

A Novel Voxel-Based Approach to Examine Network Plasticity During Recovery from Traumatic Brain Injury

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1. Introduction

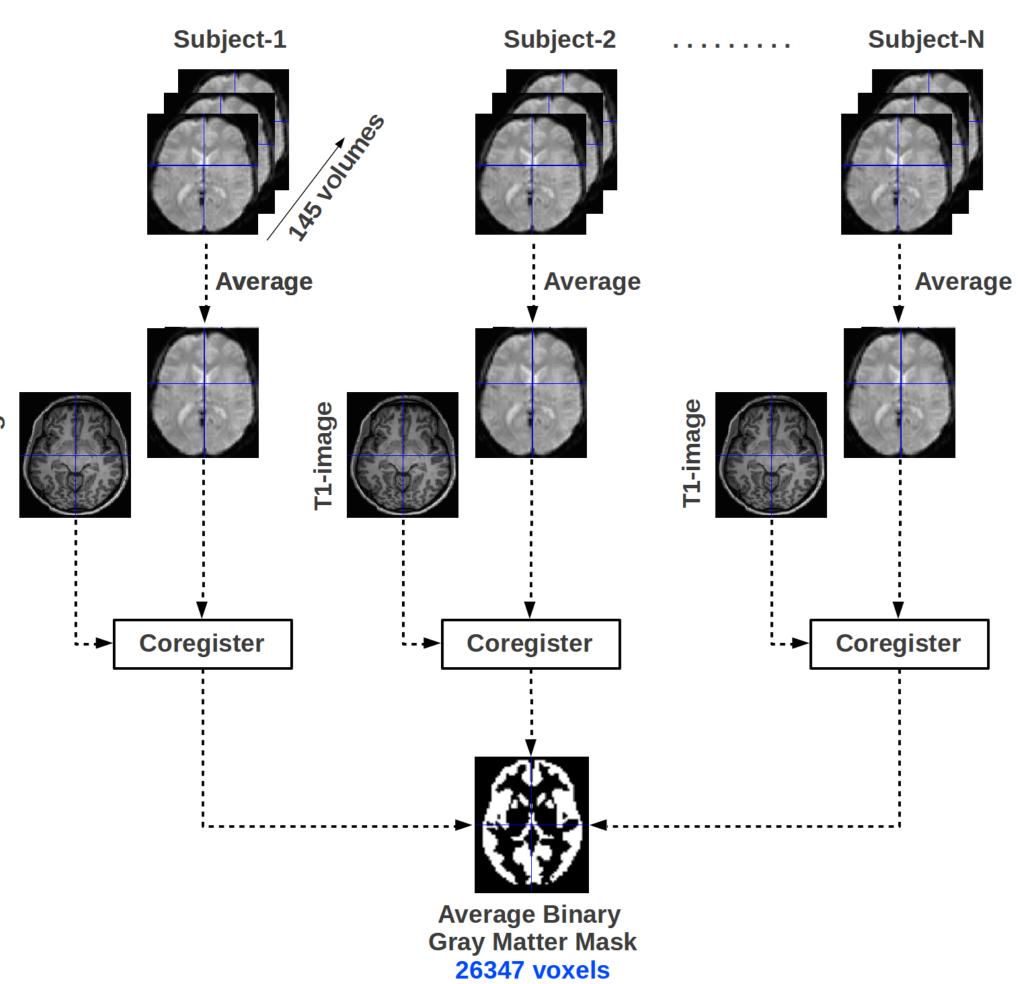
Several studies have confirmed that traumatic brain injury (TBI) leads to altered functional connectivity in the brain. This study aims to understand how functionally connected regional-pairs (FCRPs) in a resting-state network evolve during recovery from moderate to severe TBI. Using whole-brain analyses, we present a data-driven voxel-based approach to discover the FCRPs that distinguish the TBI-subjects from the controls.

