Revealing relationship between the functional and structural connectivity: a multimodal neuroimaging study

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***Abstract*—Although accumulating evidence suggests a shaping of structural pathways in functional networks, our understanding of the relationship between structure and function is still rudimentary. The emerging field of combining both functional and structural brain networks has offered insightful implications for better understanding of various brain functions and diseases. In this multimodal neuroimaging study, we constructed functional connectivity using fMRI and structural connectivity using diffusion tensor imaging (DTI) tractography in the same individuals with the aim of revealing the functional-structural relationship.**

I. Introduction

Two neural populations are considered to be functional connected if the neuronal activity of them is temporally coherent while the structural connectivity provides putative bundle pathways of macroscopic white matter fibers linking cortical areas. Since the propensity for two populations to interact would vary in part to the density and efficacy of the projections connecting them [1]. It is logical to assume that the repertoire of functional configurations and interactions is reflective of underlying anatomical linkage. Studies combining multimodal neuroimaging have provided some of the nascent opportunities in comprehensive understanding of various brain functions and diseases [2].

II. Methods

In the current study, we measured functional connectivity (FC) based on resting-state fMRI data and structural connectivity (SC) through diffusion tensor imaging (DTI) in 14 healthy subjects (M/F=6/8, age=68.6±8.4 y). A flowchart of the analysis steps is shown in Fig.1. Details about the neuroimaging data preprocessing and network construction (Fig. 1(a) and (b)) have been introduced in our previous study.

After obtaining the FC and SC network, the FC-SC relationship was firstly assessed through examining the probability densities of FC when the SC counterparts are present or absent (Fig. 1(c)). We expect to observe a more robust relationship between the strength of FC and SC when direct structural connectivity is present – the mean value of the FC distribution should be significantly higher than 0. We further quantify the relationship between FC and SC through calculating the correlation coefficient between all nonzero entries of the SC matrix and their functional counterparts (Fig. 1(e)), resulting a single FC-SC coupling metric for each subject.

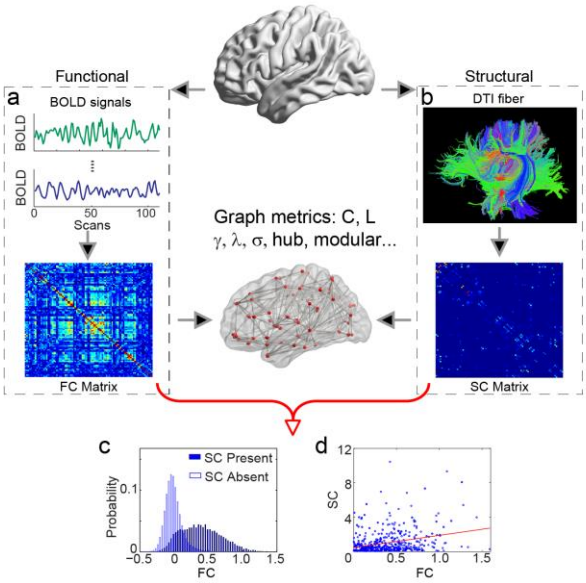

Figure 1. The flowchart of the analysis steps. (a) FC and (b) SC network construction; (c) the probability densities of FC between structurally connected and unconnected region pairs; and (d) scatter plot of SC strength against FC.

III. Results & Discussion

An evident relationship between FC and SC strengths was revealed (mean value of FC distribution is significantly higher than 0) together with a significant (p <0.05) correlation (r = 0.18±0.05) between FC and SC were observed in all 14 subjects. Our results provide further support for a shaping of structural pathways in functional networks. A combined approach of multimodal neuroimaging may be more fruitful than using either one alone.

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