REPRODUCIBILITY OF CONNECTIVITY BASED PARCELLATION: PRIMARY VISUAL CORTEX

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INTRODUCTION

Motivation: In-vivo cortical parcellation based on the brain connectivity structure, as elucidated by diffusion based tractography, has the potential to identify cortical regions with mutually distinct and internally coherent connectivity that are believed to be strongly correlated with the brain function.

Aim: To investigate the stability of parcellation over time and establish a paradigm that can be used to parcellate the brain based on study-specific hypotheses.

Outcome: If parcellation is stable and consistent

- It can be used to define a parcellation profile for a subject and will constitute a first step in quantifying differences between people.
- Any change can be interpreted as pathology induced.

METHODS

- Data: One healthy adult female subject, 3 time points, two weeks apart. 64 directions Hardi images on a Siemens 3T Verio scanner.

- Primary visual cortex (V1) is segmented using Freesurfer [1].
- V1 segmentation is downsampled to 2 mm voxels (480 seed voxels).
- V1 segmentation is registered to other 2 time points.

- WM / GM boundary is downsampled to 4 mm voxels (4900 target voxels)
- WM / GM boundary is rigidly transformed to other 2 time points.

- Probabilistic tractography [2] is performed for all time points and the connectivity profiles are computed.

- Unsupervised spectral clustering algorithm [2] is used on cross-correlation matrix.

- Clusters are compared using normalized mutual information

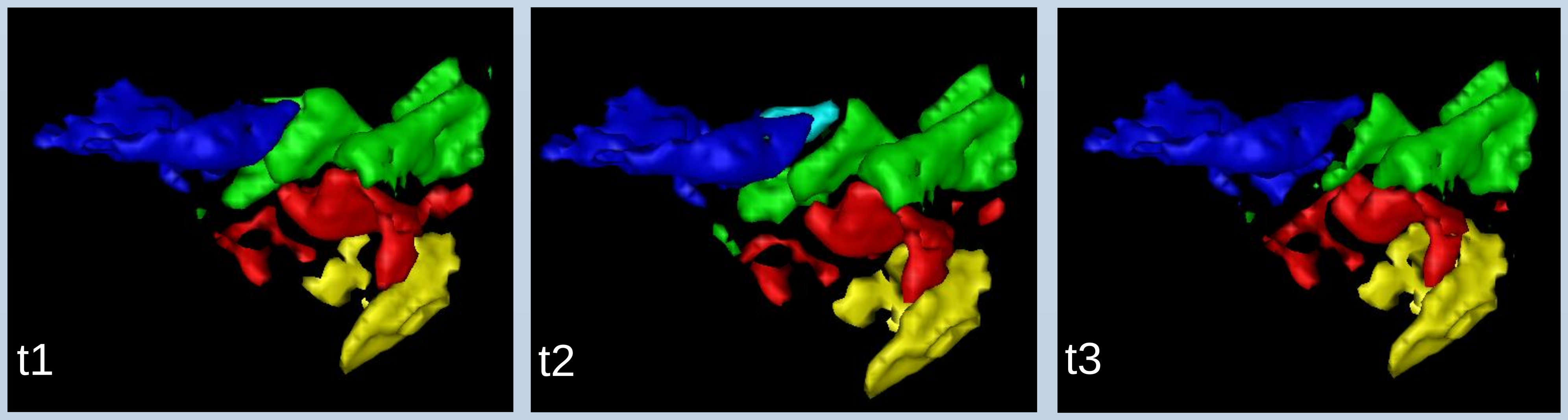

Figure 1: 3D rendering of the clusters for V1 connectivity based parcellation on a sagittal view. Left-right axis is the antero-posterior axis. First and third time points show 4 clusters and the second time point shows an extra cluster.

RESULTS

- Figure 1 shows stability of the clusters across time points (4 clusters for time points 1 and 3 and 5 clusters for time point 2).

- Parcellation of primary visual cortex shows an organization in layers, oriented obliquely from the tip of the occipital lobe towards the antero-superior part.

