# Effect of Aging on CBF mapping of Default Mode Network : An fMRI study

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## Introduction

Normal aging is often accompanied by non-diseased cognitive decline. Recent neuroimaging studies have explored the effect of aging on brain's default mode network (DMN) by computing the brain's functional connectivity of healthy aged subjects associated with blood oxygenation level dependent (BOLD) [1]. However, the interpretation of findings based on BOLD-fMRI is complicated by age-related alterations in cerebrovascular dynamics [2]. Compared with BOLD signals, cerebral blood flow (CBF) has been demonstrated to be more linear with the neural activity [3]. Thus, we investigated the functional connectivity in resting state utilizing CBF mapping with arterial spin labeling (ASL) technique [4-6], which provides more spatial specificity and consistency [7].

## Materials and Methods

A total number of 26 right-handed subjects, including 10 healthy adults (5 women, 22-28 years old, mean 25±2.8), and 16 old subjects (7 women, 60-73 years old, mean 67±5.5) were recruited in this study. All participants were proved to be with no specific brain disease and no other psychological symptoms based on extensive clinical examinations conducted by both neurologists and psychologists. None of them were on medications which may alter brain activity. During the scanning time, all of subjects were instructed to keep their eyes closed, think of nothing and stay awake. Simultaneous acquisition of BOLD and CBF was performed for 8 minutes during resting state.

All MRI experiments were performed on a GE 3T Signa system with a standard head coil. Functional data were acquired using a dual echo spiral-out sequence with simultaneous CBF and BOLD acquisition. CBF/BOLD readouts were acquired at TE of 3.1/30 ms covering 12 axial slices of the cerebrum and most of the cerebellum. REST2007, SPM5 and MATLAB were used for data processing. The posterior cingulated cortex (PCC) of right side was selected as a seed region. All the time courses from brain volume were filtered in 0.01-0.04Hz. We averaged the time courses in right PCC region, which was correlated with every pixel time course to build a functional connectivity map for each subject. Finally, the results of the two groups were compared and two sample t-test was used to identify regions with statistically significant different correlation between the two groups (uncorrected voxel level $p<0.001$, contiguous voxels > 10).

| Region | Cluster size | MNI coordinates | | | Peak t | Peak p (uncorrected) |
|---|---|---|---|---|---|---|
| | | x | y | z | | |
| L-Precuneus (BA 7) | 271 | -10 | -64 | 42 | 4.79 | 0.000 |
| R-Insula (BA 13) | 216 | 38 | -12 | 10 | 5.39 | 0.000 |
| L-Insula（BA 13） | 31 | -44 | -22 | 20 | 4.82 | 0.000 |
| R-rACC (BA 24) | 67 | 4 | 22 | 20 | 4.31 | 0.000 |

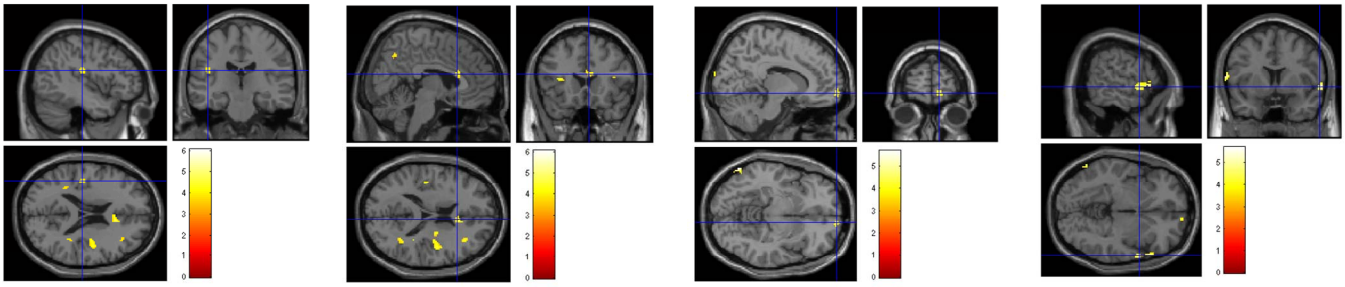
Table 1. Brain regions which have a significantly strengthened correlation with right PCC in normal aging group.

| Region | Cluster size | MNI coordinates | | | Peak t | Peak p (uncorrected) |
|---|---|---|---|---|---|---|
| | | x | y | z | | |
| R-vMPFC (BA 10) | 38 | 12 | 64 | -8 | -4.30 | 0.000 |
| R-STG (BA 22) | 97 | 64 | 6 | -2 | -4.96 | 0.000 |
| L-Precentral Gyrus（BA 44） | 61 | -64 | 8 | 12 | -5.69 | 0.000 |
| L-MOG (BA 19) | 76 | -62 | -68 | -8 | -5.61 | 0.000 |
| R-MOG (BA 18) | 25 | 14 | -98 | 16 | -3.99 | 0.000 |

Table 2. Brain regions which have a significantly weakened correlation with right PCC in normal aging group.

## Results

Significant between-group differences in functional connectivity based on CBF mapping were found. Comparing with the healthy adults, the regions which have a strengthened correlation with right PCC in aging group (Table 1, Fig.1a, Fig1.b) were contralateral (left) precuneus, bilateral insulas and ipsilateral (right) rostral anterior cingulated cortex (rACC). The regions which have a weakened correlation with right PCC in aging group (Table 2, Fig.1c, Fig1.d) were right ventral medial prefrontal cortex (vMPFC), right superior temporal gyrus (STG), left precentral gyrus and bilateral middle occipital gyrus (MOG).



(a) Bilateral insulas with strengthened correlation (b) Right rACC with strengthened correlation (c) Right vMPFC with weakened correlation (d) Right STG with weakened correlation

Figure 1. Typical brain regions which have significantly strengthened or weakened correlation with seed-region right PCC in normal aging group.

## Conclusion

In conclusion, this study first depicted the effect of aging on CBF-based functional connectivity in DMN system. Compared with the healthy adult group, the correlations of the aging group with PCC node were found significantly decreased in right vMPFC, left precentral gyrus, right STG and bilateral MOG, which may be the principal cause of cognitive, motor, linguistic and visual dysfunctions in normal aged human beings. The results would be helpful in interpreting the neurovascular mechanisms of normal aging. These findings might illuminate the potential application of CBF mapping in functional connectivity analysis.

## References

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