Individual Variability in Functional Connectivity is Lower During Movie-Watching Compared to Rest

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Introduction

- The lack of control over the cognitive state of the participants in Resting-State (**RS**) functional Magnetic Resonance Imaging (**fMRI**) studies may result in high intersubject variability in estimates of Functional Connectivity (**FC**)[1].
- High intersubject variability limits the sensitivity of this approach to abnormalities (i.e., for clinical applications).
- Watching engaging movies in the scanner synchronizes the audio-visual sensory input and participants' cognitive states over time[1, 2].
- This may result in lower individual variability in FC in the Movie Watching (**MW**) task compared to the RS paradigm; rendering movie watching a potentially more sensitive method to index abnormalities in FC resulting from neurological conditions.

Materials and Methods

Participants and Scanning

- *79* young (*22 - 35*), healthy, and unrelated adults (*F = 41*) from the Human Connectome Project (**HCP**) S1200 release[3, 4].
- All data was acquired by a Siemens Magnetom *7T* MR scanner with *TR = 1000 ms* [3, 4].

Conditions

- **RS**: *4* sessions of *~15 min* resting state with eyes open
- **MW**: *4* sessions of watching short independent films and Hollywood movie excerpts
  Each session included *4* or *5* movies, each *64 - 259 sec* long.
  Movies were interleaved with resting periods of *20 sec*. } *~15 min/session*

Preprocessing and Parcellation

- Data was preprocessed with the HCP ICA-FIX preprocessing pipeline, including registration to FSLR template[5-7].
- The *360* cortical Regions Of Interest (**ROI**s) of the Glasser parcellation[8] were used for a region based analysis.
- Volumes corresponding to the *20 sec* resting periods in MW sessions were removed from the analysis, using a *6 sec* lag reflecting the latency of the canonical hemodynamic response function.

