

Neural Decoding of Conscious vs. Unconscious Visual Stimuli: Testing the Global Neuronal Workspace and Integrated Information Theories



Ling Liu^{1,2}, Zvi Roth³, Oscar Ferrante⁴, Aya Khalaf⁵, David Richter^{6,7,8}, Yamil Vidal⁶, Ole Jensen^{9,4}, Huan Luo², Floris P de Lange¹⁰, Hal Blumenfeld⁵, Lucia Melloni^{11,12,13}, Michael Pitts¹⁴, Liad Mudrik^{15,16}

¹Cognitive Science and Allied Health School, Beijing Language and Culture University, Beijing, 100083, China; ²School of Psychological and Cognitive Sciences, Peking University, Beijing, 100871, China; ³School of Psychological Sciences at Tel Aviv University, Tel Aviv, 69978, Israel; ⁴Centre for Human Brain Health, School of Psychology, University of Birmingham, Birmingham, B15 2TT, UK; ⁵Department of Neurology, Yale School of Medicine, New Haven, CT, 06510, USA; ⁶Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, 6500 HB, the Netherlands; ⁷Department of Experimental and Applied Psychology, Vrije Universiteit Amsterdam, Amsterdam, 1081 BT, the Netherlands; ⁸Institute for Brain and Behavior Amsterdam (IBBA), Amsterdam, 1081 BT, the Netherlands; ⁹University of Oxford, Oxford OX2 6GG, UK; ¹⁰Radboud Universiteit, Donders Institute for Brain, Cognition and Behaviour, Kapittelweg 29, 6525 EN NIJMEGEN; ¹¹Department of Neurology, New York University Grossman School of Medicine, New York, NY, 10016, USA; ¹²Neural Circuits, Consciousness and Cognition Research Group, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, 60322, Germany; ¹³RUHR-Universität Bochum, Universitätsstraße 150, 44801 Bochum; ¹⁴Psychology Department, Reed College, Portland, OR, 97202, USA; ¹⁵Sagol School of Neuroscience, Tel Aviv University, Tel Aviv, 6997801, Israel; ¹⁶School of Psychological Sciences, Tel Aviv University, Tel Aviv, 69978, Israel

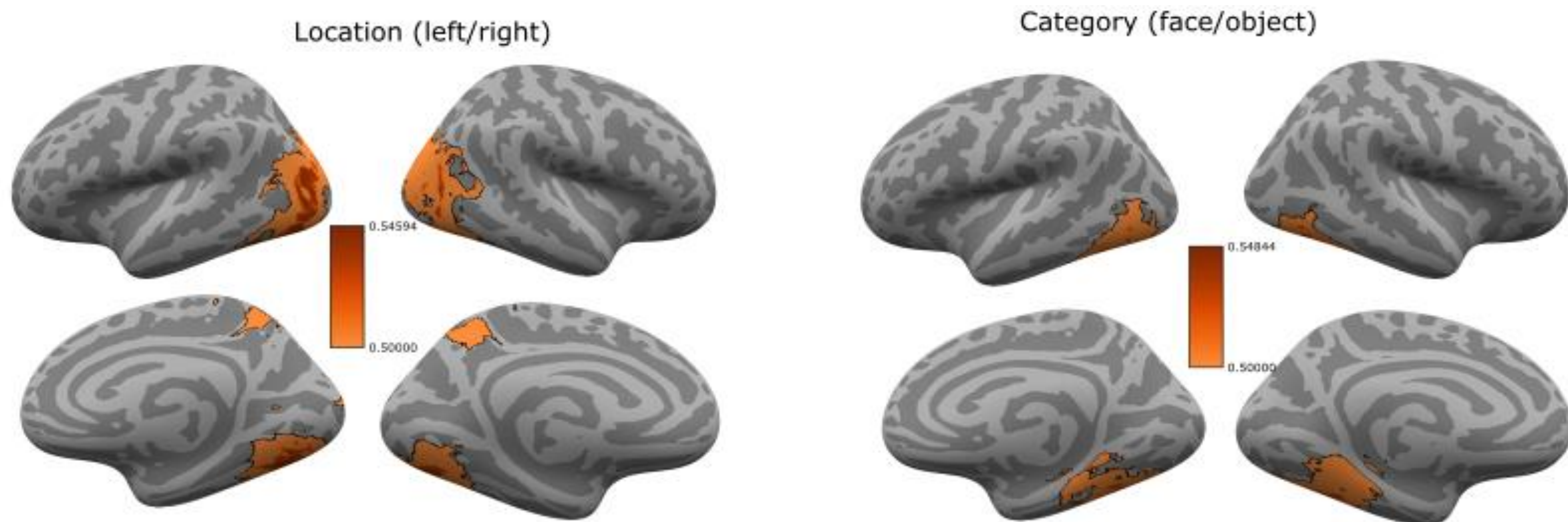
Introduction

The Cogitate consortium aims to test the Global Neuronal Workspace Theory (GNWT) and Integrated Information Theory (IIT). In Experiment 2, this was done by employing an attention-demanding task to evaluate brain responses to seen and unseen processed visual stimuli. Using magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI), we tested the theories' predictions about decoding of content (category and location) for physically identical stimuli that were seen versus unseen.

