

Assessing the Reproducibility of Dynamic States of Individual Brain

Functional Parcels

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Introduction

The complex spatiotemporal organization of the brain can be summarized using brain parcels, based on several minutes of fMRI signal. However, the brain has been observed to slowly reconfigure over seconds (Salehi et al., 2018). Thus, we hypothesize the existence of several discrete modes of functional parcellations at finer time scale. Here, we suggest a new approach to capture these dynamic states of brain parcellations.

Methods

Our dynamic states parcellation approach at the subject level for resting-state fMRI signal consists on: first, generating group parcellations (Urchs et al., 2017), and extracting the medoid coordinates for each parcel. For a given subject, we generate several sliding window parcels using the the ward hierarchical clustering algorithm. Then, for a given medoid, we compute a similarity matrix between the dynamic parcels associated with that medoid using the Dice score. The third step is to use this matrix as input for the ward hierarchical clustering algorithm, and group dynamic parcels into "states". The average of all the parcels that have been associated to a particular state represents its probabilistic spatial map.

Results

To assess the intra-subject reproducibility, we divided the test-retest Midnight scan club sessions into two independent sets for each subject. This dataset is composed of 10 subjects, 10 sessions for each subject, and five hours of resting state fMRI data. Here, we matched probabilistic maps of four states based on a maximized pearson correlation score for three subjects. We found different distribution of reproducibility scores across the brain regions. For example, the motor region has high reproducibility scores for all states (i.e., dice scores within [0.65 .. 0.9]). However, the salience network has different distribution of values across states (i.e., dice scores within [0.3 .. 0.7]). In the case of DMN, most of the DMN regions had high scores of reproducibility for all states across subjects (e.g., the dorsal ACC (left) and the IFG triangular part (right) had dice scores > 0.5). Within the DMN, the posterior MTG (right) had the lowest scores across states [0.3 .. 0.6].

Conclusion

Here, we have proposed a new approach to identify dynamic states of parcels. We have found that the distribution of reproducibility scores for these dynamic states is different across regions.

References

1. Salehi, M., Greene, A., Karbasi, A., Shen, X., Scheinost, D., Constable, T. There is no single functional atlas even for a single individual: Parcellation of the human brain is state dependent. 2018. doi: <https://doi.org/10.1101/431833>
2. Urchs, S., Armoza, J., Benhajali, Y., St-Aubin, J., Orban, P., Bellec, P. 2017: MIST: A multi-resolution parcellation of functional brain networks. MNI Open Research. 2017