

Resting-state functional MRI for evaluation of brain development from childhood to young adulthood

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Introduction Magnetic resonance imaging techniques have been used to investigate the structure and function of the developing brain in order to understand typical growth patterns and their underlying mechanisms. Resting-state functional MRI (rs-fMRI) was used to investigate the developmental aspects of local intrinsic activity, functional connectivity (FC) and functional brain networks. Our object is to explore the local activity and FC in healthy people from childhood to young adulthood using rs-fMRI.

Materials and Methods Sixty-three healthy volunteers participated in this study, and were divided into three groups. There were 20 children (aged, 7-13 years, 8 female) in children group, 20 adolescents (aged, 14-17 years, 7 female) in adolescents group and 23 young adults (aged, 18-28 years, 14 female) in adults group. Functional images were acquired by using an EPI sequence with the following parameters: TR/ TE = 2000 ms/ 30 ms, 210 volumes. We applied Resting-State fMRI Data Analysis Toolkit (REST) V1.8 to calculate the amplitude of low-frequency fluctuation (ALFF) and the FC for each subject. For FC analysis, we used prefrontal cortex (brodmann area 8, 9, 10, 11, 44, 45, 46 and 47) as seed region and investigated the connectivity between the seed region and all other voxels in the brain. A one-way analysis of variance was performed by SPM8 to determine the ALFF and FC differences among the three groups, as well as the between-group. Correlation analysis of REST was used to investigate the relationship between the ALFF value and age. AlphaSim was used to correct for multiple comparisons, and statistical significance was defined as $p < 0.05$.

Results In our study, we found ALFF significant changes were mainly located in the frontal lobe, the limbic lobe and the cerebellum posterior lobe. Furthermore, ALFF activity in the thalamus had obviously positive correlation with age. However, most of other areas had negative correlation with age.

The FC differences were located in the frontal lobe (superior, inferior and medial frontal gyri), the cerebellum posterior lobe, the parietal lobe (inferior parietal lobule and postcentral gyrus), as well as the insula, the caudate nucleus and the anterior cingulate cortex. The FC was increased with age in cerebellum posterior lobe and were decreased with age in the frontal lobe and the parietal lobe.

Discussion Our results suggested development with age of the frontal lobe and the cerebellum posterior lobe. The prefrontal cortex has been found to be involved in decision making, complex cognitive behaviors, planning personality expression and moderating social behavior ^[1]. The cerebellum posterior lobe plays an important role in fine motor coordination, specifically in the inhibition of involuntary movement. Furthermore, the previous literatures showed that the cerebellum was connected with frontal lobe, which are known for their contributions to higher cognitive function ^[2,3]. In summary, the ALFF and the FC were developed with age from children to young adults, which associated with cognitive development.

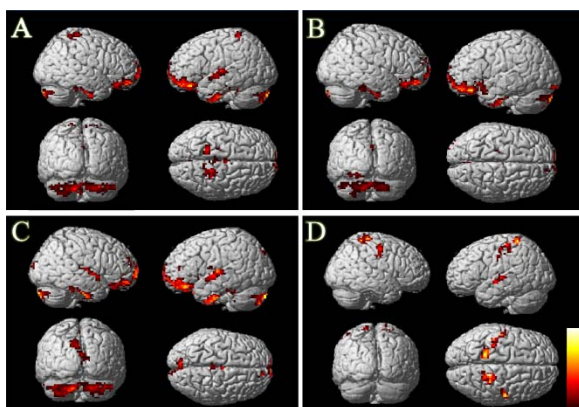


Figure 1 Differences of ALFF among three groups: children group, adolescents group and adults group.

A: main effect among three groups;
B: children group compared to adults group;
C: children group compared to adolescents group;
D: adolescents group compared to adults group.

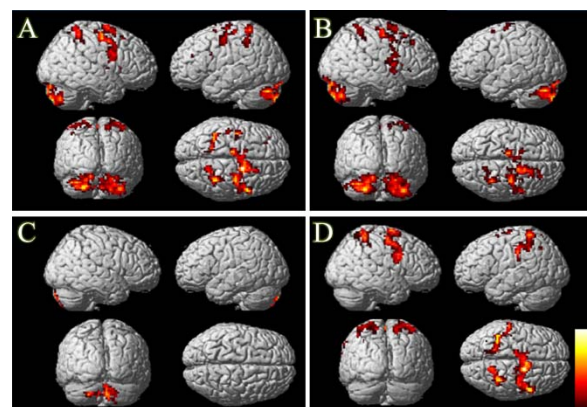


Figure 2 Differences of FC among three groups: children group, adolescents group and adults group.

A: main effect among three groups;
B: children group compared to adults group;
C: children group compared to adolescents group;
D: adolescents group compared to adults group.

References

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