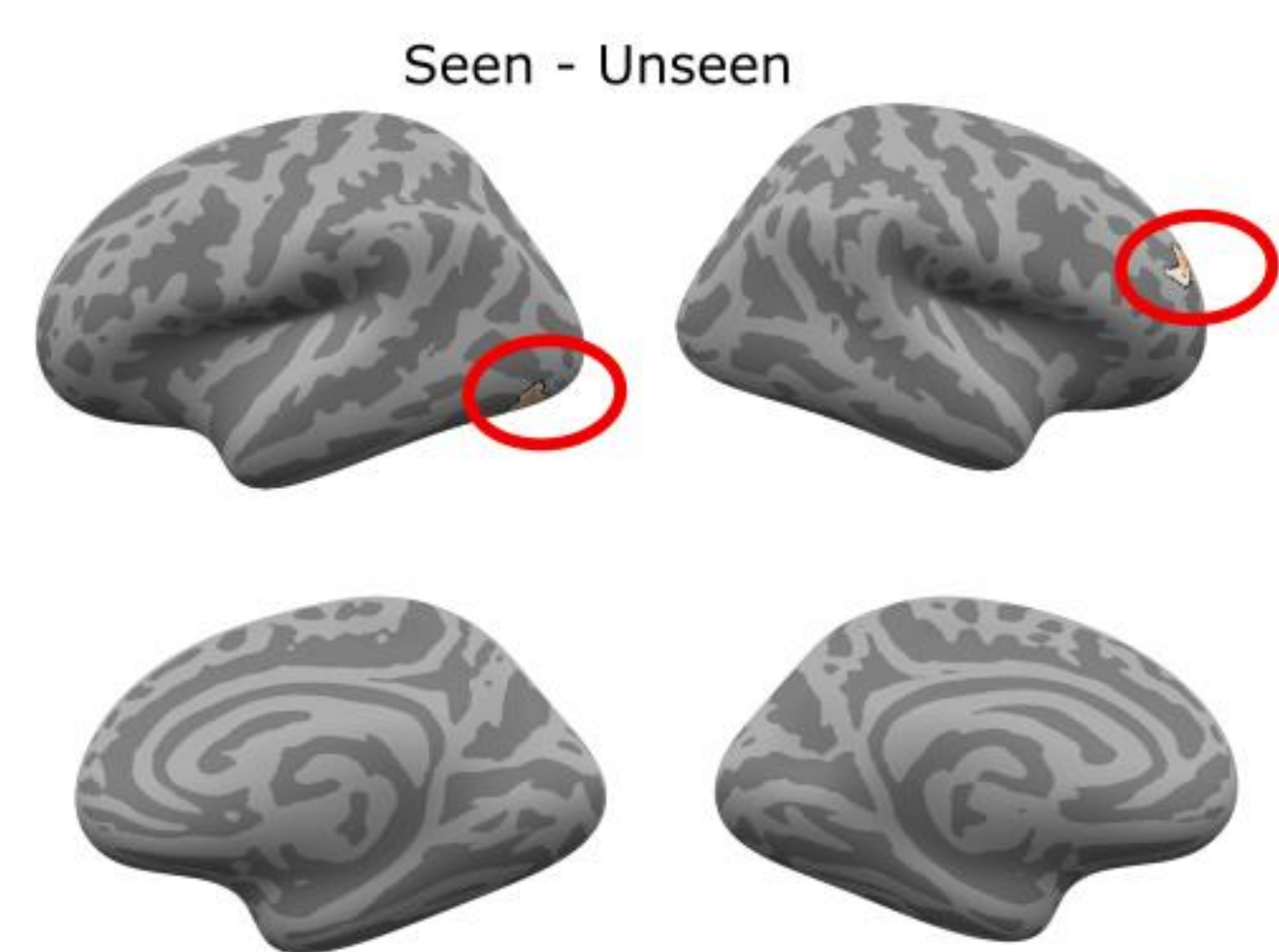
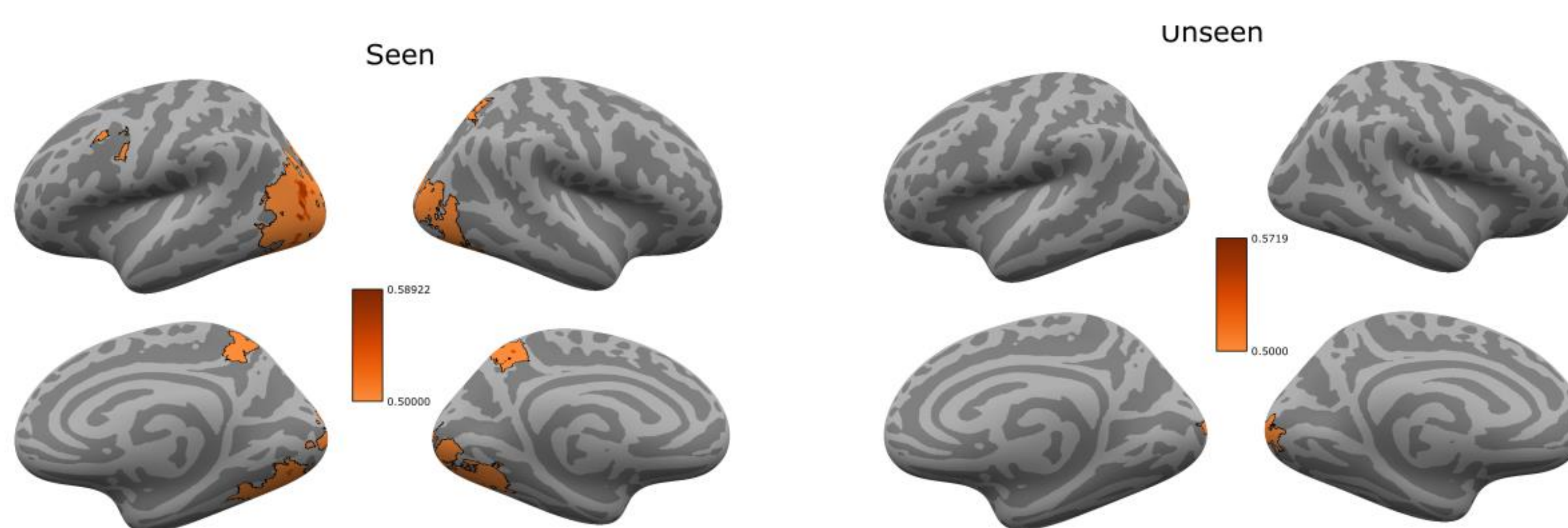
GNWT predictions	IIT predictions
Critical!	Non-critical!
Prediction #1: Decoding analyses	
Generalization of decoding category (faces/objects) in ANY PREFRONTAL area from dAT-seen to AT-seen ¹⁰ OR from AT-seen to dAT-seen during 250-500 ms ¹¹ post-stimulus onset.	Generalization of decoding category (faces/objects) in ANY POSTERIOR area from dAT-seen to AT-seen ¹⁰ OR from AT-seen to dAT-seen within 100-600 ms post-stimulus onset.
Generalization of decoding location (left/right) in ANY PREFRONTAL area from dAT-seen to AT-seen OR from AT-seen to dAT-seen during 250-500 ms post-stimulus onset.	Generalization of decoding of location (left/right) in ANY POSTERIOR area from dAT-seen to AT-seen OR from AT-seen to dAT-seen within 100-600 ms post-stimulus onset.
(1) Significantly higher decoding of category (faces/objects) for dAT-seen vs. dAT-unseen in ANY PREFRONTAL area, during 250-500 ms post-stimulus onset.	(1) NO increase in generalization of decoding accuracy ¹² for category (faces/objects) when adding IIT-excluded prefrontal areas (from dAT-seen to AT-seen-no-go OR from AT-seen-no-go to dAT-seen), during 100-600 ms post-stimulus onset.
(2) Significantly higher decoding of location (left/right) for dAT-seen vs. dAT-unseen in ANY PREFRONTAL area, during 250-500 ms post-stimulus onset.	(2) NO increase in generalization of decoding accuracy for location (left/right) when adding IIT-excluded prefrontal areas (from dAT-seen to AT-seen-no-go OR from AT-seen-no-go to dAT-seen), during 100-600 ms post-stimulus onset.
1 OR 2 should be TRUE for MEG source space ¹³ . If neither 1 nor 2 are found for MEG source space, but 1 OR 2 are found for fMRI, this would be consistent with GNWT ¹⁴ .	1 OR 2 should be TRUE for MEG source space ¹² . If neither 1 nor 2 are found for MEG source space, but 1 OR 2 are found for fMRI, this would be consistent with IIT ¹⁴ .

