



Local neural dynamics and large-scale network interactions in visual conscious perception



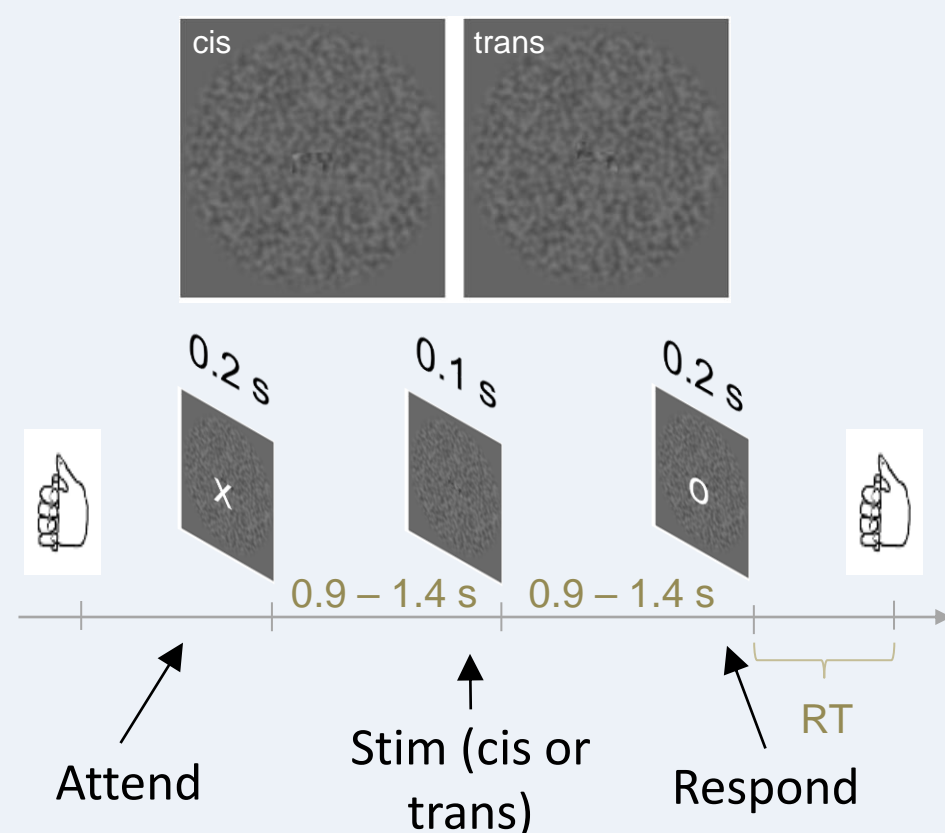
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How are neural processes coordinated to allow visual conscious perception?

