Default Brain Function in Young Adults Revealed by CASL Perfusion fMRI

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Introduction Functional brain imaging in humans has focused on the task-specific neural activations that are associated with various cognitive and affective activities. Recently, PET and fMRI observations of task-independent brain deactivations during goal-directed cognitive tasks have consistently suggested an organized mode of default brain function (1-4). Consequently, the hypothesis of default brain function posits that the default brain regions exhibit an increased level of activity during the resting state when there are no external demands on attention (2-3). Taking the advantage of CASL perfusion fMRI for non-invasive quantification of cerebral blood flow that is coupled to the neural activity, the present study examined the default mode of brain function during resting state in a large cohort of young adults. This study also examined the gender and age effects on the default mode of brain function during early adulthood.

Methods The subjects were 67 young adults (34 male, age 18-30 years, mean 22 years) from three independent CASL studies. They were scanned on a Siemens 3.0T Trio scanner during the resting and awake state with an amplitude-modulated continuous ASL technique (5) for functional scans. Functional image processing and analysis were carried out with Voxbo and SPM2. For each subject, quantitative CBF images were generated, and relative regional CBF (divided by the mean gray matter CBF) was calculated and entered for the voxel-vise GLM analysis. One sample t-test was used to detect the brain regions consistently showing higher regional CBF than mean gray matter CBF. Multiple regression analyses were used to examine the gender difference and age effect.

Results Large CBF variation across brain regions was found in the quantitative CBF image (Fig1a). A cortical network including the medial brain regions (posterior cingulate, medial frontal cortex), as well as some lateral brain regions (superior temporal, angular, inferior and middle frontal cortex) consistently showed higher CBF during resting state (whole brain corrected $p < 0.001$, Fig1b). Within this network, gender differences were found in bilateral superior temporal cortex (STC) and middle cingulate cortex (MCC), in which male subjects showed higher relative CBF than female subjects (all $p < 0.001$, Fig1c and Fig2a), while age effect was found in posterior cingulate cortex (PCC), in which relative CBF linearly increases with age ($R = 0.53$, $p < 0.001$, Fig1d and Fig2b).

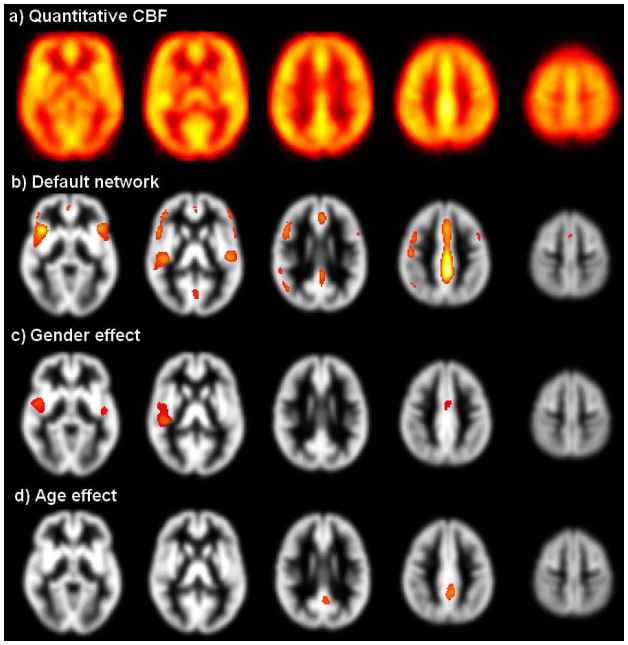

Fig1. a) Mean quantitative CBF image; b) default network; c) gender effect; d) age effect in young adults.

Conclusions Our quantitative blood flow results from CASL perfusion fMRI replicated the results from PET (2), which support the existence of an organized mode of default brain function. The result that STC and MCC showed difference in male and female subjects suggests that gender affects the default brain function. The observed correlation between PCC blood flow and age suggests that the default mode of brain function is not constant but rather dependent on age even during early adulthood.

References

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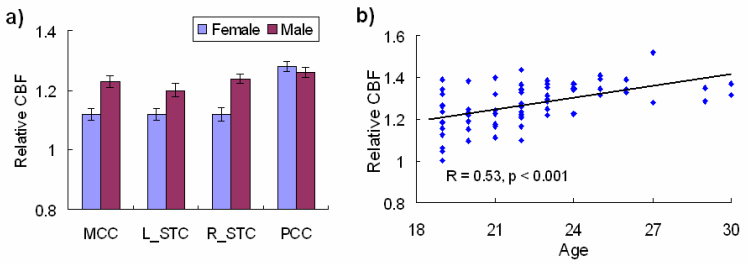

Fig2. a) Relative CBF showed gender difference in MCC, STC but not in PCC. b) Relative CBF in PCC linearly increases with age in young adults.