fMRI decoding

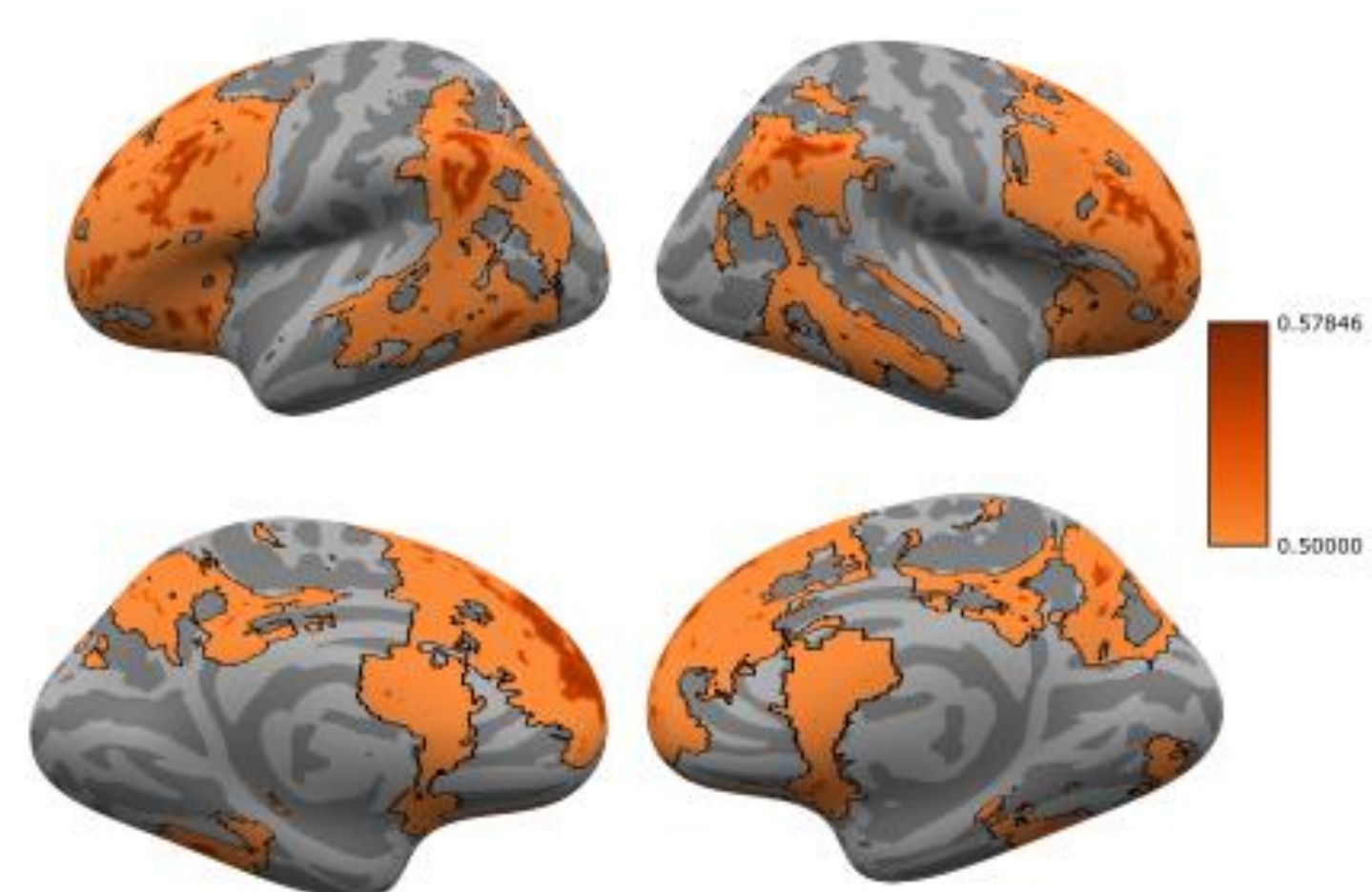
fMRI: cross-task generalization, dAT to AT



fMRI: decoding at dAT task (location)



