier, A., Woodman, G. F., Schall, J. D., & Riera, J. J. (2022). Resolving the mesoscopic missing link: Biophysical modeling of EEG from cortical columns in primates. *NeuroImage*, 263, 119593. <https://doi.org/10.1016/j.neuroimage.2022.119593>
- Kohler, P. J., Clarke, A., Yakovleva, A., Liu, Y., & Norcia, A. M. (2016). Representation of maximally regular textures in human visual cortex. *The Journal of Neuroscience*, 36(3), 714–729. <https://doi.org/10.1523/jneurosci.2962-15.2016>
- Nunez, P. L., & Srinivasan, R. (2006). *Electric fields of the brain: The Neurophysics of EEG*. Oxford University Press.

Acknowledgments

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Summary

- In our models, V3d was most predictive of the even harmonic response pattern, likely due to its overall position on the cortex relative to V1 and V2.
- hV4 and LO2 were most predictive of the odd harmonic response patterns, likely due to specific folding properties.
- The extent of structure predictivity varies between subjects, thereby exemplifying the importance of individualized forward modelling in EEG analysis.