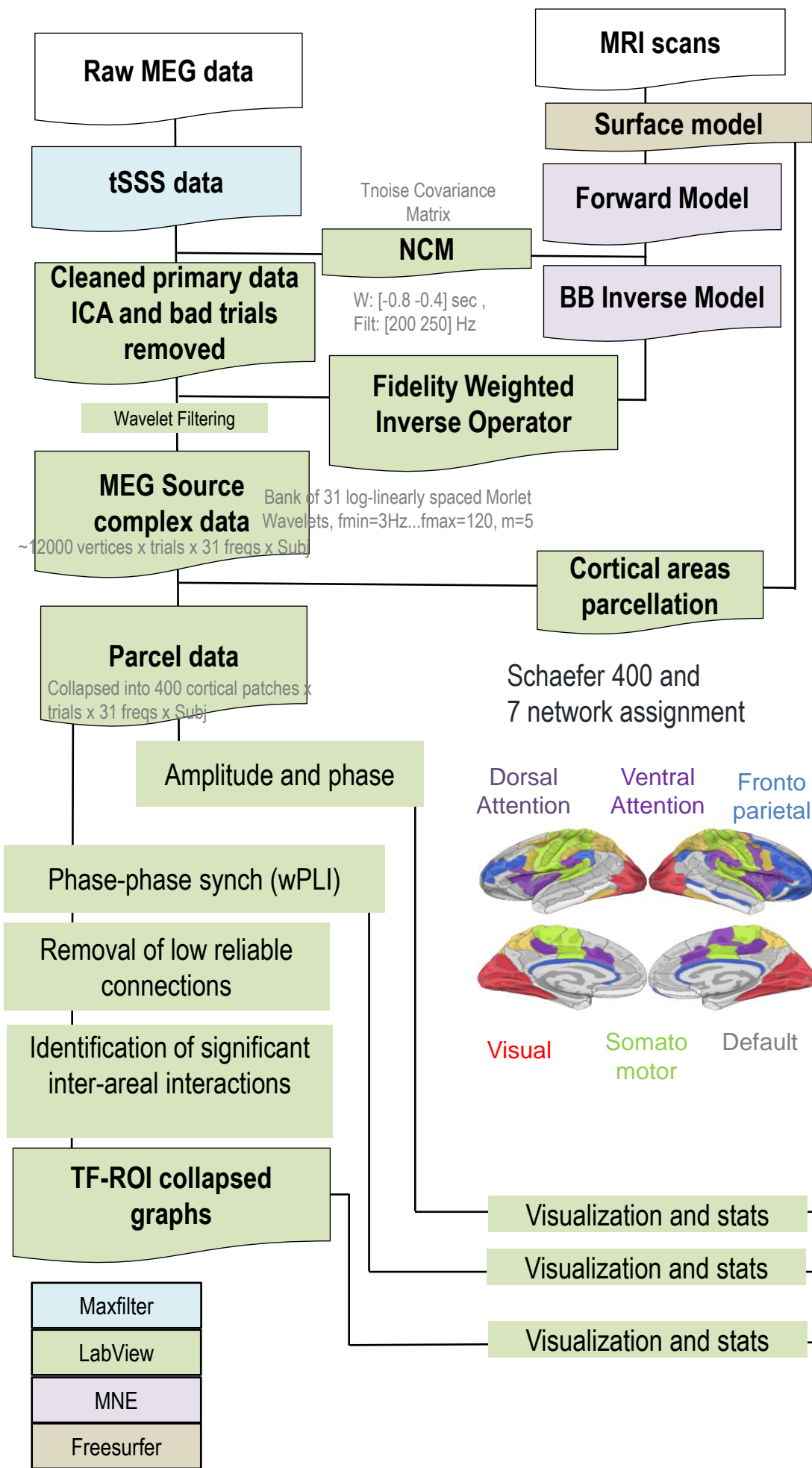
We propose large-scale network synchronization as the mechanism underlying visual awareness. Furthermore, our study contributes to the debate of whether conscious perception relies on posterior cortical zones or necessarily requires the prefrontal cortex (PFC)

Our experimental design

14 participants undertook a continuous performance task (CPT) with simultaneous magnetoencephalographic recording. A stream of visual stimuli was presented at the verge of consciousness in well controlled conditions, where confounds related to attentional- and post-stimulus-processing have been accounted for. Participants indicated if a stimulus was perceived by lifting their thumb from a response pad

