BrainNet Viewer: A graph-based brain network mapping tool

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Introduction

The human brain organizes naturally into a complex system represented as a structural connectome (Sporns et al., 2005) of interconnected cortico-cortical axonal pathways and a functional connectome (Biswal et al., 2010) of synchronized interregional neural activity. Mapping human brain connectome and uncovering the underlying organizational principles are fundamentally important in cognitive neuroscience and neuropsychology. Recent studies have suggested that the human brain connectome can be investigated using neuroimaging and neurophysiological data, and graph theoretical analysis reveals key topological properties of the brain such as small-worldness, modularity, and highly connected hubs (Bullmore and Sporns 2009; He et al., 2010).

Given the abstract nature of this methodology and the huge complexity of brain networks, it is important to visualize human brain connectomes and highlight their intrinsic organization. Here, we developed a flexible and rapid human brain network mapping tool, BrainNet Viewer, to visualize network analysis results friendly and intuitively.

Methods

BrainNet Viewer was developed in Matlab (R2010b), under Microsoft Windows environment, and defined three kinds of import files:

1) Brain surface file, the '*.nv' file for brain surface;

2) Node file, defined as a text files (*.node) containing an n×6 matrix including coordinates, color, size and label information of network nodes;

3) Edge file, defined as a text file (*.edge) containing an n×n correlation matrix which is used for mapping edges by applying thresholds via an internal function.

The BrainNet Viewer draws brain surface, nodes and edges in sequence, and allows users to adjust the color and size of nodes and edges in an easy way.

Results

The BrainNet Viewer can achieve the following functions:

1) Display several combinations of mesh, node, label and edges.

2) Three manners to adjust node size: equal, depending on thresholds or input size value and four manners to adjust node color: same, depending on thresholds, render by colormap or their modular info.

3) Display edges from correlation matrix by setting correlation thresholds.

4) Set edge size and color (similar as node setting).

5) Support various kinds of image format exporting, including TIFF, BMP, JPEG, PNS and EPS, while allow of image resolution, document size and DPI setting.

Conclusion

BrainNet Viewer is a useful brain network mapping tool, which could help researchers to visualize brain network with both nodes and edges from multi-views in an easy, flexible and quick way.

References

Biswal, B.B., et al. (2010), 'Toward discovery science of human brain function', Proc Natl Acad Sci USA.

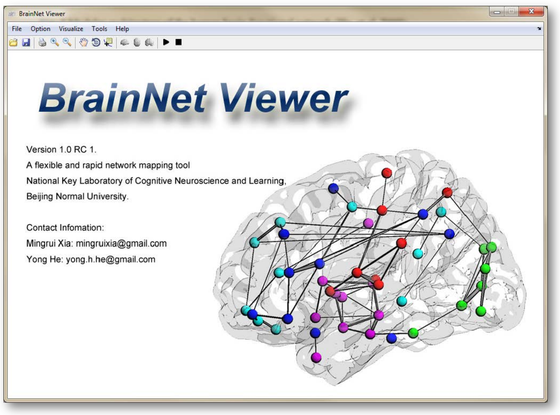
Bullmore, E. and Sporns, O. (2009), 'Complex brain networks: graph theoretical analysis of structural and functional systems', Nat Rev Neurosci.

He, Y., et al. (2009), 'Uncovering intrinsic modular organization of spontaneous brain activity in humans', PLoS One.

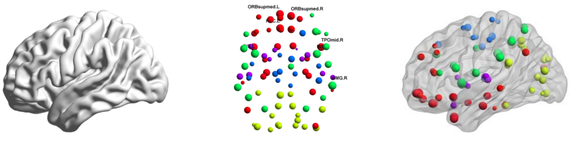
He, Y. and Evans, A. (2010), 'Graph theoretical modeling of brain connectivity', Curr Opin Neurol.

Sporns, O., et al. (2005), 'The human connectome: A structural description of the human brain', PLoS Comput Biol.

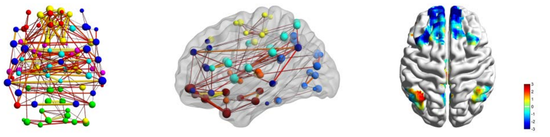
Figures



Main interface

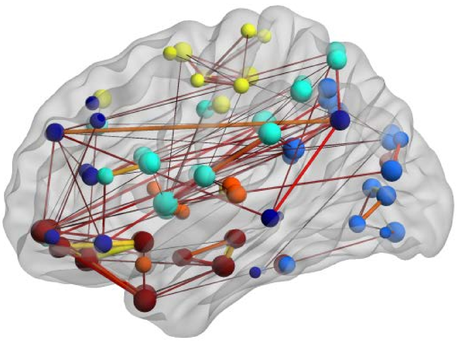


1) Brain Surface 2) Nodes 3) Surface & Nodes

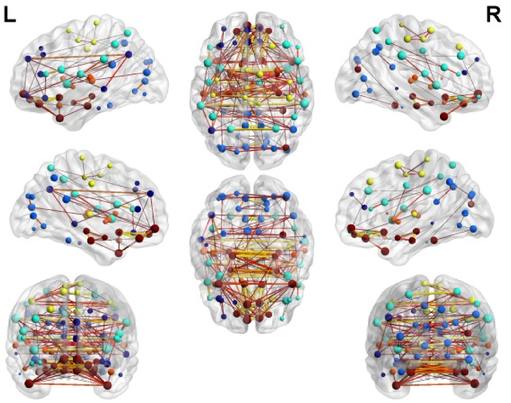


4) Nodes & Edges 5) Surface & Network 6) Volume mapping

Network graphs

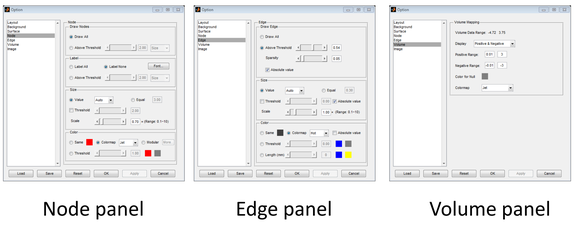


Single view



Full view

Different layouts



Node panel Edge panel Volume panel

Option panel