Dynamics for Functional Connectivity in 24-hour Default-mode Networks

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Background

Recently, functional connectivity study using functional magnetic resonance imaging (fMRI) have revealed connectional abnormalities in certain disease groups during resting brain state, often called, default-mode network. The basic assumption of using default-mode network in explorative study is that the intra-individual variability is negligible compared to group difference and reproducibility is high within a brain, which was not validated till now. According to this assumption, the default mode network might reflect long-term state of the individual brains independence of the brain dynamics which might be reflected on the acquisition time. The purpose of this study is to investigate the reproducibility and intra-individual variability of functional connectivity in the default-mode network using fMRI data measured at 8 different acquisition times during 24 hours.

Methods

Six normal right-handed adults (Mean age =25.3±1.8) underwent fMRI scanning using EPI sequences at a 3.0 Tesla MRI scanner (Siemens, Tim-Trio) with TR=2000 ms and TE=30 ms. The each subject was scanned during 10 minutes resting, eye-closed state at eight different time points (19:00(1st day), 21:00, 1:00(2nd day), 7:00, 10:00, 13:00, 16:00, and 19:00). All EPI images were realigned to the first image of the session after 10 first images were excluded. Realigned EPI images were coregistered to T1-weighted images and were normalized to a template via statistical parametric mapping toolbox (SPM2). Temporal low- and high-pass filtering was applied to normalized data with frequency ranges (0.01 Hz-0.0h Hz). We conducted simple correlation analysis and analysis of variance (ANOVA) test ($p<0.001$) between 116 brain regions defined by anatomical automatic labeling (AAL).

Results

Strong functional coherences were shown in temporal lobe or anatomically adjacent brain area among inter-hemispheric symmetric regions (Figure 1, (a)). No connectional difference was detected between acquisition time points with a threshold of alpha values corresponding to FDR <0.05. With a lower threshold ($p<0.001$, without correction), significant difference was found between the right Rolandic operculum, the left and right superior temporal lobes, and right temporal pole and the left putamen (Figure 1, (b)).

Conclusion

This study presented the dynamics of functional connectivity in the default-mode in which no significant connectivity changes were detected between acquisition times within each participant. Therefore, default-mode network could represent the long-term state of the individual brain and could be used for evaluating brain connectivity difference in disease groups compared to control groups.

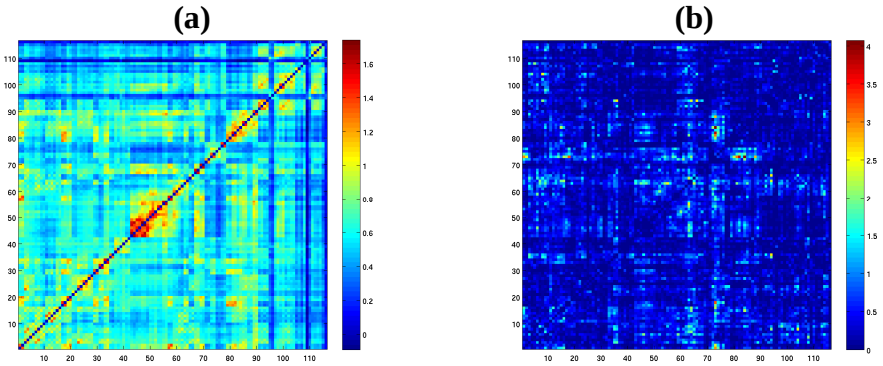

Figure 1: Example of maps between 116 regions (anatomical automatically labeling (AAL) was used)
(a) Map of Z-score : it shows some strong connectivity in temporal lobe or anatomically adjacent brain area among inter-hemispheric symmetric regions, which is a mean result from each different eight time points of six subjects.
(b) Map of P-value : the result of multiple comparison (ANOVA) for temporal change, which shows only significant difference between the right rolandic operculum, the left and right superior temporal lobes, and right temporal pole and the left putamen.