Parsing mPFC: A Joint Meta-Analytic and Graph Theoretic Approach

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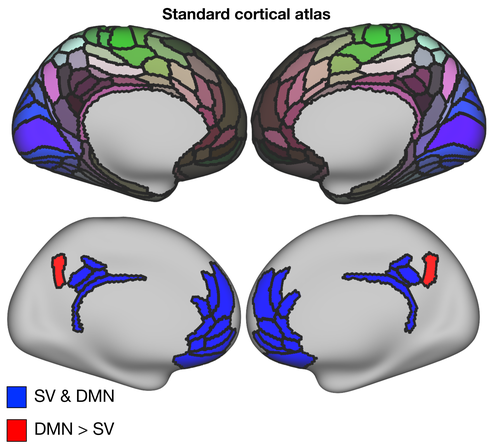
Introduction

- The spatial extent of subjective value (SV) effects is mostly indistinguishable from the default mode network (DMN) in existing meta-analyses.
- But little is known about the degree of heterogeneity in the intrinsic functional architecture of mPFC across individuals.
- Here we complement a meta-analysis with fMRI-based graph theoretic tools to subdivide mPFC and PCC into DMN/non-DMN at the single subject level.

Methods

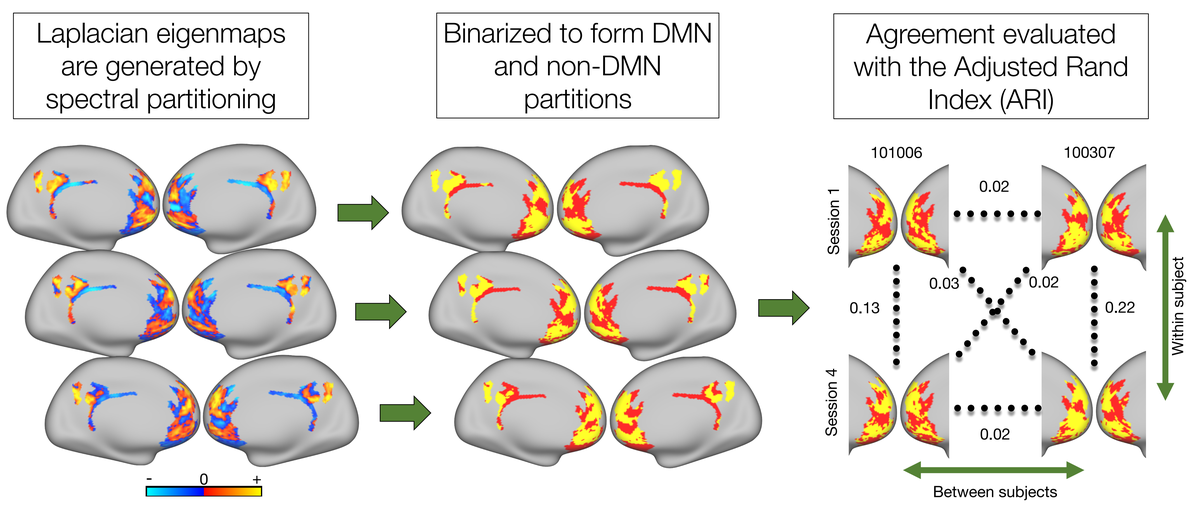
Surface parcel-based meta-analysis

- Volumetric coordinates extracted from studies of valuation (n = 27; Bartra et al., 2013) and DMN (n = 77; Laird et al., 2009).
- 10mm spheres per coordinate were projected onto a surface model and mapped to a standard cortical atlas (Glasser et al., 2016), giving the number of times each region was reported in each literature.
- Permuted χ^2 prop tests were used to identify overlapping and unique ROIs between literatures.



