Oscillation-based connectivity is dominated by an intrinsic spatial organization; not mental state or frequency

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Introduction

- Spatial organization of fMRI-based FC is largely stable across mental states (i.e. *state-invariant*).
- While fMRI measures infraslow hemodynamic changes of the brain (~<0.1Hz), neural activity itself emerges as fast oscillatory signals over a wide range of frequency.
- Given the rapid and malleable nature of oscillation-based FC, we aimed to answer the following four questions:

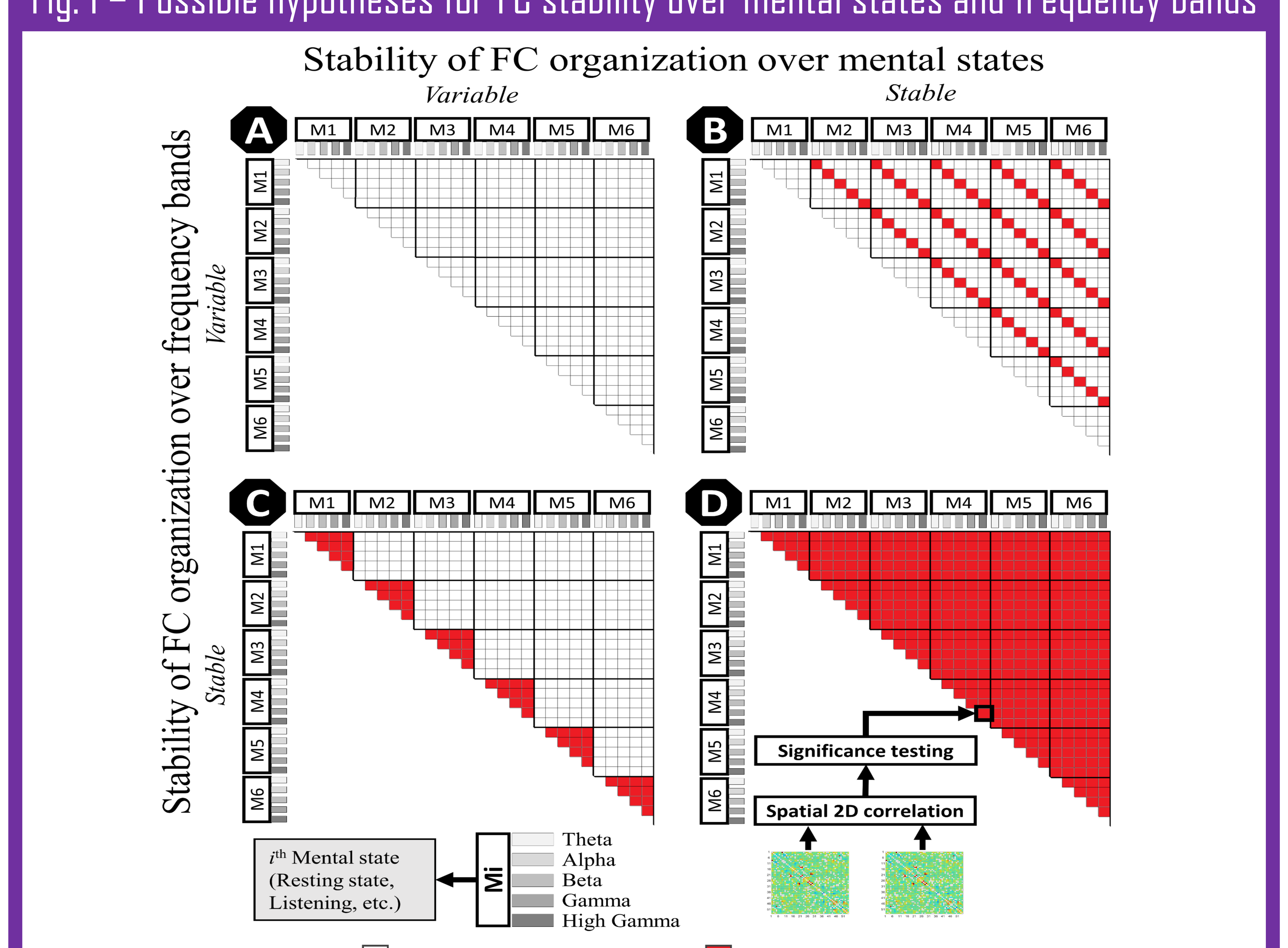
(1) Is fast oscillation-based FC primarily driven by cognitive operations or is it stable across mental states?