fMRI: visibility decoding



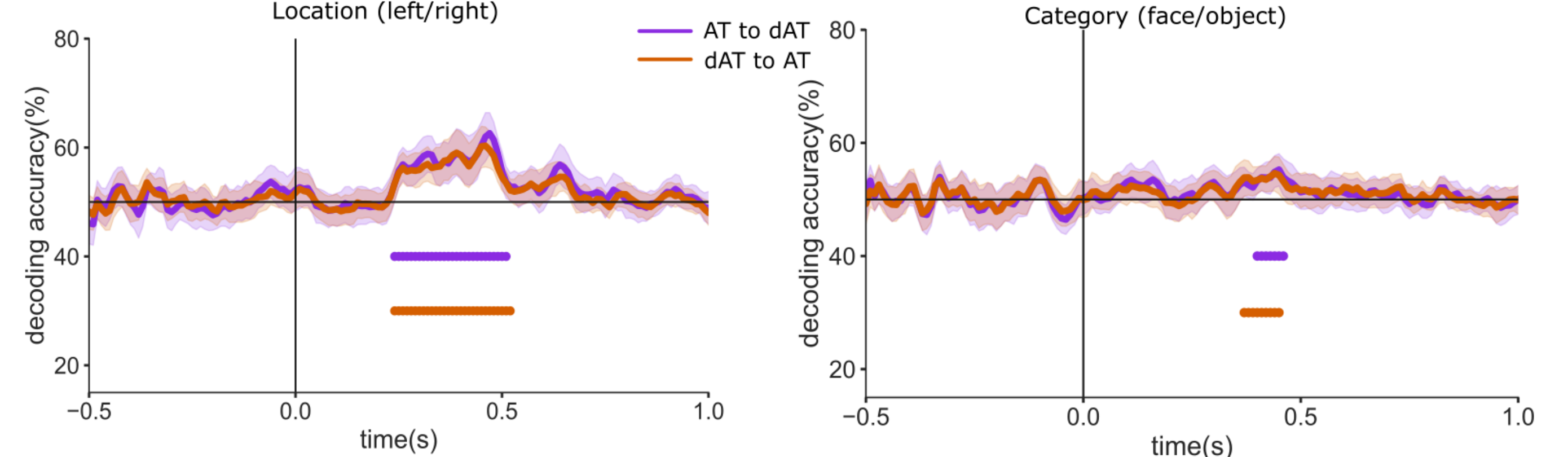
Discussion | Conclusion

- MEG decoding results confirmed GNWT's predictions during the 250-500 ms time window. Conscious content as well as the seen-vs-unseen difference was decodable in PFC.
- fMRI results show significant decoding of category and location for seen trials within the precuneus and the left frontal cortex while decoding for unseen trials remained at-chance across all prefrontal regions. When directly comparing decoding accuracies for seen versus unseen trials, decoding location was significantly higher in seen trials in right prefrontal cortex and ventral visual cortex. Category decoding was not significantly higher for seen than for unseen trials anywhere in the brain.
- In line with IIT's prediction, combining posterior and PFC regions did not show any improvements to decoding performance compared to the posterior region alone (in both MEG and fMRI).
- Together, these results confirm GNWT's critical prediction and IIT's non-critical one, while provoking further investigation into why decoding of content in the PFC was found to be weak (in MEG) and non-existent (in fMRI).