2. Subjects

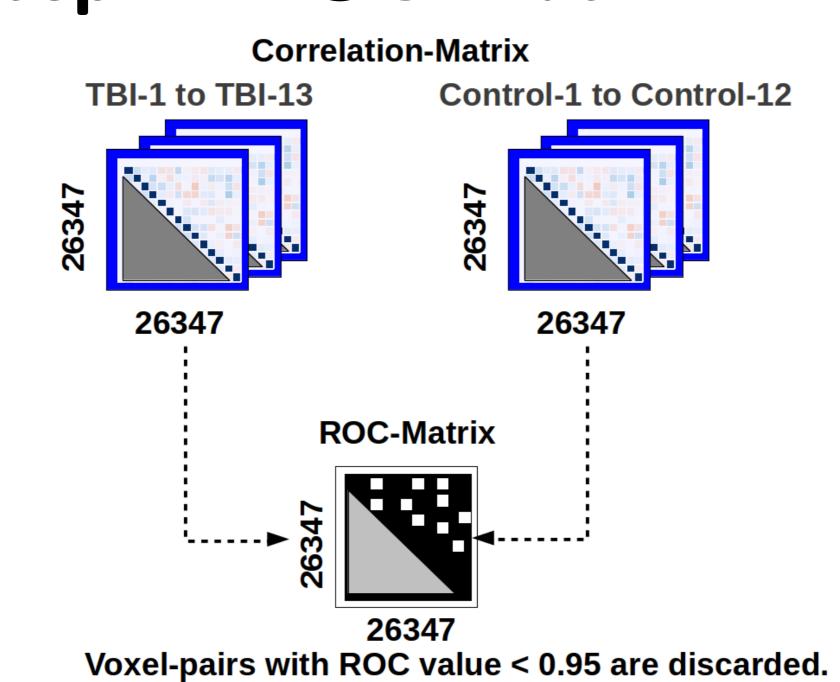
- ▶ Subjects included 13 individuals with moderate to severe TBI between the ages of 21 and 54, and 12 healthy adults with comparable age and education.
- ▶ Individuals with TBI were examined using fMRI at 3, 6, and 12 months following resolution of post traumatic amnesia.
- ▶ The controls were examined at 2 time points separated by 3 months to establish a stable functionally-connected (FC) neural-network; the voxel-pairs for which the mean connectivity strength varied significantly were discarded using t-test.
- ► All functional data were preprocessed using SPM-8 and movement corrected using ArtRepair [Mazaika et al., 2009].

