NETWORK INTEGRATION REFLECTS ATTENTION PERFORMANCE IN ADOLESCENTS

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SUMMARY

The study aimed to assess the relationship between attention performance and structural brain networks in adolescents using diffusion MRI. Our results indicate that orienting function correlates with global efficiency in adolescents. This can aid in the development of effective interventions to help adolescents improve their attention.

INTRODUCTION

Examining the underlying anatomical network of attention performance may provide new insight toward understanding the cognitive functions of the human brain. While task-based functional brain imaging studies have shown that the three subsets of attention - alerting, orienting and executive function, are arbitrated by anatomically different brain networks[4], the structural connectivity involved has been scarcely studied, especially in adolescents. We hypothesized a positive correlation of brain network integration with attention performance in adolescents, mapped using diffusion MRI. The association of attention performance with network segregation was also explored.

METHODS

Thirty-nine healthy adolescents (16.42±1.1 yrs. old; range, 14-18 yrs.; 22F/17M) underwent a 3T MRI scan that included a standard T1-weighted sequence and a spin-echo echo-planar-imaging (EPI) diffusion tensor imaging (DTI) sequence. The structural connectome was constructed using FSL, MATLAB and Diffusion Toolkit[2]-(Fig. 1). Cerebral segmentation into 90 regions of interest (ROIs) was performed. Global network integration and segregation were assessed using the characteristic path length and average clustering coefficient, respectively. The calculation of the network properties and scaling by the properties of random networks was performed using the Brain Connectivity Toolbox. The Attention Network Task (ANT) (Fan, 2005) was used to assess the three subsets of attention, as well as mean Reaction Time (RT) and Mean Accuracy.

RESULTS

A significant positive correlation between the characteristic path length and mean RT (Pearson's rho=0.380, p=0.017) was seen. The characteristic path length also appeared to positively correlate with orienting effect, though not statistically significantly (r=0.301, p=0.062) (correction for age resulted in the path length being a predictor of orienting effect at p=0.054). No significant correlations were observed for the other measures of attention, or for associations with the average clustering coefficient.

CONCLUSIONS

The integration of structural (white matter) brain networks showed a significant positive correlation with attention performance in adolescents. Network integration reflects the network's capacity for parallel information transfer between brain regions (global efficiency), and is believed to be the basis of integrated processing for cognitive functions[3]. Higher network integration of structural networks has been previously shown to correspond to higher scores on intelligence tests and to higher executive attention[3]. In contrast, our results indicate that mean RT and orienting function correlate with global efficiency in adolescents. The results of our study can aid in the development of effective interventions to help adolescents improve their attention.

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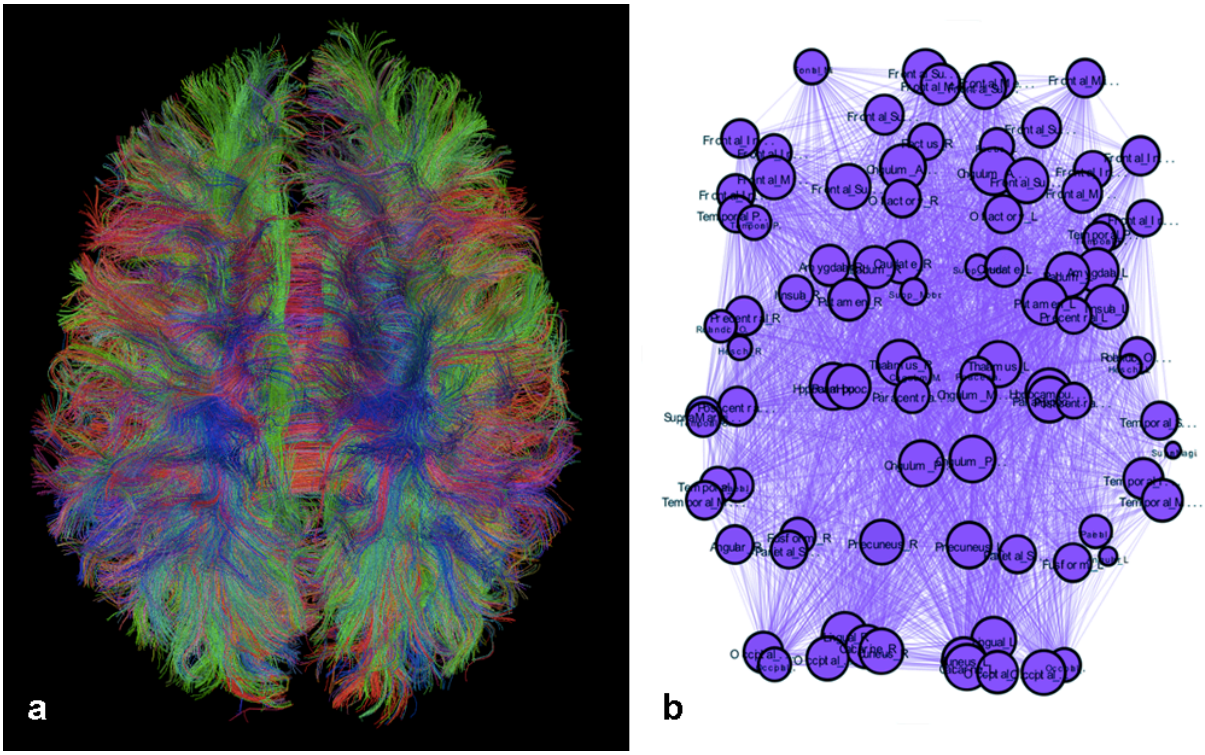

Figure 1. a) DTI-based whole-brain tractogram in an adolescent; b) the corresponding graph (set of nodes and edges).