(2) Is the spatial organization of oscillation-based FC dependent on oscillation frequency?

(3) Does such frequency-independence reflect a single broadband coupling process or multiple frequency-specific processes?

(4) Do the above observations hold for both phase- or amplitude coupling?

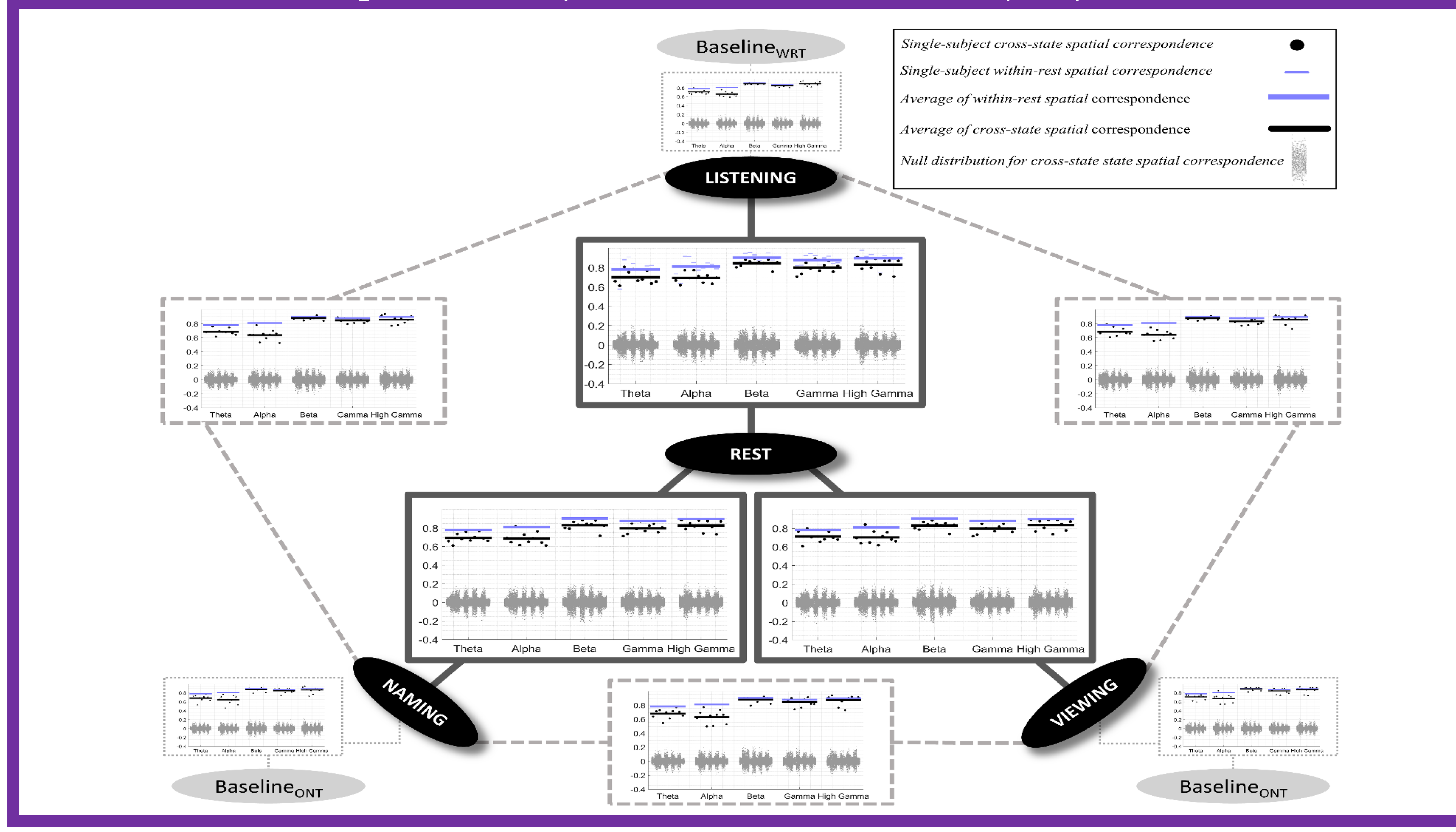
Fig. 1 – Possible hypotheses for FC stability over mental states and frequency bands



Oscillation-based FC is stable over mental states

Static FC has a state-invariant spatial organization in each frequency band.