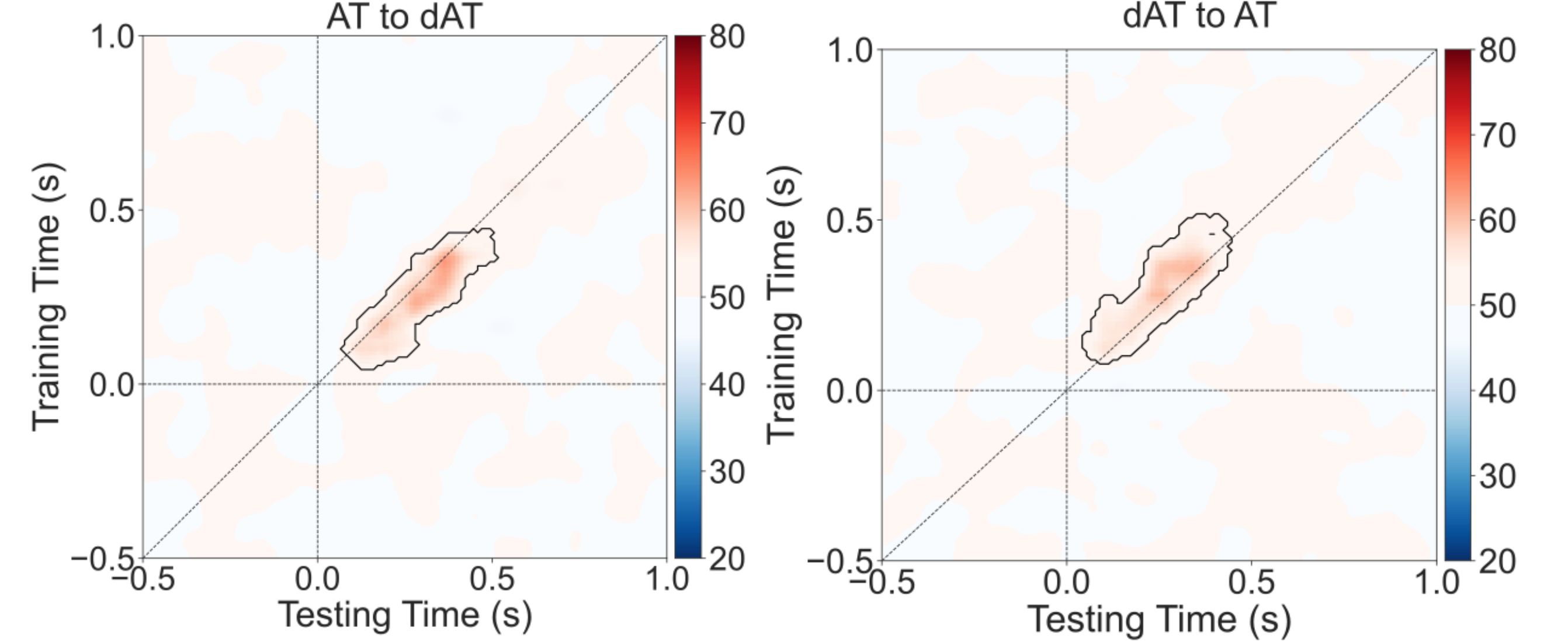
Results

MEG decoding

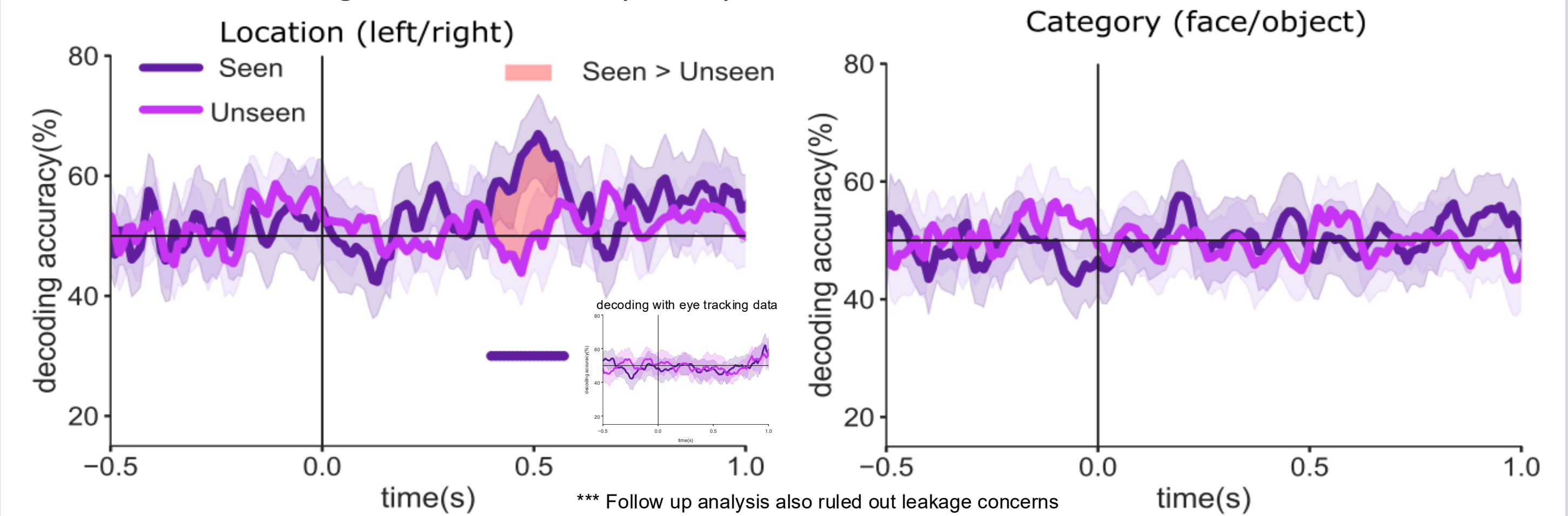
MEG: cross task decoding (PFC)



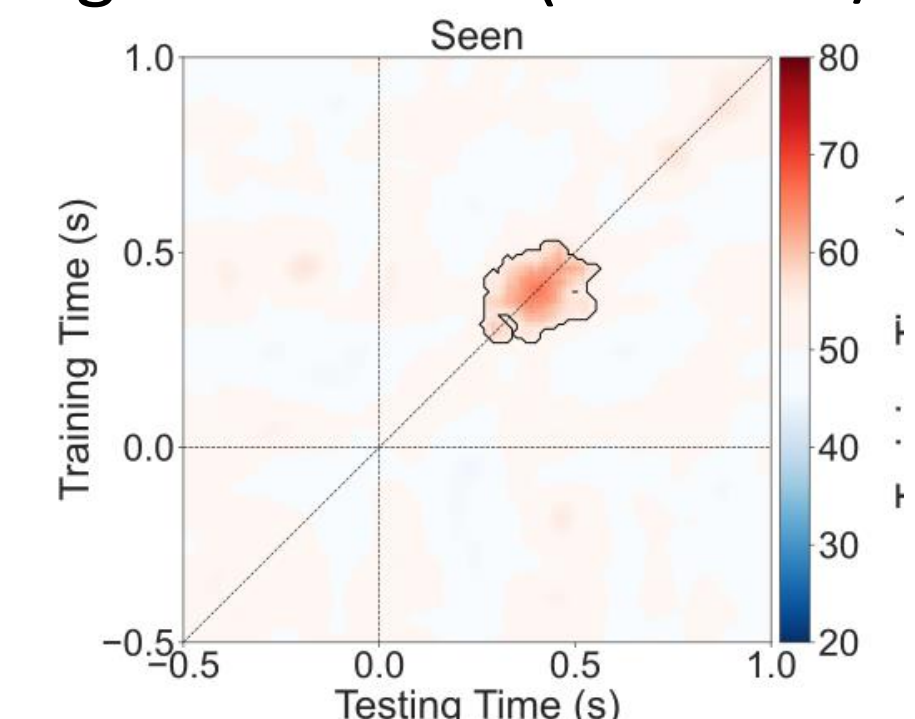
MEG: cross task temporal generalization decoding of location (PFC)



