Modelling similarity statistics in the chronnectome to quantify replicability of dynamic connectivity patterns in 7500 resting fMRI datasets

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Background: Recent studies on characterization of temporal trends in functional network connectivity (FNC) as discrete connectivity states using sliding-window correlation method have been limited to analysis on a single functional magnetic resonance imaging (fMRI) dataset. In this study, we aim to evaluate and quantify replicability of these discrete FNC states by modelling similarity statistics from our dynamic FNC results from multiple age matched datasets each having a large sample size.

Methods: For this study, resting state data from 7500 subjects were decomposed using a higher order group-level spatial independent component analysis (gICA) into different functional networks (components). In the next step, 28 age matched sub-datasets each of 250 samples were decomposed individually and resulting components were matched with the components from the entire dataset. A total of 37 intrinsic connectivity networks (ICNs) were identified common across all decompositions. For all groups, dynamic FNC amongst their respective ICN time courses (reconstructed by gICA back reconstruction) were estimated using a sliding window approach. K-means clustering (k=5) on the resultant windowed component covariance matrices resulted in 5 discrete connectivity patterns for each of the groups. Similar ongoing analysis over a large range of k is expected to demonstrate consistent results. Finally, mapping connectivity patterns across groups using pairwise Manhattan distance, similarity statistics like average states, one-sample t-test, cross-correlation, percent state occurrence times modeled with time, distribution of the state dwell times, and average state transition probability matrices were computed to quantify replicability of the state properties across groups.

Results: For all groups, the sliding window analysis revealed states with variable but structured FNC patterns (e.g. strongly correlated or anti-correlated). Cross-correlation analysis revealed high correlation numbers with the 25th percentile correlation values being greater than 0.75 in 4 out of the 5 states. The occurrence frequency of these patterns with time increased for 3 states suggesting these states become more active the more time one spends in rest, and decreased for the other 2 states suggesting decrease in activity over time. Results suggest certain state transition probabilities with higher mean and lower standard deviations are more consistent and reliable.

Conclusions: Although resting state fMRI is a highly unconstrained experiment, high cross-correlation numbers between mapped connectivity patterns suggest high reproducibility of the connectivity patterns across independent groups. Percent occurrence across states is highly variable, and shows that transitions between states occurs commonly in rest. Ongoing work continues to characterize these underlying networks in more detail.