Neuroanatomical priors improve image-based cortical thickness computation: ROI-DiReCT

Abstract

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Keywords:

Introduction

Working memory is a temporal process to maintain and manipulate information over short periods of time. WM has been shown to be impaired in many neurological and psychiatric syndromes including Schizophrenia. It was thought to be tightly associated with cognitive deficits in Schizophrenia (Green 2000). WM itself is a complex process which has been multidimensionally related to the psychosis.

Thus, a examination of the underlying neurological mechanism provided us with insight into the causes, progression and even treatment of schizophrenia. There has been abundant imaging studies in this area, but the differences among the tasks and material make it difficult to make a conclusion. There have been evidence of multi-modality deficits: visual spatial, visual object, verbal, and other types of working memory. One popular and original model of WM is a system encoding and maintaining modality-specific short-term memory and central executive component to manipulate the information. Some studies have found evidence for different patterns of functional connectivity during different working memory task conditions (e.g., as a function of load, stimulus type, or task phase). Such ndings suggest that functional connectivity changes could reect differences in task engagement or responsivity of brain networks to modulation,rather than stable changes that persist across all task states. Some studies have found both impairments in the modality-specific perception component and the later manipulation component. In a recent meta analysis, the author draw attention to a consistent and restricted "core network" emerged form conjunctions across analyses of specific task designs and contrasts. This distributed network was believed to

be active in WM task ignoring the task type , stimulus type and WM load and may be act as a base part in WM.

Schizophrenia has often been conceived as a disorder of connectivity between components of large-scale brain networks(Lynall, 2010). A few studies has focused on the relationship between WM impairment and disturbed functional connectivity both in the resting state and under various task. Some imagining studies reporting altered patterns of interregional functional connectivity in patients with schizophrenia during working memory task performance (Meyer-Lindenberg et al., 2001; Quintana et al., 2003; Schlosser et al., 2003a; Whalley et al., 2005). However, seldomly studies have investigate the functional connectivity in resting state.

Materials and Methods

Subjects

The resting state fMRI data presented here was collected from six hospitals in China which paticipated in the Brainnetome Project for Schizophrenia. The six hospitals are Patients and controls are matched as much as possible for age, sex, handedness, and race distributions with each site. Peking University Sixth Hospital (PKUH6); Beijing Huilongguan Hospital (HLG); Xijing Hospital (XJ); Henan Mental Hospital (HM); Renmin Hospital of Wuhan University (RWU); and Zhumadian Psychiatric Hospital (ZMD). Henan Mental Hospital provided two distinct MRI scanners: Siemens (HMS) and General Electric (HMG), for a total of eight scanning centers. The study at each center was approved by the local ethical review board. All the participants provided written informed consent.

All patients had a diagnosis of schizophrenia confirmed by trained psychiatrists using the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I/P). (First et al., 2002b). Exclusion criteria were a current neurologic disorder, a history of serious medical illness, substance dependence, pregnancy, electroconvulsive therapy within the last six months, or a diagnosis of any other Axis I disorder. The Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1989) was used to assess positive, negative, and general psychopathology symptoms in the patients. The healthy controls, who had no current axis I psychiatric disorders, were recruited from the local community near each center through advertisements. None of the HCs had any personal history of psychotic illness and no family history of psychosis in their first, second, or third degree relatives. All the participants were Han Chinese in origin, right-handed, and had no contraindications to MRI scanning. After extensive quality checking of the brain imaging data, 662 patients and 613 HCs were included in the analysis.

Data acquisition and preprocessing

Two types of 3 T MRI scanners (four Siemens, three General Electric) were used at the participating centers. To ensure equivalent data acquisition protocol and high quality imaging data, the scanning parameters of the functional scans at each of the six centers were set up by an experienced researcher before data acquisition. An echo planar imaging sequence was used to obtain the functional images, the parameters were as follows: 30 axial slices, TR = 2000 ms, TE = 30 ms, matrix = 64 64, flip angle = 90, FOV = 240*240 mm 2, slice thickness = 4 mm, gap = 0.4 mm. A total of 250 brain volumes were collected, resulting in a total scan time of 500 s.The MRI scan

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sequences and parameters for each center are listed in eTable 1. To be noticed, the time point number of the images from ZMD is 180 and is different from the 240 of the other sites. We did not exclude this site since we are eager to keep as much data and sites as possible, to support the validation of the muli-site analysis.

