

# Brain Activity and Synchronization in Conscious Perception: Insights from Cogitate Experiment 2



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## Introduction

The Cogitate consortium employs an adversarial collaboration approach to rigorously test Integrated Information Theory (IIT) and Global Neuronal Workspace Theory (GNWT).

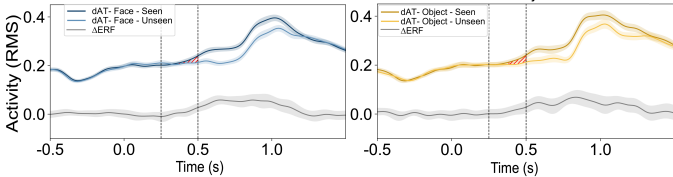
In the second experiment, we evaluated predictions regarding (1) activation patterns underlying conscious perception in critical brain regions and (2) connectivity patterns between these regions.

Non-critical	GNW predictions	Activation analyses	IIT predictions
(1) Higher activation for dAT-seen vs. dAT-unseen faces in ANY PREFRONTAL area, during 250-500 ms post-stimulus onset in at least ONE measure of activation (evoked response, increased gamma, BOLD)			
(2) Higher activation for dAT-seen vs. dAT-unseen objects in ANY PREFRONTAL area, during 250-500 ms post-stimulus onset in at least ONE measure of activation (evoked response, increased gamma, BOLD)			
<b>Synchronization analyses</b>			
(1) Stronger theta/beta/gamma band synchronization between PFC and content-specific areas (FFA&LOC) for their preferred stimulus vs. their non-preferred stimulus within 250-500 ms time window, for all seen conditions (dAT-seen AND AT-seen-go AND ATseen-no-go; the same areas in PFC are expected to be found in all three).	(1) Stronger gamma band phase synchronization between activated V1/V2 and activated content-specific areas (FFA&LOC) for their preferred stimulus vs. their nonpreferred stimulus within 100-600 ms post-stimulus onset, for seen conditions <sup>2</sup> in every task (dAT-seen AND AT-seen-go AND ATseen-no-go).		
(2) Stronger synchronization between PFC and content-specific areas (FFA and LOC) for dAT-seen vs. dAT-unseen preferred stimuli, within 250-500 ms post-stimulus onset.	(2) Stronger phase synchronization between activated V1/V2 and activated content-specific areas (FFA&LOC) for dAT-seen vs. dAT-unseen preferred stimuli, within 100-600 ms post-stimulus onset.		

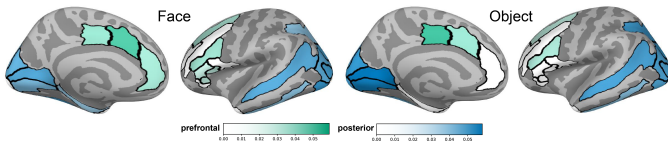
1 A positive finding for faces OR objects would suffice.  
2 Analyses will initially collapse across the three seen conditions (dAT-seen, AT-seen-go, AT-seen-no-go) to increase trial numbers. If synchronization is not evident, follow-up analyses will be conducted on each condition separately.  
Task: attended task (AT) & distracted attention task (dAT).  
Prefrontal Cortex (PFC), earlier visual areas (V1/V2), Face Fusiform Area (FFA), Lateral Occipital Complex (LOC), blood-oxygen-level-dependent (BOLD).

## Activation analyses

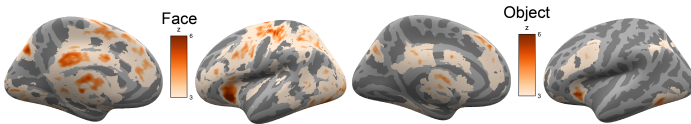
**MEG-Evoked Response: Stronger Activation in Prefrontal ROIs for dAT-Seen vs. Unseen**



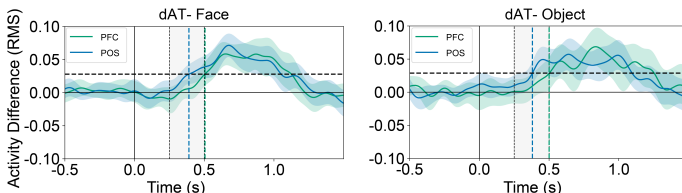
Prefrontal (Green) and Posterior (Blue) ROIs with Stronger Activation for dAT-Seen vs. dAT-Unseen Stimuli Suggesting Results Do Not Merely Stem from Leakage