Fig. 2 – FC stability across mental states in each frequency band



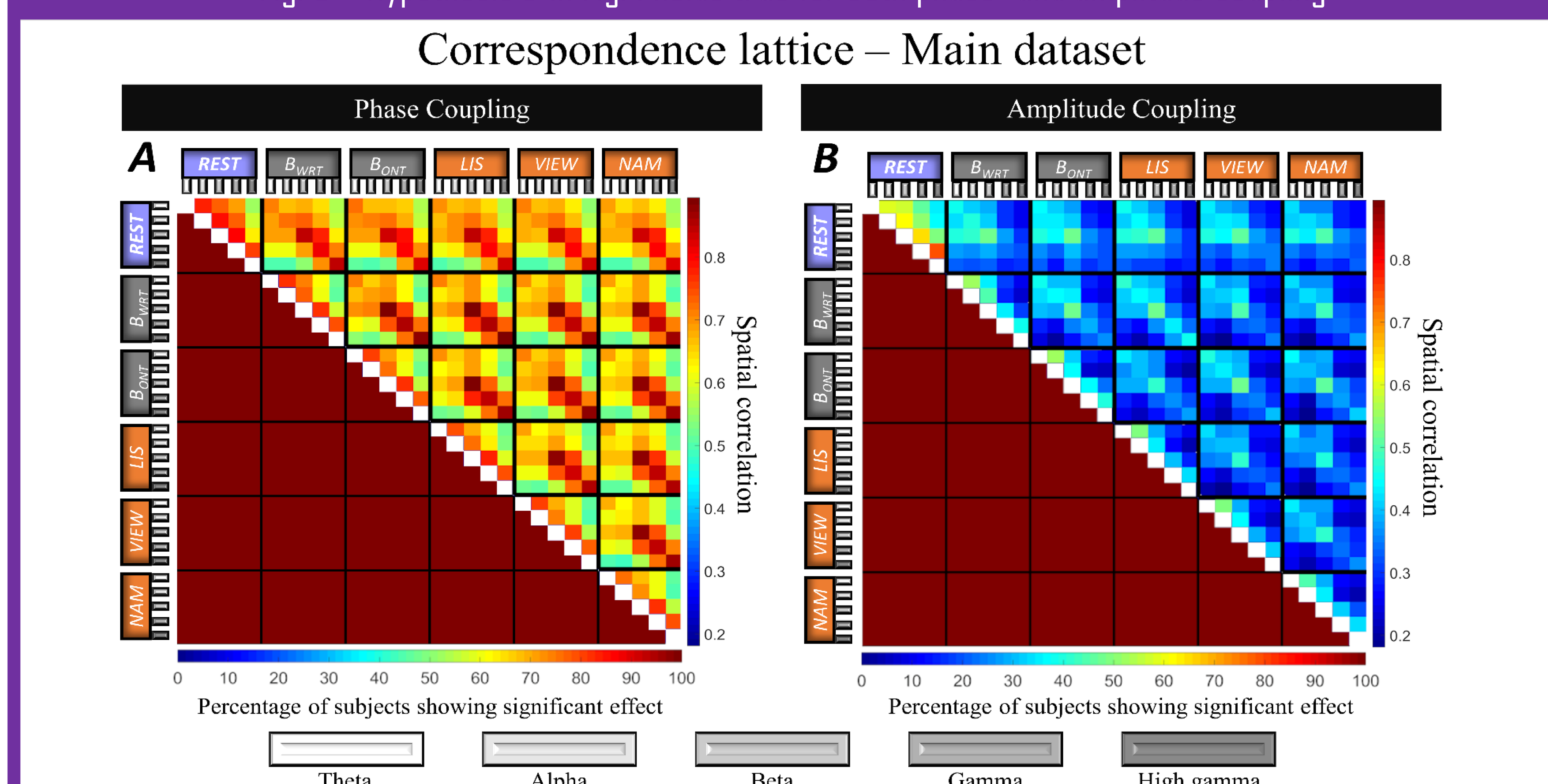
Intrinsic oscillation-based FC is stable over frequencies

The state-invariant FC organization is shared across all frequency bands.

Intrinsic oscillation-based FC governs both phase- and amplitude coupling

Spatial organization of both phase- and amplitude coupling show mental state invariance and frequency invariance.

Fig. 3 – Hypothesis D in Fig. 1 holds true for both phase- and amplitude coupling



Conclusion

The spatial organization of oscillation-based FC is primarily intrinsic in nature, shared across frequency bands, and largely stable over mental states.