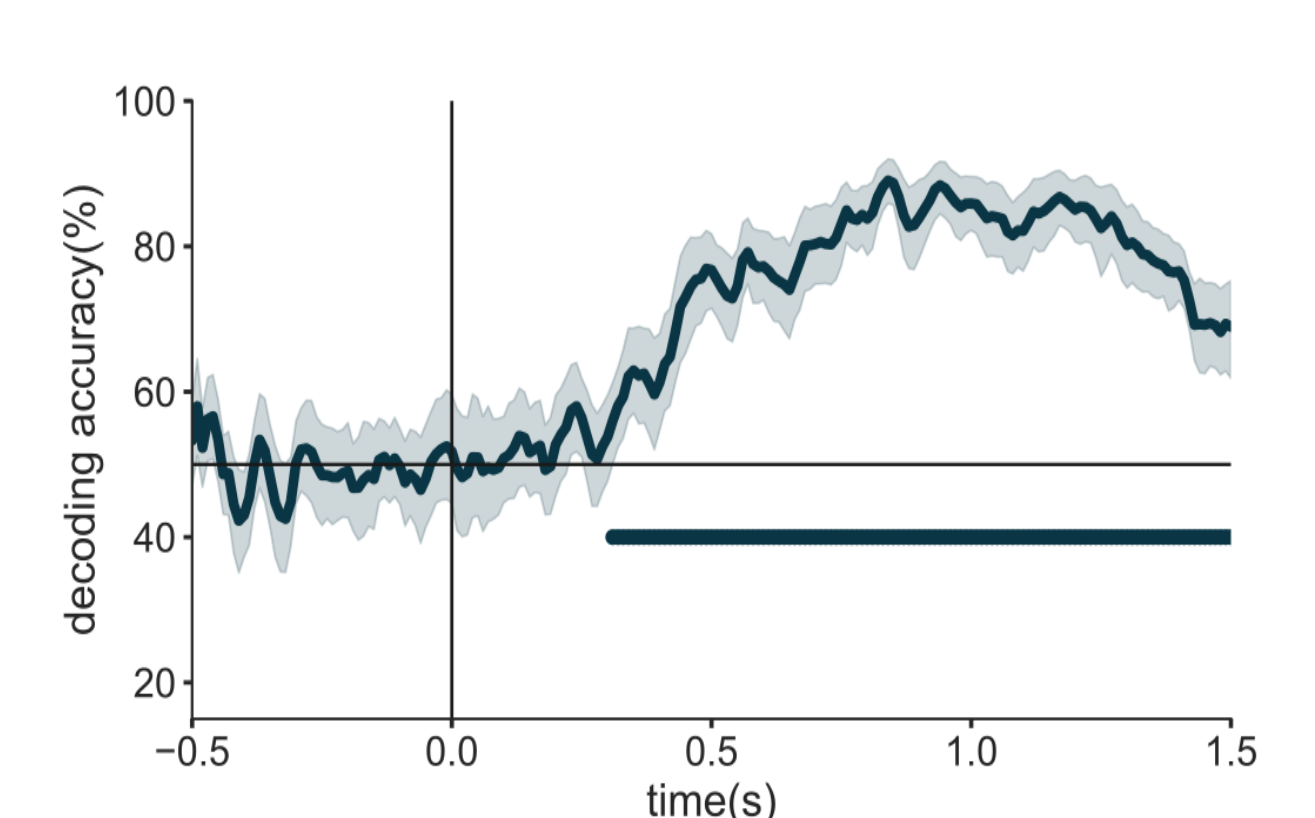
MEG: decoding at dAT task (PFC)



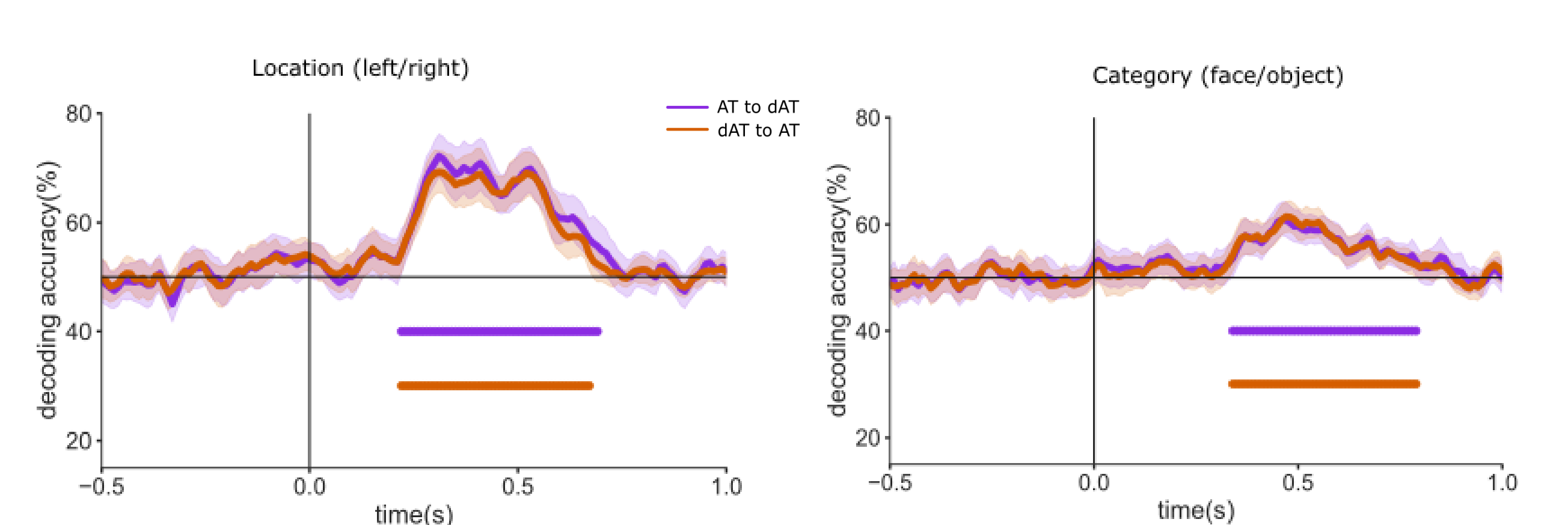
MEG: Temporal generalization of decoding at dAT task (Location/PFC)