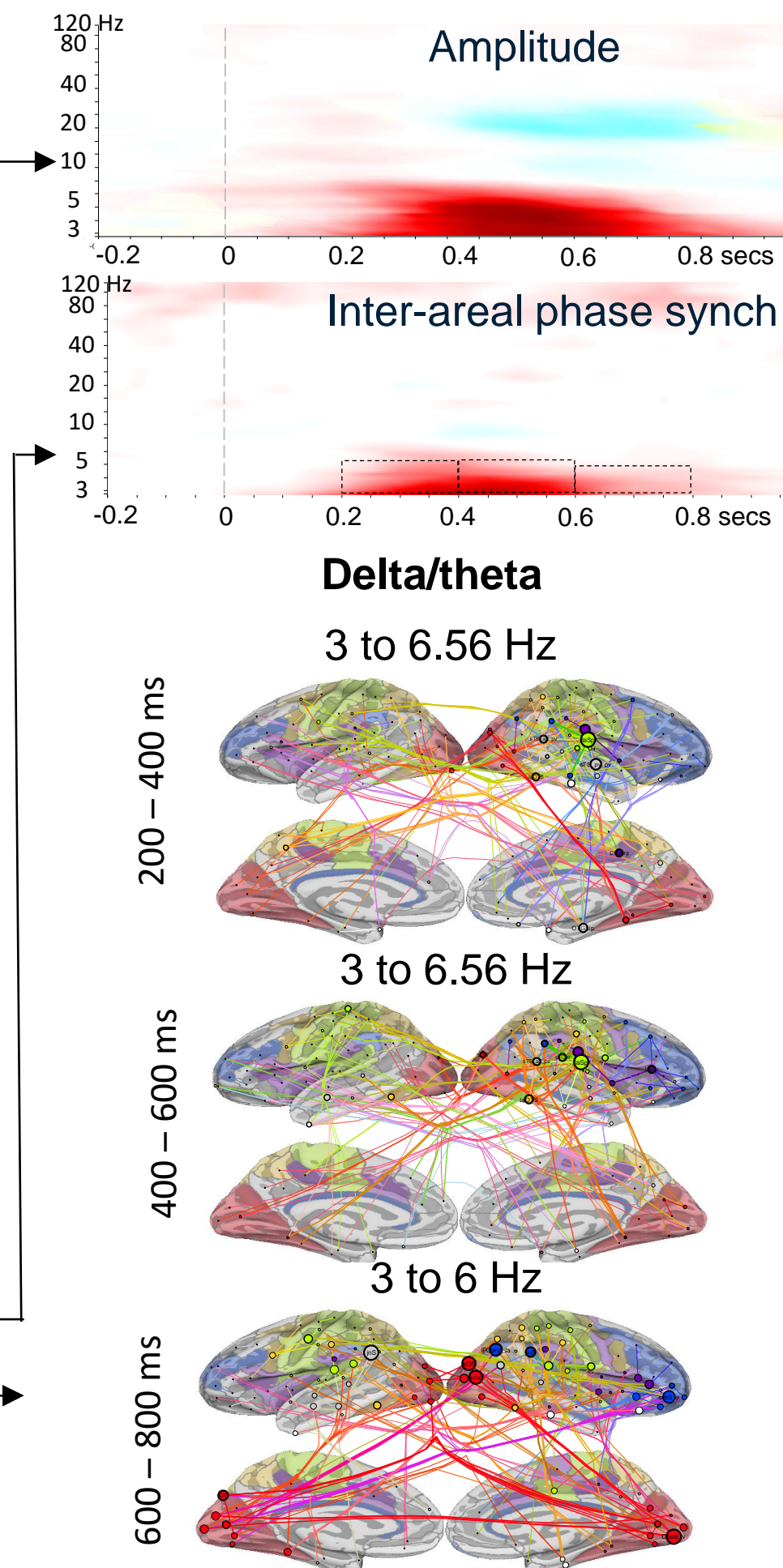


Data processing



Results

All figures show SEEN minus UNSEEN stimuli



Enhanced amplitude of theta oscillations and stronger alpha/beta suppression are correlated with conscious perception.

Red colors represent the fraction of cortical parcels where the amplitude of SEEN stimuli was greater (P+) compared to UNSEEN stimuli (Wilcoxon signed rank test, p < 0.05, FDR corrected). Blue colors represent stronger amplitude suppression (P-)

Strong delta/theta band inter-areal phase synchronization characterizes visual conscious perception, while it is absent for UNSEEN stimuli.

Time frequency plots of significant inter-areal phase synchrony, the extent of synchrony was estimated with wPLI. K represents the connection density, which is the proportion of significant inter-areal interactions from all possible pairwise interactions among the 200 brain areas in our cortical parcellation. Red colors represent stronger (K+) synchronization for SEEN stimuli

Large scale inter-areal phase synchronization networks of theta and alpha band oscillations for SEEN minus UNSEEN stimuli (see TF-ROI in inter-areal synchronization plot)

Estimated with wPLI and displayed on inflated cortical surfaces. Edges are amongst the 600 highest Edge Eigenvector Centrality (ECV) edges. Nodes size reflects node ECV and colors represent the different brain systems indicated at the bottom of the figure. Thickness of the lines represent the strength of the connections.

- Large-scale synchronization in the delta/theta band between visual areas and fronto-parietal regions is stronger for SEEN stimuli shortly after stimulus onset.
- Synchronization between visual areas and fronto-parietal networks seem to decay between 400 and 600 ms to increase again at later stages of the stimulus-processing.
- This controlled experimental conditions show the involvement of the prefrontal cortex at early stages of the stimulus processing. Therefore, its involvement is likely related to the actual perception of stimuli and not a confounding produced by postperceptual, cognitive processes related to sensory content or attention.
- We have replicated these results in a task condition that only controls for postperceptual cognitive processes (n=13), data not shown here

In conclusion, our study confirms that large-scale network phase synchronization across distributed brain regions is the mechanism underlying conscious perception. In addition, our results provide support for the GNW theory, that predicts early synchronization between the PFC and posterior brain regions (ignition) together with wide-spread network synchronization involving posterior regions (information broadcasting across the network).

Work in progress, we are currently recruiting more participants and performing more analysis on this data