Poster No. Th776

Subcomponents of the superior longitudinal fasciculus/arcuate fasciculus and their connectivity

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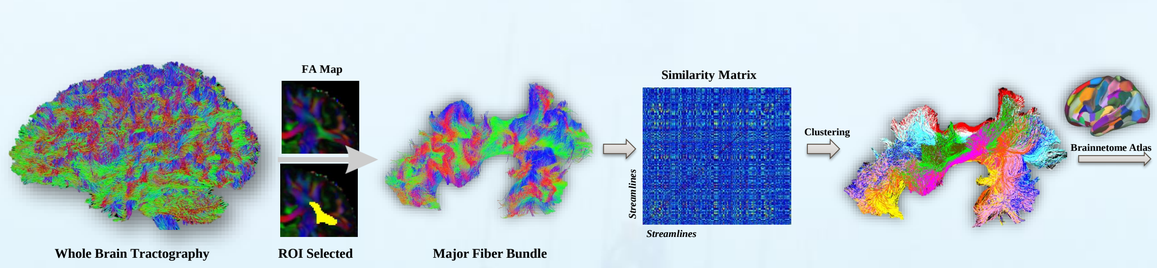
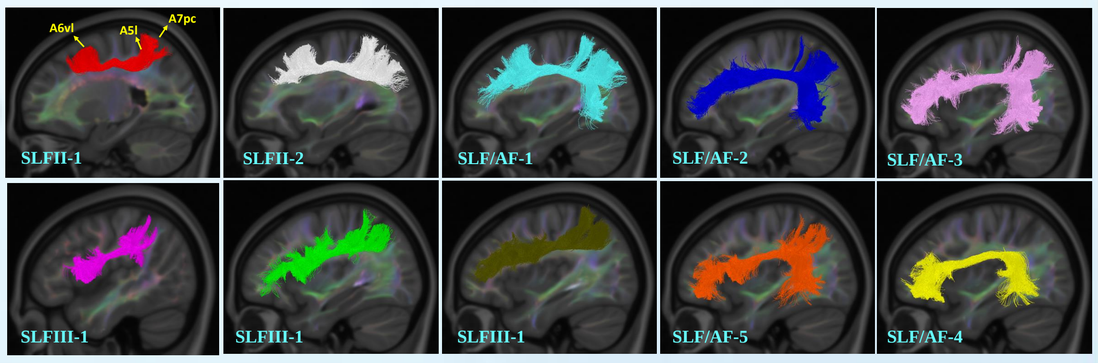
Introduction

The fasciculus is a bundle of axons that follow the same pathway, and with origins and terminations of the same brain regions. Most of the human brain fiber bundles can be identified using traditional white matter dissection or non-invasive diffusion tensor based tractography [1]. However, the detailed categorization of these fiber bundles, including superior longitudinal fasciculus/arcuate fasciculus (SLF/AF), remains controversial [2]. Here, we firstly subdivided the SLF/AF into 10 sub-fiber bundles using unsupervised clustering method according to the connectivity patterns. Then, benefit from the newly parceled fined-gained human Brainnetome atlas [3], we calculated the connectivity profiles for each sub-fiber bundle quantitatively. A new framework for subdividing the major fasciculus based on the connectivity differences was proposed for an individual, which could provide a new perspective to better understand the human brain.