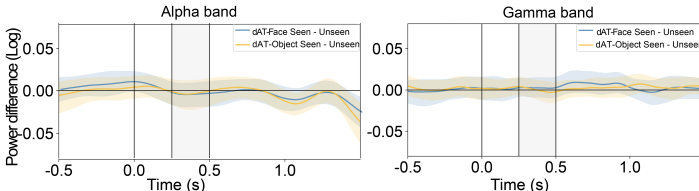
**fMRI-BOLD Signal: Regions with Stronger Activity for dAT-Seen vs. Unseen**



**MEG-Evoked Response: Activity Difference for dAT-Seen vs. Unseen Occurs Earlier in Posterior than in Prefrontal ROIs**

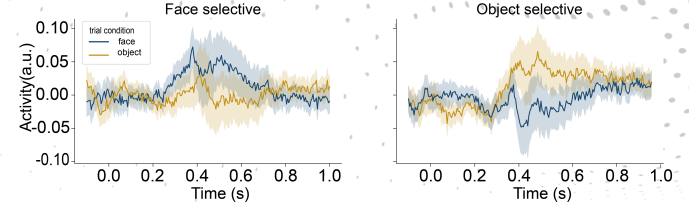


**MEG-alpha/gamma power: No Gamma Increase or Alpha Decrease for dAT-Seen vs. Unseen in Prefrontal ROIs**

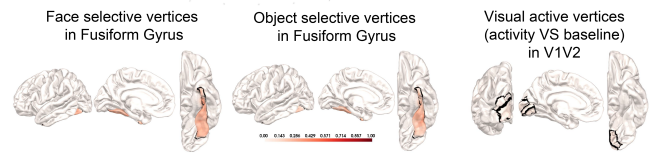


## Synchronization analyses

**GNWT: Spatial Filters Applied to Extract Face- and Object-Selective Activity from the Fusiform Gyrus (Generalized Eigenvalue Decomposition, GED<sup>3</sup>)**



**IIT: Content-Specific Vertices Used to Extract Face- and Object-Selective Activity from the Fusiform Gyrus and Visual Activity from the Early Visual Cortex**

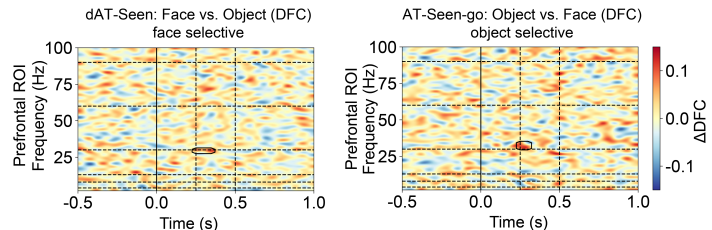


For all seen conditions (dAT-seen & AT-seen-go & ATseen-no-go):

no significant connectivity differences between the preferred and the non-preferred stimuli were found between

- Fusiform Gyrus and PFC (GNWT) in DFC and PPC analysis.
  - Fusiform Gyrus and early visual area (IIT) in PPC analysis.
- DFC: Dynamic Functional Connectivity<sup>4,5</sup>; PPC: Pairwise Phase Consistency<sup>6</sup>

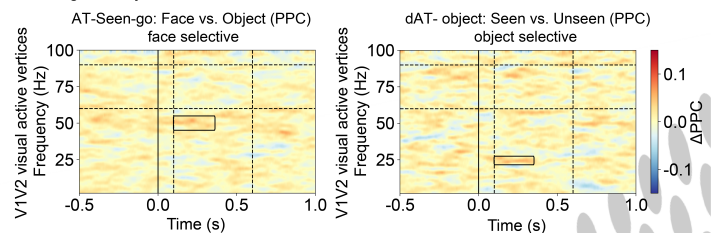
GNWT – Prediction 1: DFC between Fusiform Gyrus and PFC for Faces (dAT-Seen Only) and Objects (AT-Seen-go Only); No Findings in PPC Analysis



GNWT – Prediction 2: No Stronger theta/beta/gamma Synchronization (Seen vs. Unseen) between Fusiform Gyrus and PFC found in PPC/DFC analysis

GNWT – fMRI: No Connectivity between PFC and FFA/LOC Found in Generalized Psychophysiological Interaction (gPPI) analysis<sup>7</sup>

IIT – Prediction 1: PPC between Fusiform Gyrus and V1/V2 for Faces (AT-Seen-go Only); No Findings for Objects



IIT – Prediction 2: PPC between Fusiform Gyrus and V1/V2 for Objects; No Findings for Faces

## Conclusions

Activation results from both MEG & fMRI support GNWT's predictions (although these were pre-defined as non-critical for theory testing).

Synchronization results from MEG & fMRI challenged both theories, as the predicted patterns were only found in some specific conditions.

## References

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Pre-registration



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