Gender Difference of Resting Rhythms Detected by BOLD-based fMRI

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Introduction

The consistent and characteristic default network (named as tripod component, TC, for the pattern of spatial distribution of default network) of resting rhythm has been detected by utilizing BOLD-based fMRI at both 1.5T and 3T field strength (Yeh et al, 2005). The resting TC involved bilateral occipital, precuneus, posterior cingulate, inferior parietal lobules and medial prefrontal cortices (Yeh et al, 2002 and 2006). Similar TC coexists with task-relevant signal components in sensori-motor or cognitive tasks (e.g. word naming task), and implies the functional connectivity (Laufs et al, 2003). To study the gender difference of default network, a routine protocol of resting fMRI has been adapted to functional and anatomical studies. Forty normal subjects, gender- and age-matched, were recruited, and the default network was identified using informax independent component analyses (informax ICA) and automatic component sorting in individual raw-data space using the spatiotemporal template. Men had relatively more extensive default network than women in bilateral posterior cingulate cortices.

Subjects and Methods

(1) Resting fMRI

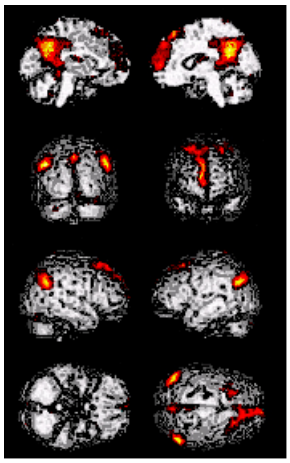
Forty right-handed subjects (gender- and age-matched, age: 26 +/- 6 years old) were instructed to “empty their mind” and “prohibit imagery tasks” during the studies. After 5-minute sensory deprivation by auditory protection and dimmed room light, imaging studies of resting state were obtained with eye fixation on a dimmed red cross which was viewed through a mirror projection. Subjects were free to blink during eye fixation for the resting fMRI study of about seven minutes with the head fixation using a vacuum pillow. For verifying the state of consciousness, subjects responded to the end of imaging session by pushing bottom using right hand. Images were acquired using a 3T Medspec S300 system (Bruker GmbH, Ettlingen, Germany) equipped with an actively shielded gradient coil and a quadrature transceiver of head. Single-shot echo planar images (64x64 matrix, slice thickness/ gap = 5/1 mm, 20 slices) covering whole brain were acquired with a flip angle = 90 degree, echo time (TE) = 50 ms, repetition time (TR) = 2000 ms, dummy scan (DS) = 5 for reaching stable magnetization and repetition number (NR) = 200.

(2) Data Analyses

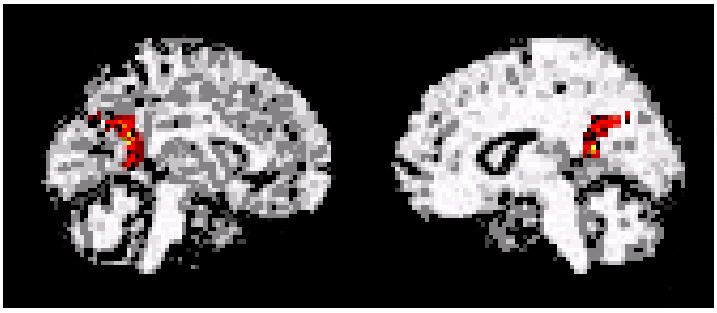
On-line analysis using modified AFNI (Analysis of Functional NeuroImages, NIMH, Bethesda, USA) ensured the head motion with head translation < 2 mm and head rotation < 1 degree. Off-line processing included (1) preprocessing of Individual data sets using SPM2 (Functional Imaging Laboratory, Wellcome Department of Imaging Neuroscience, UCL, London, UK) was applied for slice timing and realignment; (2) ICA processing was obtained using GIFT (Calhoun et al, 2001) of informax ICA (Computational Neurobiology Laboratory, The Salk Institute for Biological Studies, La Jolla, USA) with minimizing preprocessing; (3) template-based classification using a spatial template of default network, created by an independent cohort of fourteen normal subjects (gender- and age-matched, age: 24 +/- 2 years old; **Figure 1**); and (4) temporal course of default network was derived for each individual from GIFT, and the temporal course was applied as the regressor for GLM estimation after co-registration/normalization to MNI T1 template and smoothing of 8x8x8 mm in SPM2. Group analyses using two-level statistical evaluation of random-effect analysis was performed with statistical criteria of p<0.001/voxel extension>0 for the first level and p<0.05/voxel extension>0 for the second level, respectively.

Results

Gender difference showed more extensive default network in bilateral posterior cingulate cortices (Brodmann area 31) in male group (male > female), [**Figure 2**, center of mass (x, y, z) = (3, -31 42)]. No area was detected by the statistical contrast of female > male.



< Figure 1 : The spatial template of default network was created by fourteen normal subjects. The template involved posterior medial parietal, posterior lateral parietal, ventral medial prefrontal and dorsal medial prefrontal cortices.



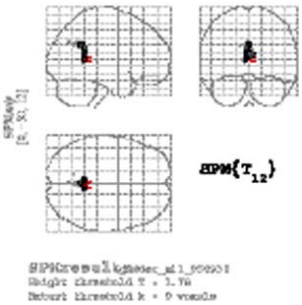


Figure 2 : Statistical contrast of male > female showed more extensive default network in bilateral posterior cingulate cortices.

Discussion

Correlates of the tripod component (default mechanism) mainly involved posterior medial parietal (interpretation of environment), posterior lateral parietal (multi-modal integration), ventral medial prefrontal (integration of information from internal/external environments) and dorsal medial prefrontal cortices (monitoring and reporting one’s mental states). For the BOLD-based fMRI studies of resting default networks, random-effect analysis confirmed the more extensive default connectivity in bilateral posterior cingulate cortices in male group. This finding echoed previous FDG PET result which demonstrated men had relatively higher metabolism than women in temporal-limbic and cerebellar regions (Gur et al, 1995). But further study will be required for evaluating this finding as one of the neuro-imaging markers for gender difference.

Acknowledgement

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References

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