3. Method

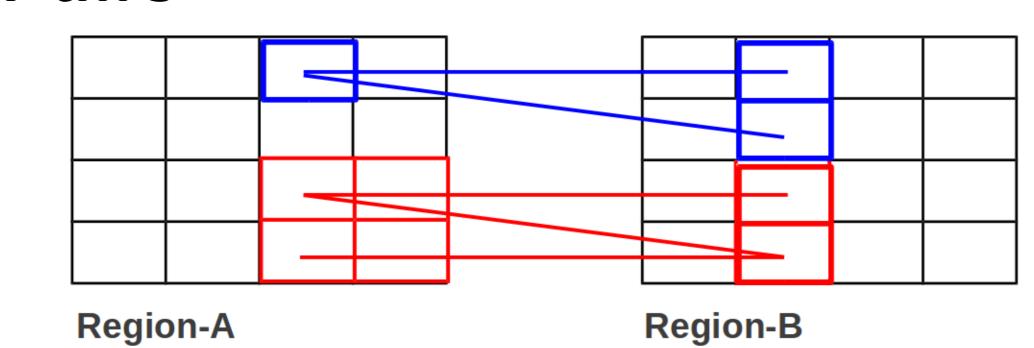
Step-1: Binary Mask



Step-2: ROC Matrix

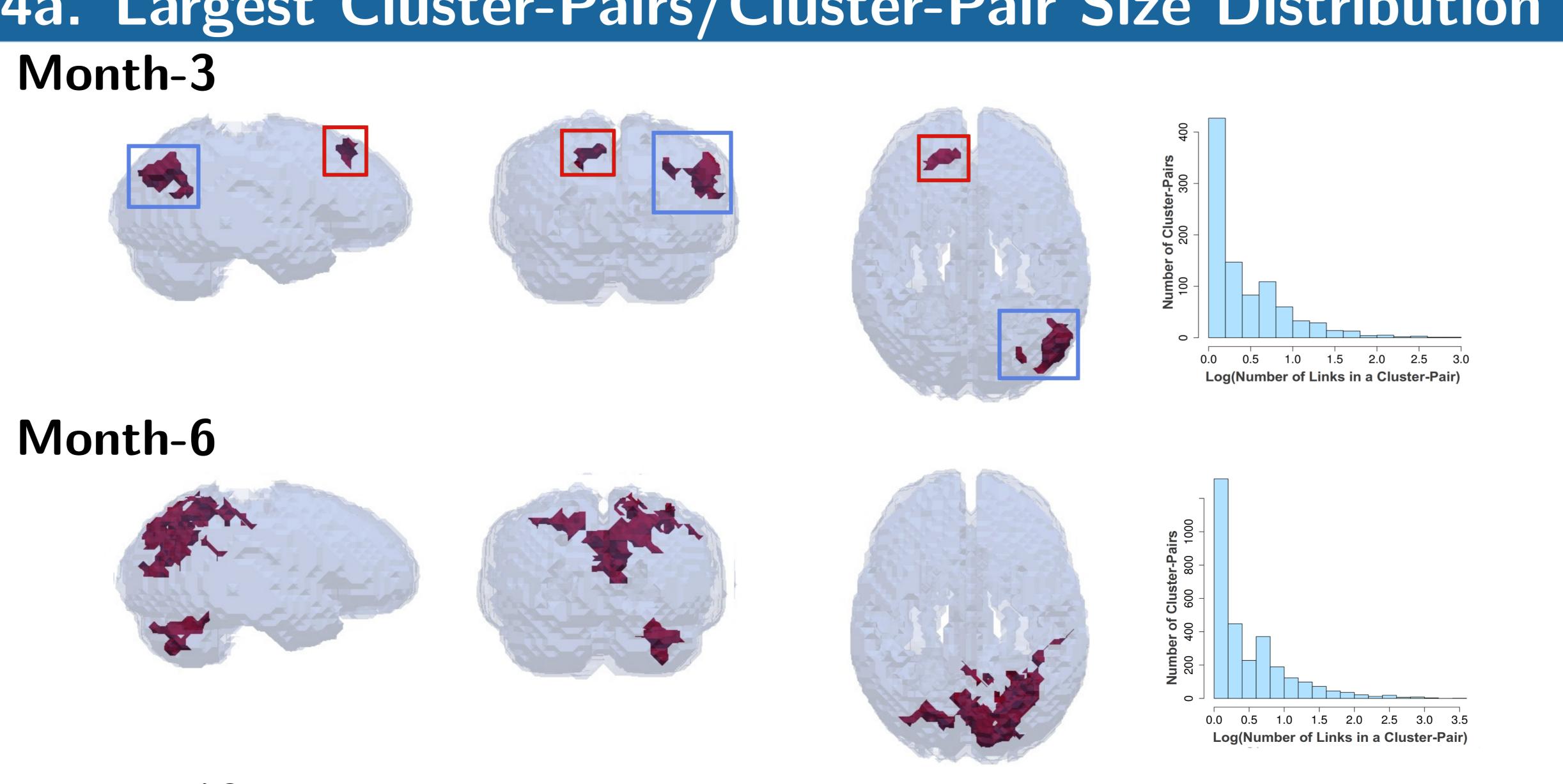


Step-3: Regional-Pairs

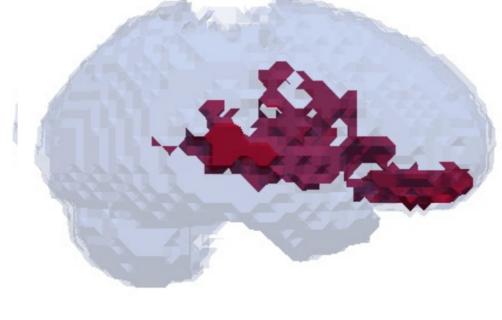


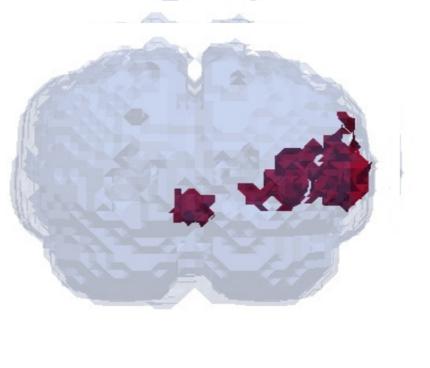
- ▶ The FCRPs were extracted using Zalesky's Spatial Pairwise Clustering (SPC) algorithm [Zalesky et al., 2012].
- ▶ This is a data driven approach and requires minimal prior-knowledge unlike seed and anatomical-atlas based techniques.

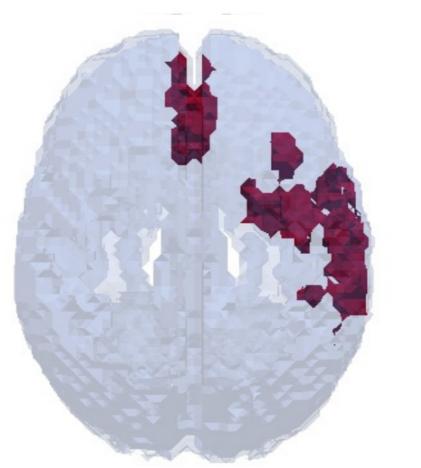
4a. Largest Cluster-Pairs/Cluster-Pair Size Distribution | 4c. Intra-Cluster Homogeneity Analysis