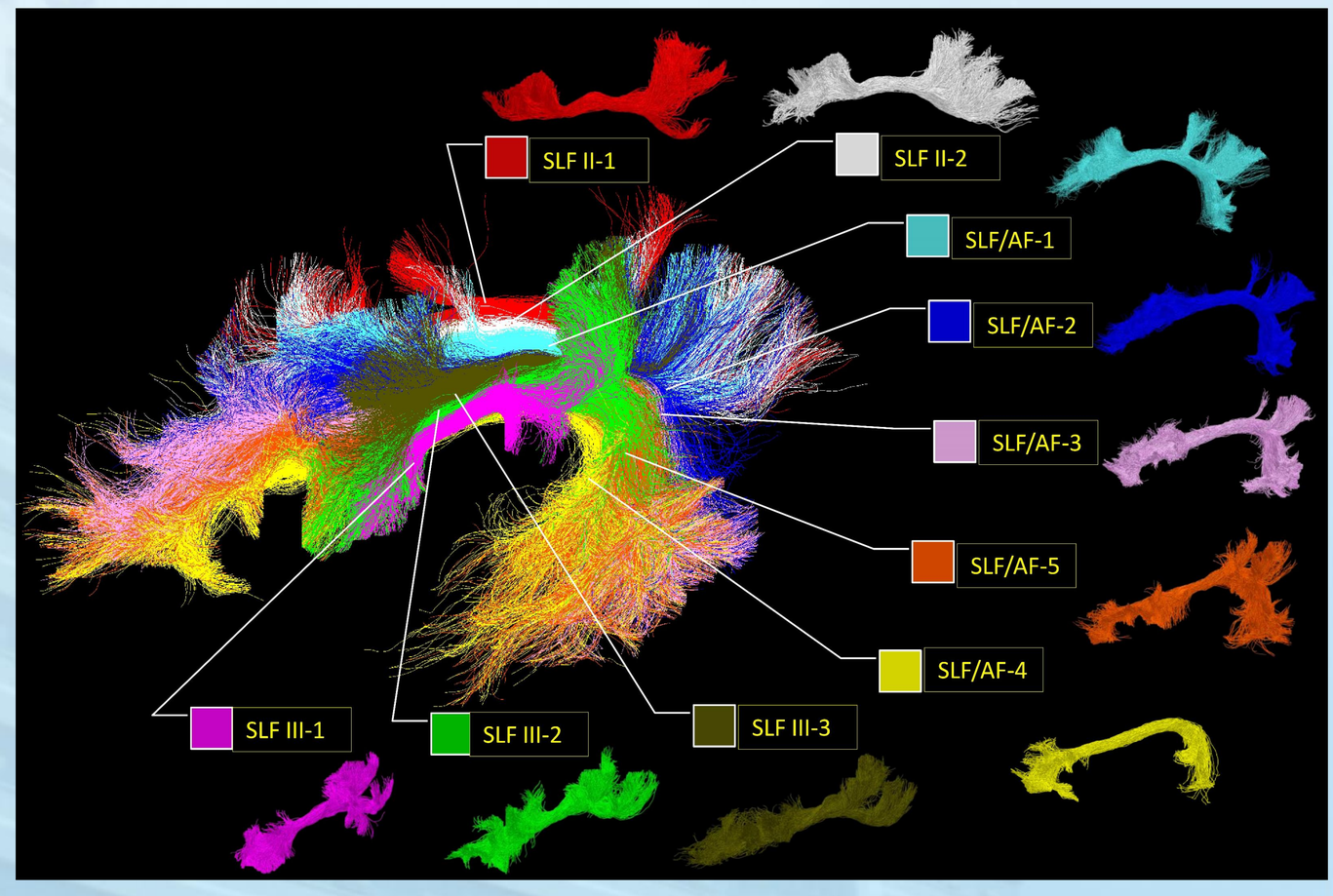


Framework of fiber bundle segmentation



Material and Methods

- **Data**. One HARDI data (b = 1000, 2000, 3000mm/s) was selected from the Human Connectome Project (HCP) S500 database, which had been preprocessed following the HCP's minimal preprocessing pipelines [4].
- **Tractography**. The fibre orientation distribution (FOD) and whole brain tractography was performed using Mrtrix [5, 6]
- **Fiber reconstruction**. Two ROIs were manually extracted on a coronal slice of the DTI colored FA maps to select the streamlines of the SLF/AF in the hemisphere.
- **Fiber clustering**. Each streamline was mapped back to the individual volume space to calculate the connectivity matrix. The cross-correlation matrix was acquired, and fed into spectral clustering to identify different sub-fiber clusters.
- **Connectivity profile**. The Brainnetome atlas was use to define the connectivity profile of each subcomponents.
- This whole framework was verified well accuracy and repeatability by conducting on other subjects.