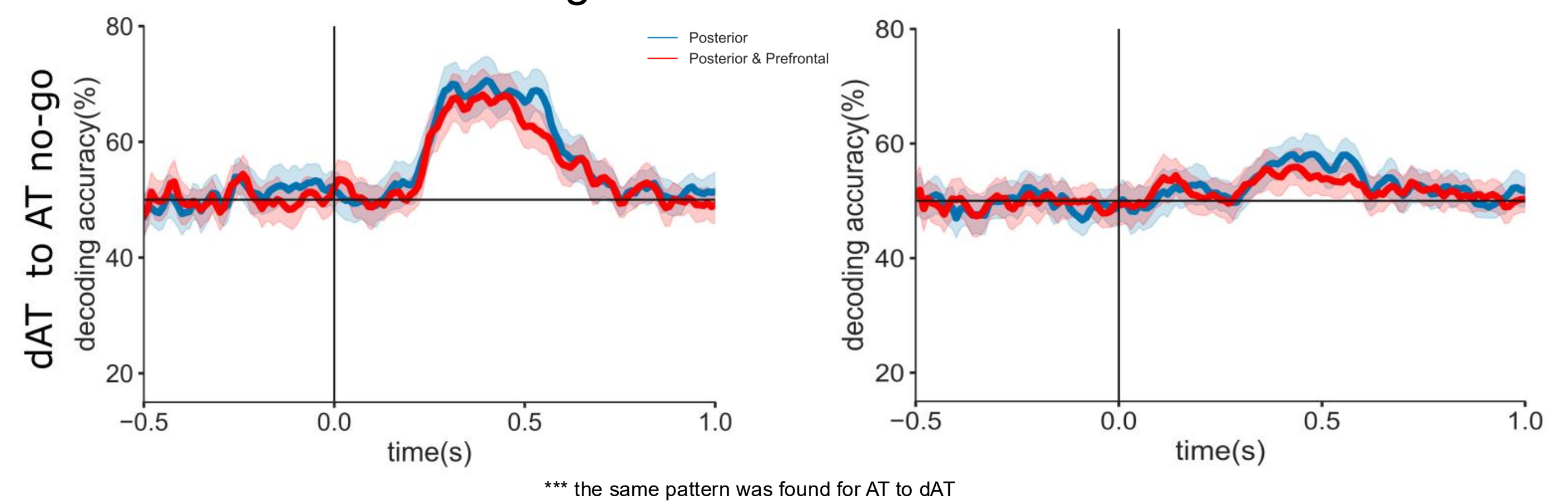
MEG: visibility decoding (PFC)



MEG: cross task decoding (Posterior)



MEG: cross task decoding with and without frontal areas

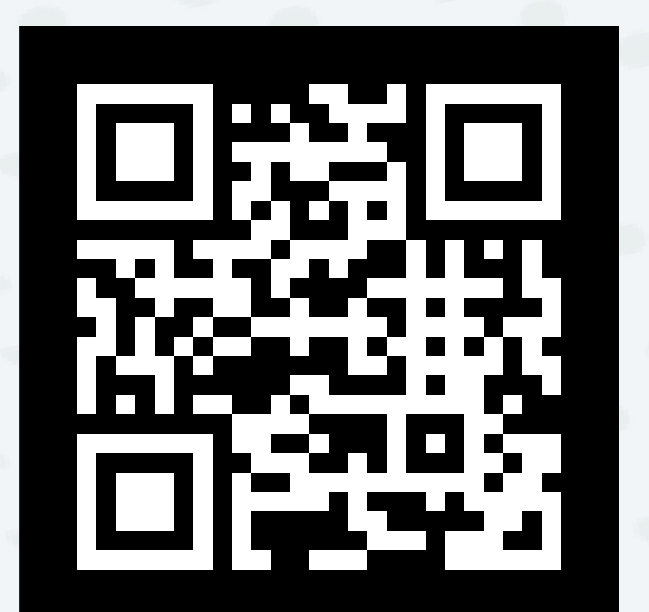


Contact

Ling Liu
ling.liu@bcu.edu.cn

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OSF preregistration

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