Data-driven approach to dynamic resting state functional connectivity: an ENIGMA-PGC PTSD study

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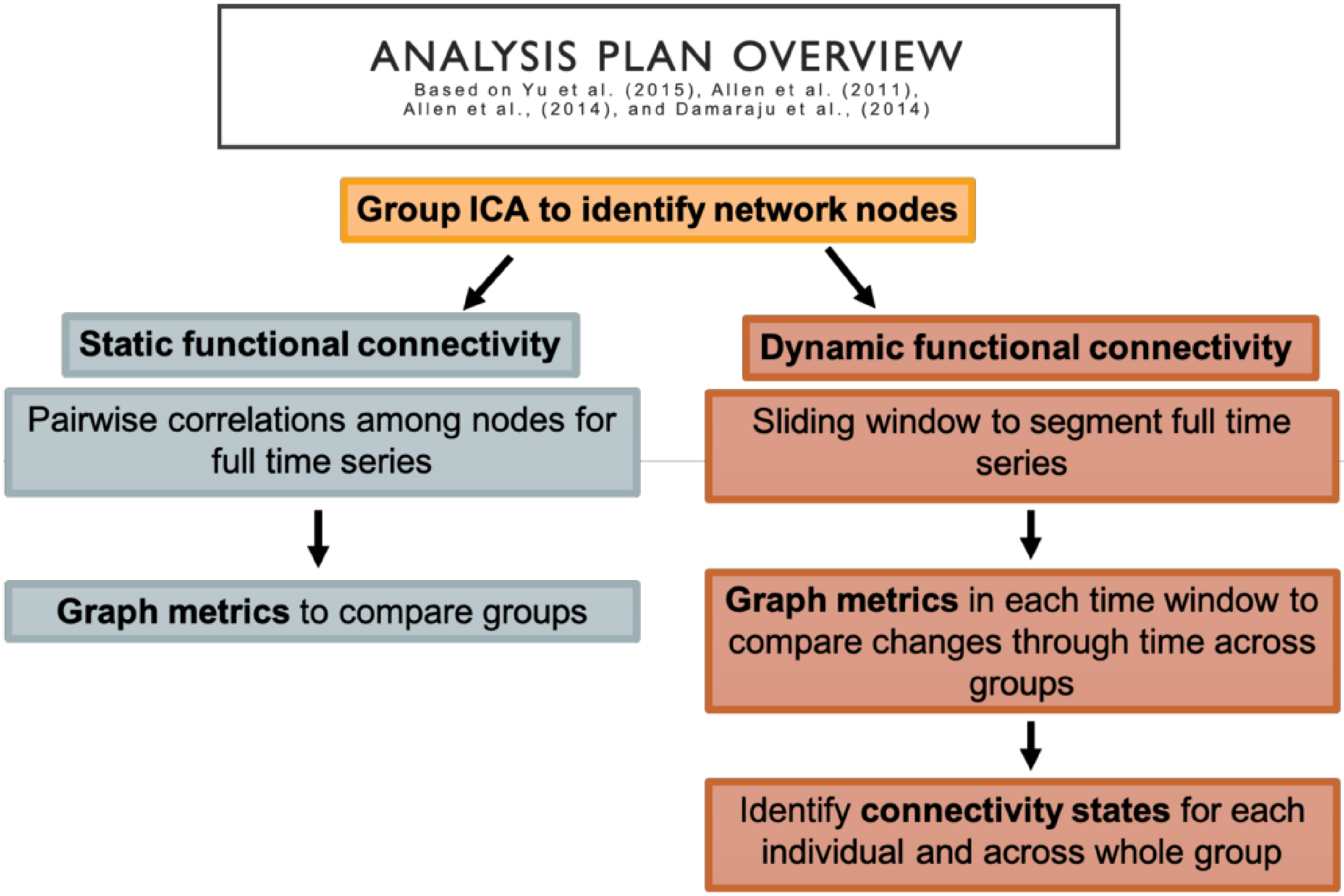
Introduction:

Post-traumatic stress disorder (PTSD) is a heterogeneous psychological disorder that may result from exposure to a traumatic event. Using functional magnetic resonance imaging (fMRI), symptoms of PTSD have been associated with aberrations in patterns of brain functional synchrony that emerge in the absence of a given cognitive demand or task, called resting state networks. Most prior research on resting state networks in PTSD has focused on aberrations in the static functional connectivity among specific regions of interest (ROI) in the brain and within canonical networks constrained by a priori hypotheses. However, dynamic fMRI, an approach that examines changes in brain network characteristics over time, may provide a more sensitive measure to understand network properties underlying dysfunction in PTSD. In addition, a data-driven analytic approach may reveal the contribution of other larger network disturbances beyond those revealed by hypothesis-driven examinations of ROIs or canonical networks.