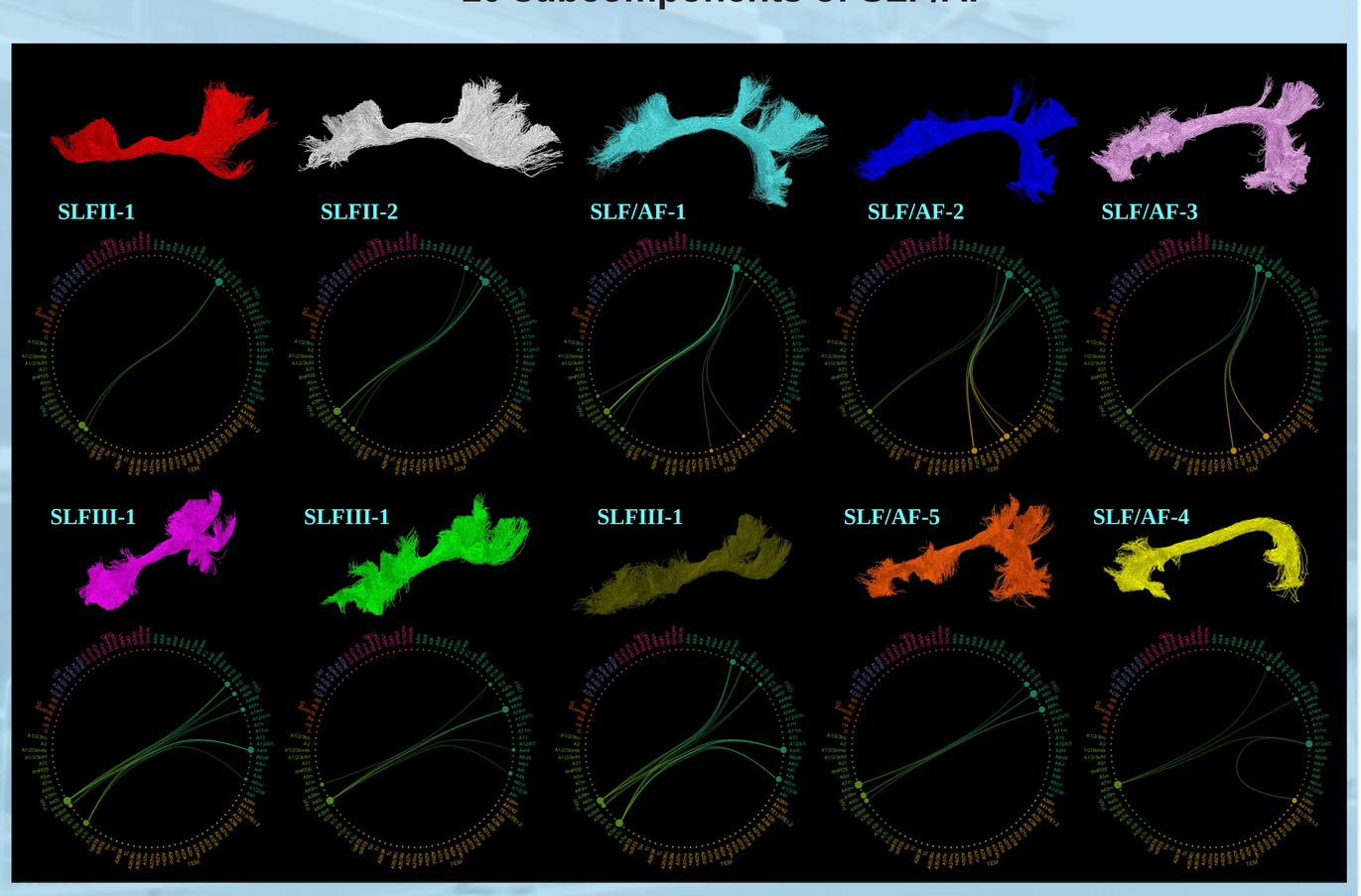
10 subcomponents of SLF/AF

Results

The SLF/AF was subdivided into 10 fibers using the above-mentioned framework, including SLFII-1, SLFII-2, SLFIII-1, SLFIII-2, SLFIII-3, SLF/AF-1, SLF/AF-2, SLF/AF-3, SLF/AF-4, SLF/AF-5. The distinct connectivity of each fiber was calculated based on the Brainnetome atlas quantitatively.

Conclusion

The identified 10 subcomponents of the SLF/AF show distinct connectivity profiles, which could provide a cue that the major fiber in the human brain is not a uniform model and contains distinct subcomponents connecting the brain regions uniquely. Fined-gained fiber bundles with fine-gained Brainnetome atlas parcellations allow us to better understand and interpret the connectional and functional anatomy of the human brain.



Connectivity profiles of 10 subcomponents

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