Graph-theoretic community detection

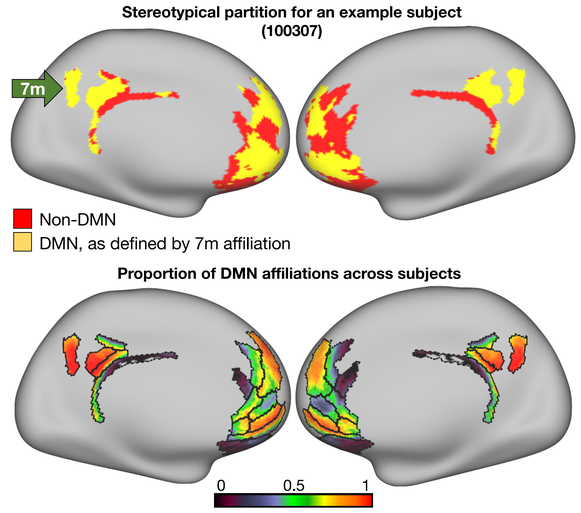
- Resting-state fMRI data from the Human Connectome Project (Van Essen et al., 2013):
  - 100 subjects x 4 sessions x 1200 TRs.
- Subject networks: ROI vertices as nodes (n = 5081), and Pearson correlations of activity in every pair of nodes as edges.
- Community: Strongly interconnected groups of nodes that are sparsely connected with other clusters.
  - Estimated through spectral partitioning, and validated with modularity (high agreement across methods: M=0.85, SD=0.1).



Results

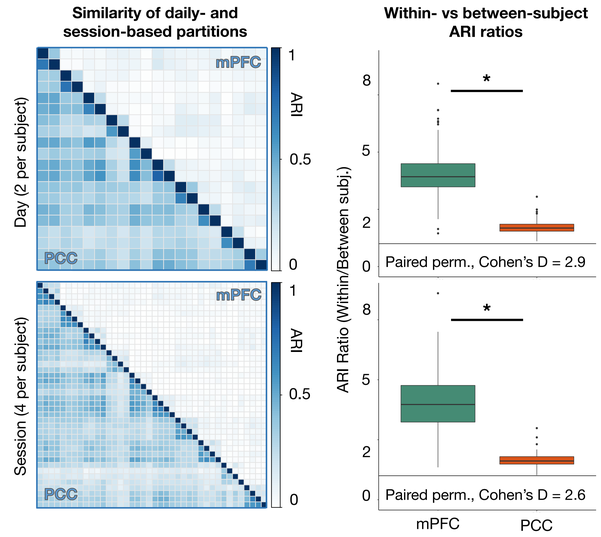
Community detection

- DMN shows dorsal and ventral mPFC coverage, with non-DMN areas in pregenual ACC and OFC.
- Greater alignment across subjects in PCC than in mPFC.
  - PCC: M=0.43, SD=0.1
  - mPFC: M=0.11, SD=0.1
- Spatially averaging the binarized maps reveals both a common topographic structure and individual heterogeneity.



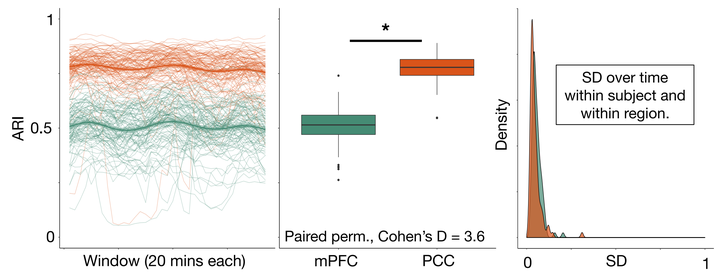
Test-retest reliability of individualized patterns

- Each day and session was analyzed independently.
- The mean ARI of within-subject patterns was markedly higher than across subjects, and this ratio was significantly higher for mPFC.
- This indicates that mPFC organization is idiosyncratic across individuals.



Pattern stability over time

- Sliding window analysis shows stable agreement with overall pattern across individual time series, but lower for mPFC.



Conclusions

- Functional topography of mPFC has substantial variability across individuals.
- Spectral partitioning captures stable individualized functional organization even with small amounts of data.
- Meta-analytic overlap does not necessarily signify that SV and DMN functions share a common cortical substrate.

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