Long-term impact of major trauma on brain network function in traumatic survivors

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Target audience the psychologists, radiologists and psychiatrists.

Purpose Previous study has provided evidences of acute impact on the brain activity and functional connectivity in healthy survivors of the natural disasters (Lui et al., 2009). However, little is known about the long-term impact of trauma on the brain network function of healthy survivors. The aim of current study was to evaluate the neural network function in survivors 2-year after trauma.

Methods 21 physically healthy survivors underwent resting-state functional magnetic resonance (rs-fMRI) scan about 2 years after the Wenchuan earthquake. 21 age- , years of education- and sex-matched healthy controls were scanned shortly before the earthquake. The whole-brain functional networks were constructed by thresholding correlation matrices of 90 brain regions, and their topological properties (small-world and nodal centrality) were analyzed using graph theory analysis, which reflect the alterations of brain network function. Nonparametric permutation tests were further used for group comparisons of topological metrics. The Pearson's correlation analysis was performed to investigate the relationship between reported levels of distress and altered brain network topologies in survivors.

Results The survivors displayed small-world properties in the brain functional network, but a lower small-worldness value comparing to the controls. The survivors showed significantly increased nodal centralities in the precuneus (PCUN, $p=0.02$) and right supplementray motor area (SMA, $p=0.04$), and decreased nodal centralities in left inferior frontal gyrus (IFG, $p=0.01$) and right parahippocampal gyrus (PHG, $p=0.01$) (Figure1). The altered nodal centrality in the precuneus was correlated with Self-rating Anxiety (SAS) score ($r= -0.5$, $p=0.02$).
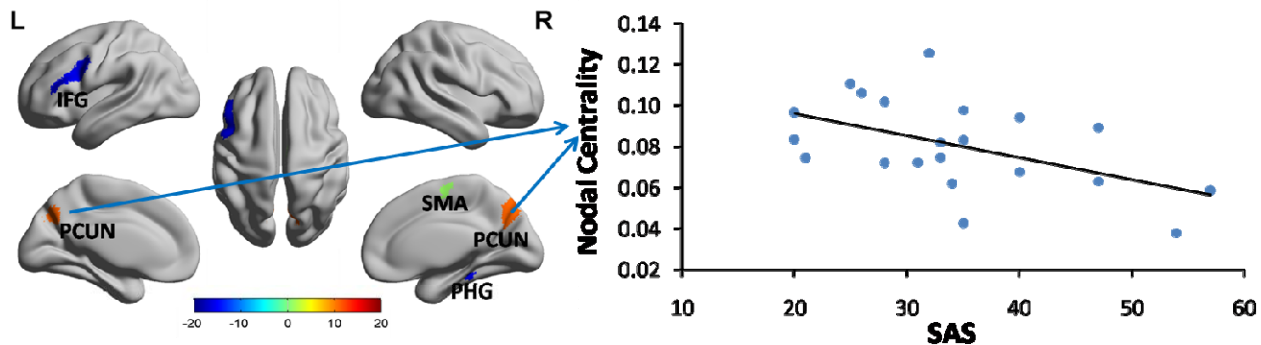

Figure1 Brain regions with abnormal nodal centrality in brain functional network and their relationship with reported level of anxiety in survivors.

Discussion Graph theory analysis can examine the topology of complex networks and reveal important information about both the local and global organization of functional brain networks (Bullmore and Sporns, 2009). Although the healthy survivors groups show small-world topology in the whole brain functional networks, suggesting the brain generates and integrates information with high efficiency (Achardet al., 2006; Hagmann et al., 2007), the decreased small-worldness value comparing to the controls indicates a shift toward randomization and less optimally in their brain networks (Zhang et al., 2011). The altered nodal centralities in the frontal, limbic and parietal regions reflect abnormal information transport and integration function of these regions across the functional network (Rubinov and Sporns, 2010). The association between reported level of anxiety and nodal centrality in precuneus indicates that alterations in precuneus may contribute to or reflect the ongoing hyperarousal experience in some trauma survivors.

Conclusion These results provide evidence that the major trauma has long-term impact on the brain network function in physically healthy survivors, highlighting the need for long-term evaluation and intervention for trauma survivors. Further longitudinal study which focuses on the progression of the brain functional alteration after the trauma may lead to a better understanding of post-traumatic responses.

References 1. Achard et al, JNeurosci 2006.   2. Bullmore and Sporns, Nat Rev Neurosci 2009.   3. Hagmann et al, PLoS One 2007.   4. Lui et al, PNAS 2009. 5. Rubinov and Sporns, Neuroimage 2010.   6. Zhang et al, Biol psychiat 2011.