Two new-discovered functional networks of resting brains

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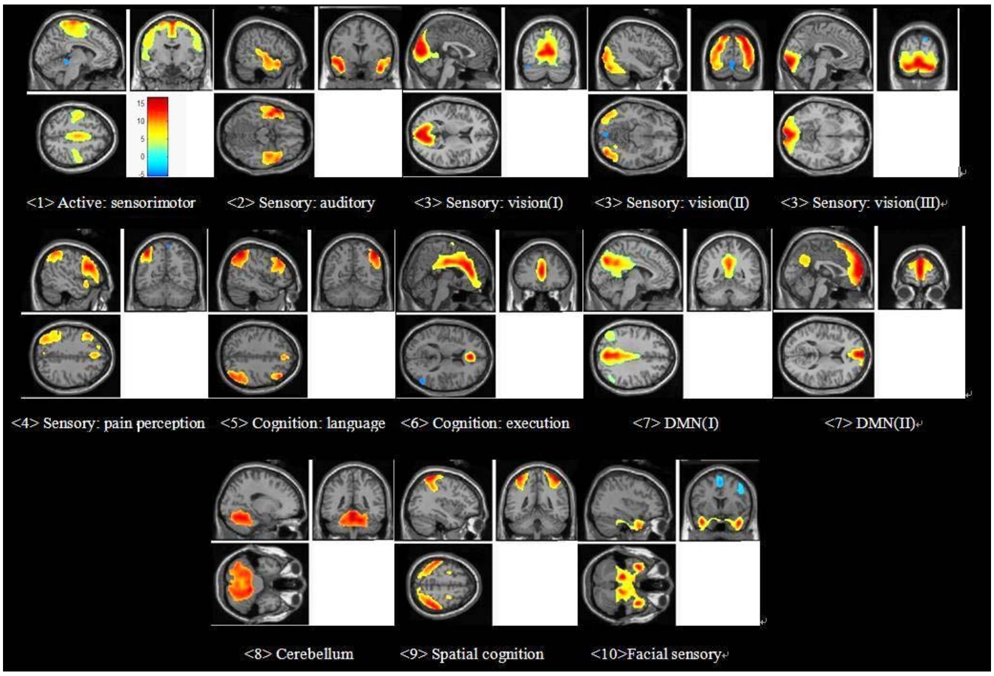
Introductions Up to 10 functional networks contributed by low frequency fluctuations (LFFs) have been reliably identified to consistently exist in human resting brains [1, 2]. These networks consist of regions which are known to be involved in function of motor, vision, execution, auditory, pain perception, language, cerebellum, and the so called default-mode network (DMN). In our present work, we analyzed resting-state fMRI data of 11 healthy participants to further investigate functional networks which consistently exist in resting brains. The functional networks obtained in our work largely corresponded to the findings in prior literatures [1, 2]. Additionally, we discovered two new functional networks: spatial cognition network and facial sensory network. Spatial cognition network consisted predominantly of superior and inferior parietal gyrus (BA 7/40), which were crucial in visuo-spatial processing during cognition-Chinese-language paradigms (reading and writing) [4-9]. Facial sensory network covered pons and medial temporal pole, which served to process sensory information from human faces such as the sense of smell and taste [3].

Methods Eleven healthy right-handed Chinese volunteers (5 M, 6 F), ranging from 20- to 32-years-old, were recruited, trained, and imaged. Scanning was performed on a Bruker Medspec 3.0 Tesla whole body scanner. During the acquisition of resting-state fMRI data, the volunteers were asked to remain as still as possible, resting with their eyes open. 200 24-slice whole-brain volumes were acquired using a T2*-weighted gradient-echo, echo-planar-imaging sequence (TR / TE = 2000 / 30 ms; flip angle = 84°; slice thickness / gap = 5 / 0 mm; 64 × 64 image matrix, FOV 256 × 256 mm^2). Afterwards, fast spin-echo, 24–slice 2D T1-weighted anatomical images (TR / TE = 2000 / 17 ms; echo train length = 4; slice thickness / gap = 5 / 0 mm; 256 × 256 image matrix, FOV 256 × 256 mm^2) were acquired in the same slice positions, in order to facilitate the precise determination of the structures corresponding to the functional activation foci. The preprocessing of fMRI data contained slice timing, rigid body motion correction, spatial normalization, Gaussian spatial smoothing (6 mm FWHM), linear trend removal, correction of physiological noises, and temporally band-pass filtering (BPF; 0.01-0.08 Hz). Group ICA (Independent Component Analysis) was performed to obtain functional networks of resting brains. The number of independent components was constrained to 20.



Results and Discussions After group ICA decomposition we visually inspected all components and selected functional connectivity maps representing the functional networks of resting brains, which showed in the figure above. The functions of all the selected networks were labeled in the figure. Network <1> - <8> corresponded to the findings in prior literatures [1, 2]. Additionally, we discovered two new functional networks: spatial cognition network (network <9>) and facial sensory network (network 10). Spatial cognition network consisted predominantly of superior and inferior parietal gyrus (BA 7/40). Superior parietal cortex played a crucial role in learning visuo-spatial aspects of Chinese characters and was strongly correlated with behavioral performance of Chinese language learners [4-6]. Inferior parietal cortex was mainly involved in the mapping between orthographic word forms and their phonological representations [7-9]. All of the participants in our study were native Chinese speakers. We were not sure if the high functional connectivity in this network was induced by long-term Chinese learning with complicated Chinese character recognition because there were no related literatures published. The existence of spatial cognition network in resting Chinese brains still needs to be further proved by the experiment with larger number of Chinese subjects. Facial sensory network covered pons and medial temporal pole. Pons dealt with facial sensation. Medial temporal pole specialized for the processing of olfactory and taste information in relation to the recognition of objects [3]. We believed that the network was the fourth sensory network during resting-state besides auditory, visual, and pain-perception networks.

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