Methods:

We therefore used a data-driven approach to characterize and compare brain network dynamics and recurrent connectivity states (CS) in a large sample of trauma exposed individuals with and without PTSD from the ENIGMA-PGC PTSD workgroup (N=1,049 from 11 sites; 447 PTSD+; 440 females; Mage=37.43, SDage=11.81). A group independent components analysis (ICA) was used to derive resting state network components in a data-driven manner. Static and dynamic functional connectivity of these components were compared across groups using graph theory metrics (e.g. connectivity strength). Further, recurrent brain states were identified using k-means clustering of the dynamic functional connectivity time windows from which dwell time and number of transitions between states were compared between groups (see Figure 1 for analysis overview).



(https://files.aievolution.com/prd/hbm2101/abstracts/abs_1438/Analysis_Plan_Overview.png)

·Figure 1. General overview of analysis strategy

Results:

Forty-two components were retained from the group ICA and were organized into broad cognitive domains/subnetworks (e.g. visual, sensorimotor, cognitive control, etc.). Static functional connectivity results showed that, across the whole network (all 42 components), those with PTSD had lower network efficiencies, on average, than controls (connectivity strength: $t(1,047)=3.18$, $p<0.001$). Further, dynamic functional connectivity showed increasing network efficiencies through the course of the scan for both groups (e.g., connectivity strength was higher in second half of the resting state scan compared to the first half; $B=0.37$, $p<0.001$). However, in the visual subnetwork those with PTSD showed blunted efficiencies through time ($B=-0.04$, $p<0.02$). In the connectivity states analysis, 2 recurrent CS's were identified across the group, CS #1 represented a state with high within subnetwork FC and low between subnetwork connectivity and CS #2 represented a state with high within and between subnetwork connectivity. There were no group differences in dwell time in either state or number of transitions between states.

Conclusions:

In the static functional connectivity analysis, we found aberrancies in a diffuse brain network related to PTSD diagnosis beyond the most commonly analyzed ROIs (i.e. amygdala, hippocampus, prefrontal cortex, default mode network). Unsurprisingly, in a large and heterogeneous trauma sample, large scale group results from the dynamic and connectivity states analysis did not generalize findings from similar analyses that used smaller homogeneous trauma samples. Heterogeneity of PTSD, especially within diffuse resting state brain networks, may not be completely captured by comparing PTSD diagnostic groups; further work is needed to evaluate brain network dynamics with respect to specific symptoms and trauma types.

Disorders of the Nervous System:

Psychiatric (eg. Depression, Anxiety, Schizophrenia)

Modeling and Analysis Methods:

Connectivity (eg. functional, effective, structural) [2]
Task-Independent and Resting-State Analysis [1]

Keywords:

FUNCTIONAL MRI
Psychiatric Disorders
Trauma

[1|2]Indicates the priority used for review

My abstract is being submitted as a Software Demonstration.

No

Please indicate below if your study was a "resting state" or "task-activation" study.

Resting state

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Patients

Are you Internal Review Board (IRB) certified? Please note: Failure to have IRB, if applicable will lead to automatic rejection of abstract.

Yes

Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

Yes

Was any animal research approved by the relevant IACUC or other animal research panel? NOTE: Any animal studies without IACUC approval will be automatically rejected.

Not applicable

Please indicate which methods were used in your research:

Functional MRI

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

Other, Please list - fmriprep

Provide references using author date format

Godsil, B. P. (2012). The hippocampal–prefrontal pathway: The weak link in psychiatric disorders? European Neuropsychopharmacology, 23(10), 1165–1181.
Hutchison, R. M. (2013). Dynamic functional connectivity: Promise, issues, and interpretations. NeuroImage, 80, 360–378.
Allen, E. A. (2014). Tracking Whole-Brain Connectivity Dynamics in the Resting State. Cerebral Cortex (New York, N.Y. : 1991), 24(3), 663–676.
Damaraju, E. (2014). Dynamic functional connectivity analysis reveals transient states of dysconnectivity in schizophrenia. NeuroImage: Clinical, 5(C), 298–308.
Yu, Q. (2015). Assessing dynamic brain graphs of time-varying connectivity in fMRI data: Application to healthy controls and patients with schizophrenia. NeuroImage, 107, 345–355.
Allen, E. A. (2011). A Baseline for the Multivariate Comparison of Resting-State Networks. Frontiers in Systems Neuroscience, 5, 2.
Zhu, X. (2017). Altered resting state functional connectivity of fear and reward circuitry in comorbid PTSD and major depression. Depression and Anxiety, 34(7), 641–650.
Zhu, H. (2019). Increased functional segregation of brain network associated with symptomatology and sustained attention in chronic post-traumatic stress disorder. Journal of Affective Disorders, 247, 183–191.
Tursich, M. (2015). Distinct intrinsic network connectivity patterns of post-traumatic stress disorder symptom clusters. Acta Psychiatrica Scandinavica, 132(1), 29–38.
Spielberg, J. M. (2015). Brain Network Disturbance Related to Posttraumatic Stress and Traumatic Brain Injury in Veterans. Biological Psychiatry, 78(3), 210–216.
Shin, L. M. (2010). The neurocircuitry of fear, stress, and anxiety disorders. Neuropsychopharmacology : Official Publication of the American College of Neuropsychopharmacology, 35(1), 169–191.