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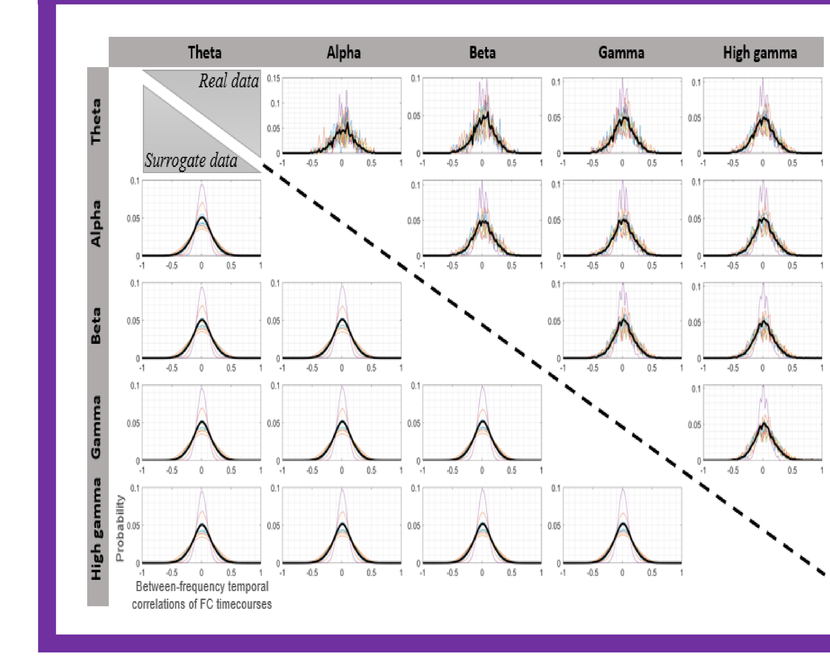
Independent FC dynamics across frequency bands

Dynamic FC analysis revealed that the frequency-invariant spatial organization of FC is not driven by broadband coupling processes. Despite, multiple frequency-specific and temporally-independent coupling processes underly the state- and frequency-invariant FC organization.

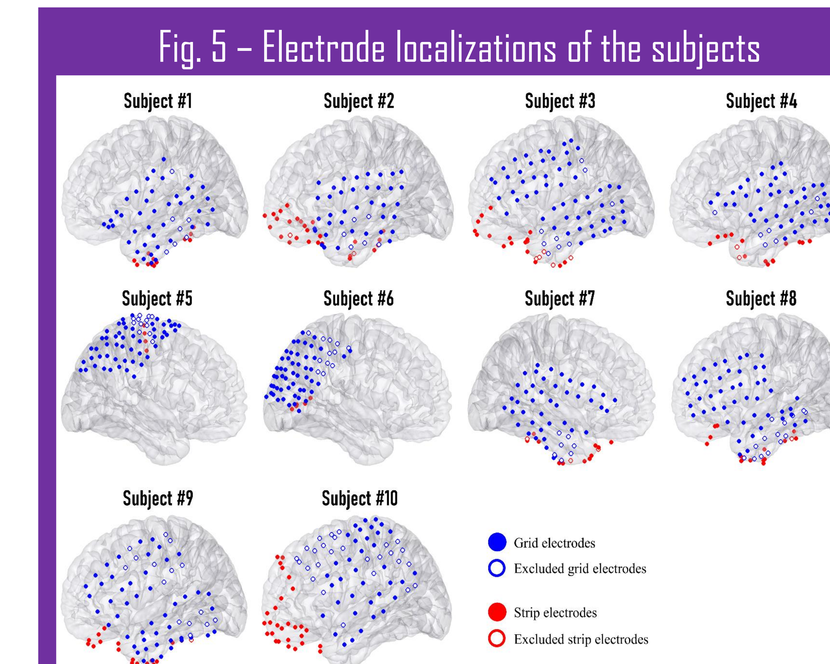
Fig. 4 – Frequency-specific FC dynamics observed within the intrinsic FC and across frequency bands



Methods

We used electrocorticographic (ECoG) recordings of 10 presurgical patients (Fig. 5) during rest and different cognitive tasks like viewing objects, and etc. (i.e. mental states). We used PLV as the measure of phase coupling over 5 canonical frequency bands: theta, alpha, beta, gamma, high gamma. For each mental state and frequency band, we estimated FC across all electrode pairs. To assess stability over mental states or frequency bands, 2D Pearson correlation was calculated between the corresponding pair of FC matrices of each subject independently. We replicated the results in amplitude coupling measure of FC. To investigate temporal dependency of time-varying FC between different frequency bands, we estimate FC dynamics of resting state data per the sliding window approach.

Fig. 5 – Electrode localizations of the subjects



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