FC estimation and Model

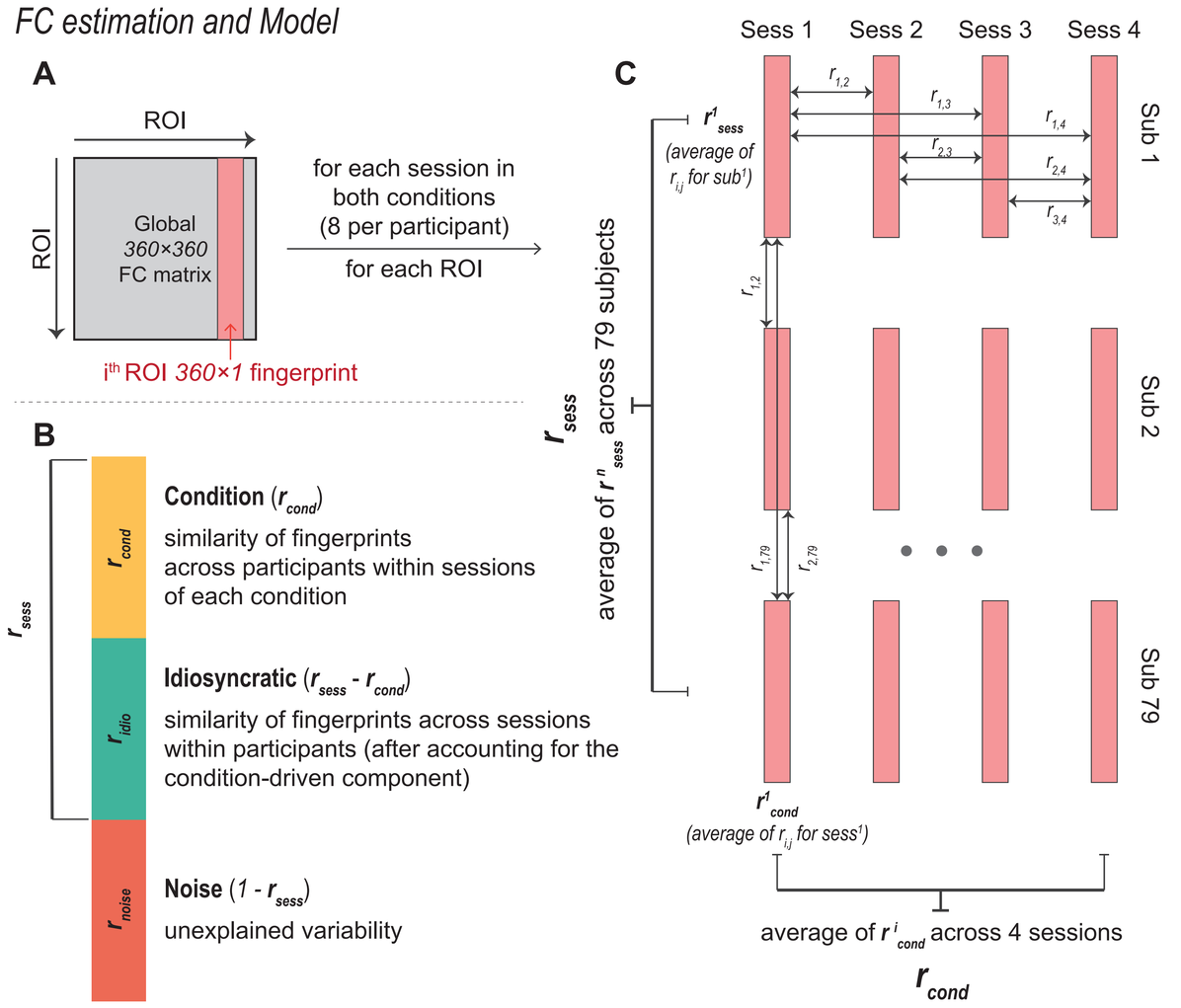

Figure 1. A. FC matrices (one per session per task; 8 per participant) were created by correlating (Pearson) pairs of ROIs[8] to index, for each ROI, the whole brain connectional 'fingerprint'. **B.** The model and the definition of the components contributing to FC variability. **C.** Variability accounted for by the effect of condition (MW vs RS), was estimated (for each ROI) by correlating fingerprints pairwise across participants, separately for each session. The pairwise correlations were averaged within session, and then these average correlations were averaged across sessions to create a single correlation value for each of the 360 ROIs (r_{cond}). Variability accounted for by individual differences (idiosyncratic) was estimated by calculating similarity within participants across sessions, (r_{sess}), which includes both condition variability and individual differences. By subtracting r_{cond} from this, we are left with an estimate of idiosyncratic variability. r_{sess} was calculated by correlating (for each ROI) individual fingerprints across the four sessions within each condition (pairwise), and then averaging these, and then taking the grand average across participants.

Results

ROIs in which task condition (MW or RS) accounted significantly for variability in connectional fingerprints

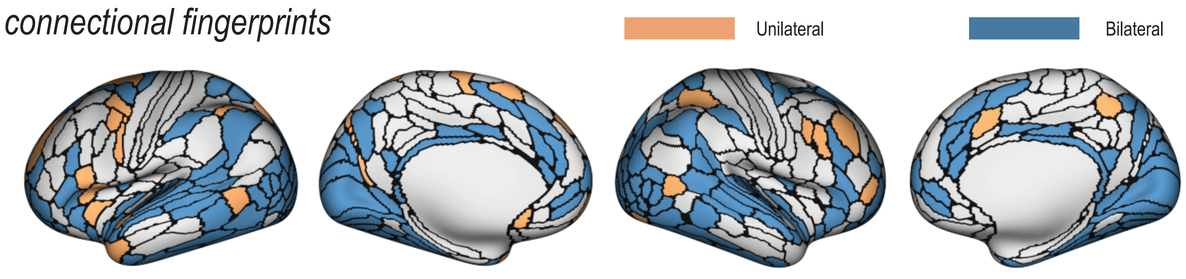

Figure 2. *168* bilateral and *32* unilateral (*200* overall) ROIs with a significant ($p < 0.05$, two-tailed) condition-driven proportion of fingerprint variability in either MW or RS (or both). For each ROI r_{cond} null-distribution was estimated by calculating r_{cond} after permuting condition and session labels.

Model Components' Contribution to FC

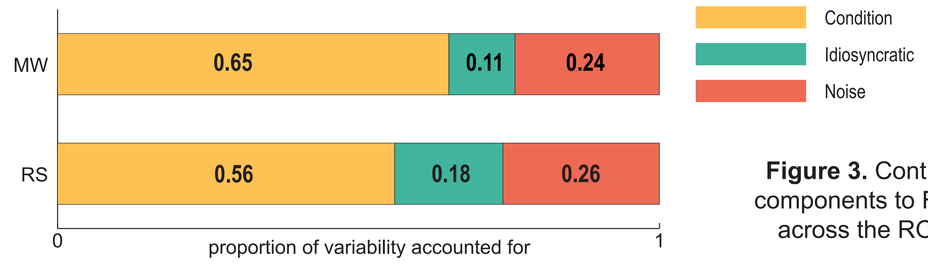

Figure 3. Contributions of the model components to FC variability averaged across the ROIs shown in **Figure 2**.