The iamges were preprocessed with a based in-house software: Brainnetome Toolkit which utilized Statistical Parametric Mapping SPM8 (http://www.fil.ion.ucl.ac.uk/s The pipeline includes the following steps: The first ten images were deleted for the signal equilibration. The remaining iamges were conducted for slice acquisition correction and head motion correction. The fMRI data which had less than 3.0 mm of head motion and 3.0 of angular rotation were included. Moreover, the mean framewise displacement (FD) was computed by averaging FDi from every time point for each subject. There were no differences for the mean FD between groups (t = 0.413, p = 0.682) (Table 1). Then the fMRI images were normalized to the standard Montreal Neurological Institute (MNI) template provided by SPM and resample to the 3-mm isotropic voxels. Artefacts due to changes in global, ventricle and white matter signals, residual motion were removed using voxel-wise regression. A temporal filter (0.01 Hz ¡ f ¡ 0.08 Hz) were used to reduce the low-frequency drift and physiological high frequency respiratory and cardiac noise. Finally, the data was smoothed with an isotropic Gaussian kernel of 6 mm full-width at half-maximum.

Discussion

Working memory networks

Working memory is the result of various combinations of processes, no processes ((and correspondingly no brain structures)are unique or specic to working memory. (Eriksson, 2015)Many brain regions interact during working memory andinclude "executive" regions in the PFC, parietal cortex, and basal ganglia, as well as regions specialized for processing the particular representations to be maintained, such as the fusiform face area for maintaining face information. Persistent neural activity in various brain regions accompanies working memory and is functionally necessary for maintenance and integration of information in working memory.

The organization of human WM has long been the topic of psychological models (Atkinson and Shiffrin, 1968; Hebb, 1949), with maybe the most inuential having been proposed by Baddeley and Hitch (1974). In Rottschy,2012, the WM network was identified by functional neuroimaging using quantiattive coordiante-based meta-analysis over almost 200 individual experiments. By pooling various working memory tasks, a main network was identified which mainly comprise the fronto-parietal network. By eliminating the effect of specific task designs and contrasts, a more restricted "core" network emerged from conjunctions analyses. A core network independently of the specific aspects and task features was identified using conjunction analysis. This network mainly comprise the dorsal area 44, anterior insula, (pre-)SMA and IPS. The dorsal areas 44/45 and the pre-SMA are part of the phonological loop, a subsystem that response for verbal working memory material maintenance. There has been evidence that the dorsal region of Broca's

area is active only during the first part of the delay period, and is involved in the formation of an articulatory rehearsal program. Generally, the same brain regions dedicated to sensory processing are believed to store sensory information during delay periods and working-memory task performance. A conjunction of verbal vs. non-verbal material in Rottschy's study revealed that the BA44/45 area may also involed in non-verbal WM tasks, that it may not be a modality-specific area in working memory. The reduced functional connectivity may underpin the verbal working memory deficits in schizophrenia. The previous research has established that the PFC is causally involved in normal working memory functioning. However, there is yet no consensus on the details of the functional organization of the PFC. The absent of DLPFC, which is believed to an neuro agent for the central executve module in Baddeley and Hitch's model in Rottschy's core network, may be due to some working memory task requires little manipulation process of the memory content. In fact, the lateral PFC clusters in the main network was subdivided to two, that the abstraction level of goals and task rules are suggested to peak in rostral PFC and decrease to the caudal part. The caudal LPFC register a working memory load effect while the rostral part was not.

Conclusions

Acknowledgments

References