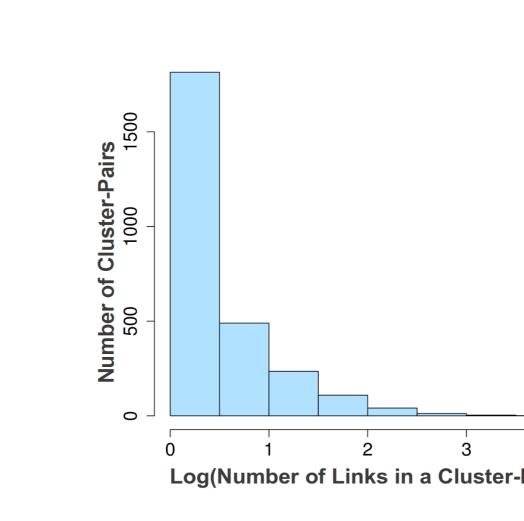




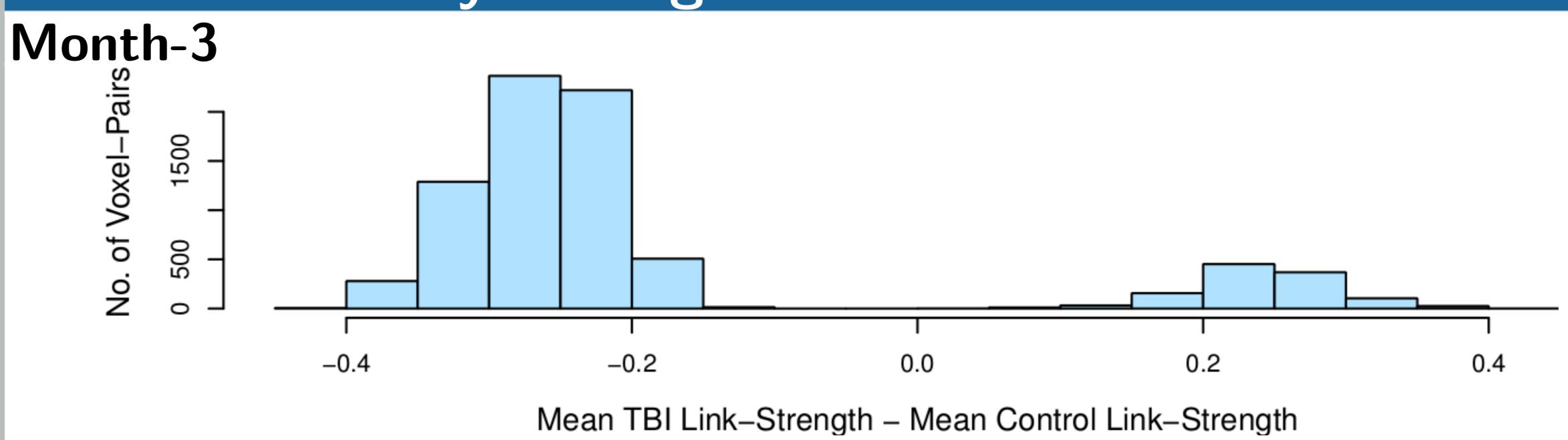


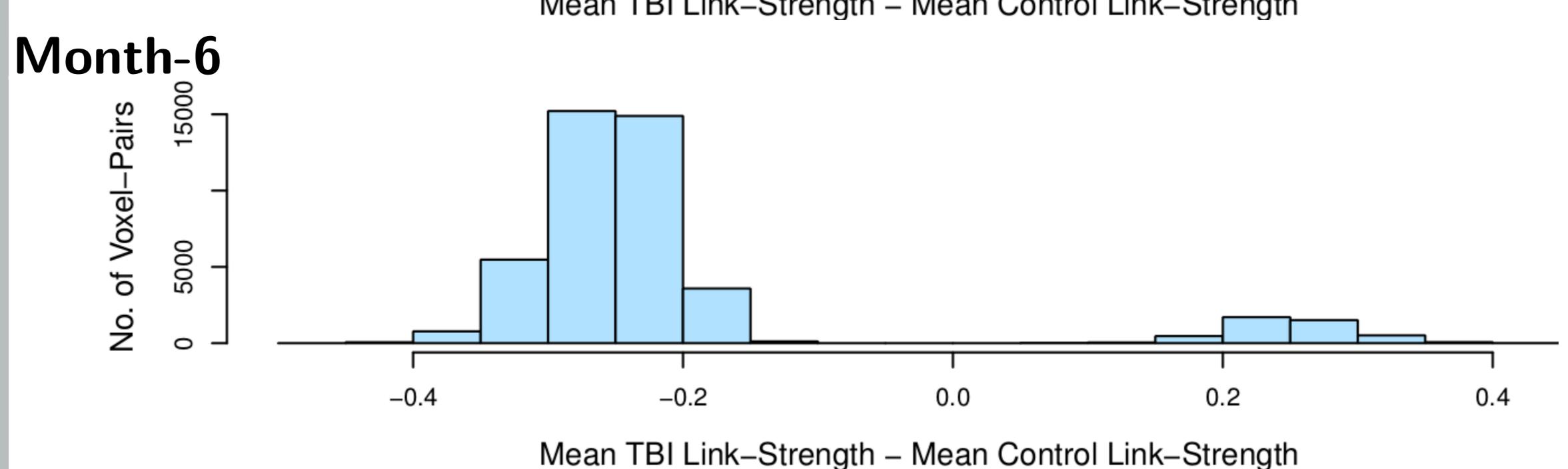


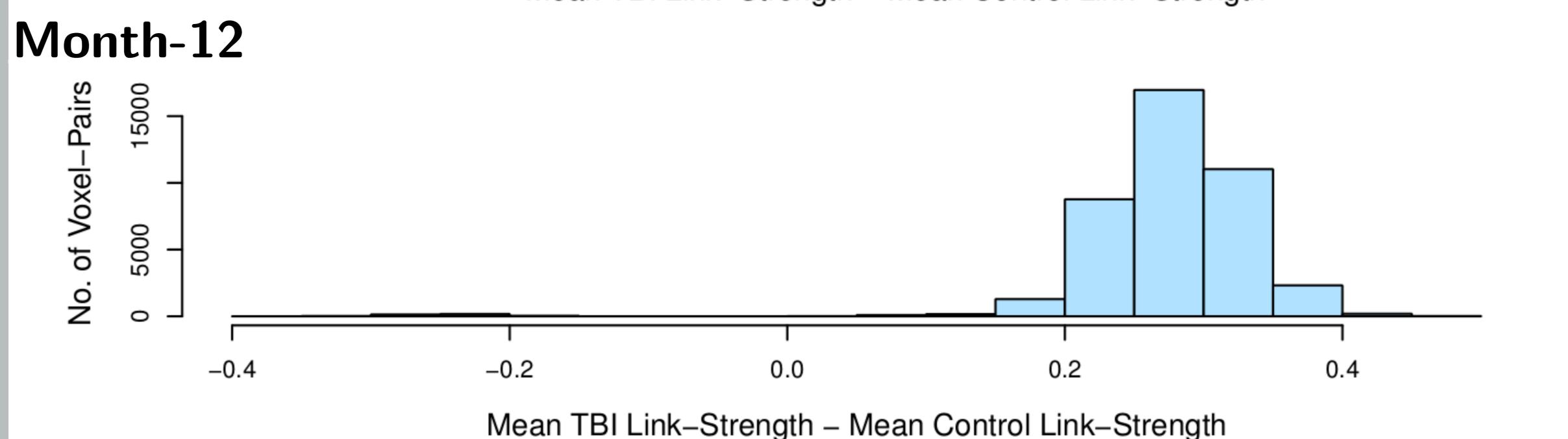


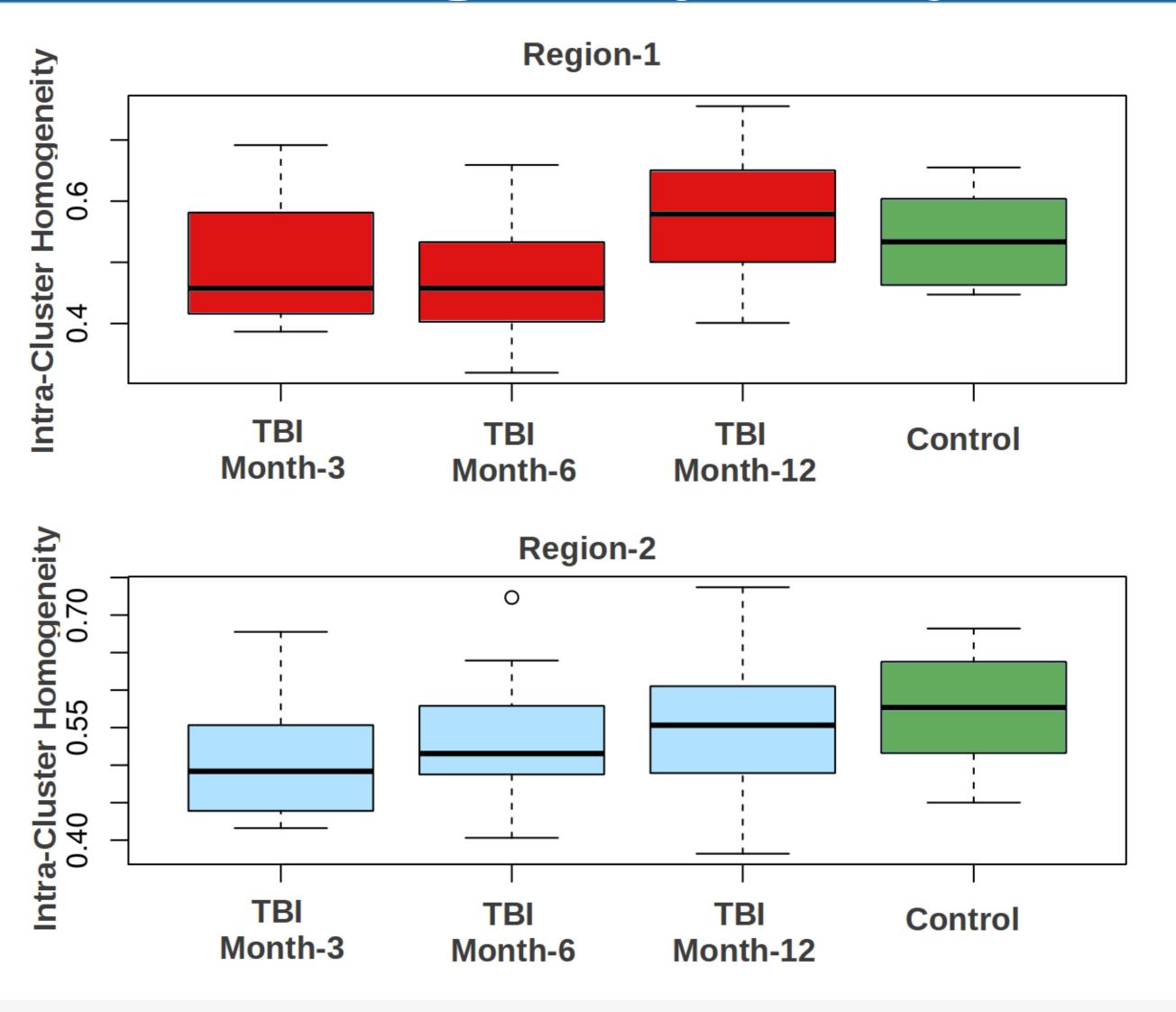


4b. Connectivity Strength









▶ The above figure shows the change in the intra-cluster homogeneity of the largest cluster-pair found at month 3 (See Box-4a) during recovery-period.

5. Conclusion

- A novel voxel-based approach was used to investigate network plasticity during the first year of recovery from TBI (See Box-3).
- ▶ The number of FCRPs characterizing the TBIs at months 6 and 12 was significantly larger than at month 3 (See Box-4a).
- ► At months 3 and 6 most functional-connections for TBI subjects were relatively weaker than the controls. In contrast, after 12 months following resolution of post traumatic amnesia hyper-connectivity was observed (See Box-4b).
- ▶ The mean intra-cluster homogeneity value for TBI-subjects slightly increases from month-3 to month-12 (See Box-4c).

6. Future work

- ▶ Discovering functionally-connected regional-pairs that are strongly connected.
- ► Extending the current approach to individual-level analysis.
- ▶ Finding non-stationary functional-connectivity patterns that characterize TBI-subjects.
- ► Mapping functional-connectivity to structural-connectivity.

References

- ▶ Methods and Software for fMRI Analysis for Clinical Subjects?, by Paul Mazaika, Fumiko Hoeft, Gary H. Glover, and Allan L. Reiss, Human Brain Mapping, 2009.
- A. Zalesky, A. Fornito, G. F. Egan, C. Pantelis, E. T. Bullmore, The relationship between regional and inter-regional functional connectivity deficits in schizophrenia, Human Brain Mapping, Volume 33, Issue 11, pages 2535 - 2549, November 2012.