Components of variability in FC: differences between MW and RS (MW - RS)

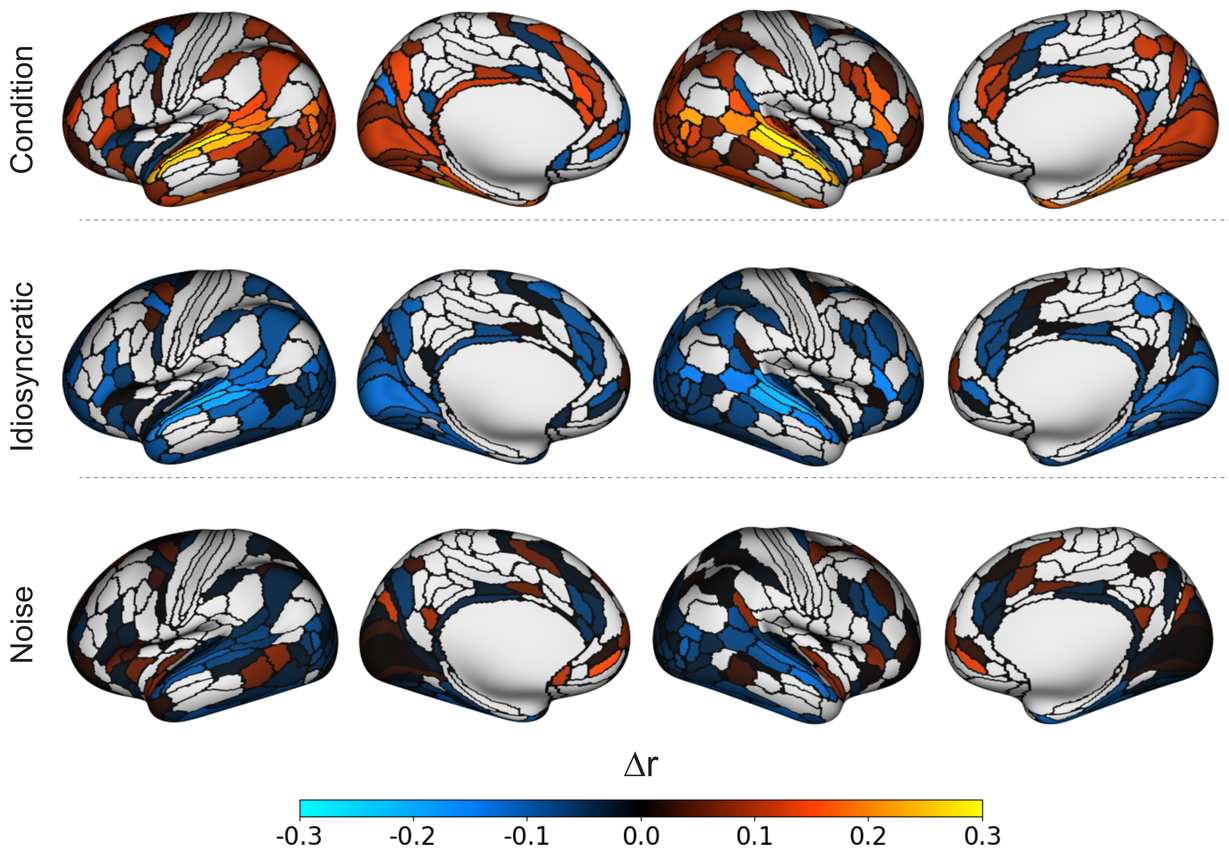

Figure 4. For each component of variability in FC, we subtracted RS values from MW values. The top, middle, and bottom panels correspond to the difference in the proportion of variability explained by condition, idiosyncratic, and noise, respectively. Positive values reflect higher proportions in MW data whereas negative values reflect higher contributions in RS data.

Conclusions

- MW **increases the similarity** of FC among healthy participants (**Figure 4**, top) and **decreases individual variability** (**Figure 4**, middle) compared to RS.
- These effects are most pronounced in **auditory**, **visual**, and **frontoparietal** areas.
- Naturalistic (movie watching) paradigms may be more sensitive to abnormality when assessing FC in clinical groups (at least in the regions highlighted in the top and middle panels of **Figure 4**).

References

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