- The cross correlation matrices exhibit the same size and organization of clusters.

- Results show that the extra cluster of time point #2 is a subdivision of another cluster.

- Mutual information is 0.81 between t1 and t2, 0.77 between t1 and t3 and 0.79 between t2 and t3.

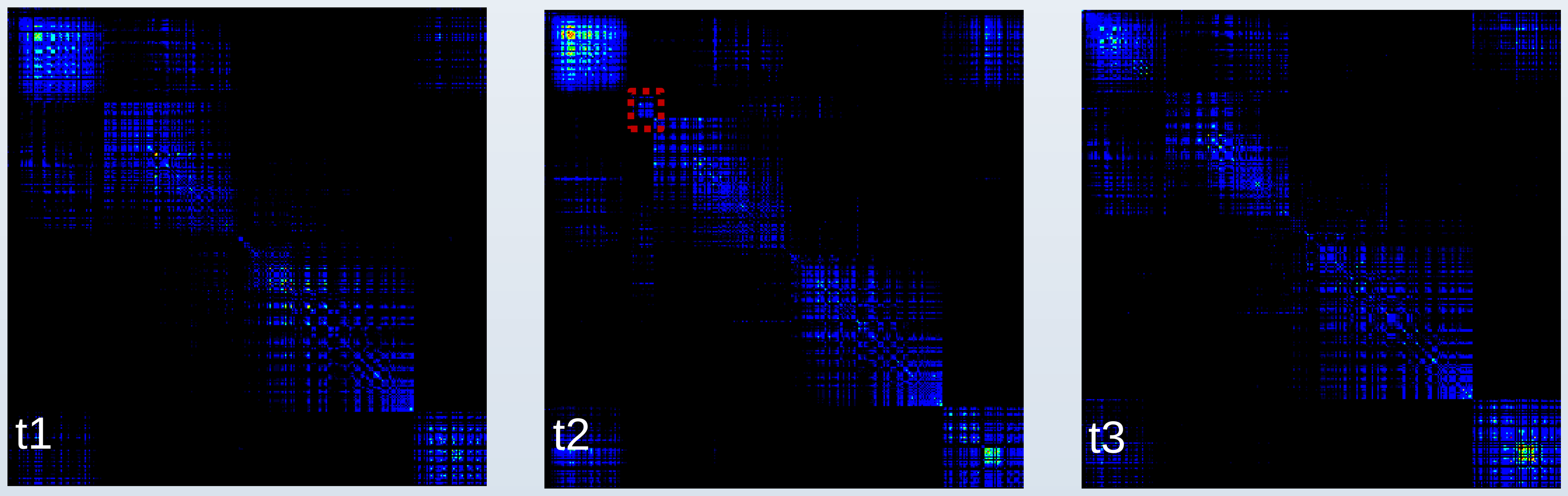

Figure 2 : Cross-correlation matrices of connectivity profiles for the three time points. The extra cluster in t2 (red box) is a subdivision of the second cluster.

CONCLUSION

To the best of our knowledge, this is the first study to test the reproducibility of connectivity based parcellation of the cortex and its application to primary visual cortex. Other techniques were proposed [3-5] to parcellate the brain but none of them have tested the stability of these parcellations over time. The main advantage of this technique is that this paradigm creates connectivity based clusters in an unsupervised manner while other methods need an additional constraint to ensure spatial consistency of the clusters or use supervised clustering methods like *k*-means to obtain a specific number of clusters, which needs to be known a priori. Extension to full brain connectivity parcellation would provide a blue print of a person's brain and will be helpful to diagnose several diseases. Moreover, the process presented in that paper can be used in clinical studies to process hypothesis driven regions to give more insight on connectivity related pathologies.

References [1] Fischl et al. Neuron 33(3) 2002 [2] Behrens et al. Neuroimage 34(1) 2007 [3] Klein et al. Neuroimage 34(1) 2007 [4] Anwander et al. Cerebral Cortex 17(4) [5] Mars et al. Journal of neuroscience 21(11) 2011

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