Superior longitudinal fasciculus

The superior longitudinal fasciculus (also called the superior longitudinal fascicle or SLF) is a pair of long bi-directional bundles of neurons connecting the front and the back of the cerebrum. Each association fiber bundle is lateral to the centrum ovale of a cerebral hemisphere and connects the frontal, occipital, parietal, and temporal lobes. The neurons pass from the frontal lobe through the operculum to the posterior end of the lateral sulcus where numerous neurons radiate into the occipital lobe and other neurons turn downward and forward around the putamen and radiate to anterior portions of the temporal lobe.

The description of human white matter pathways experienced a tremendous improvement, thanks to the advancement of neuroimaging and dissection techniques. The downside of this progress is the production of redundant and conflicting literature, bound by specific studies' methods and aims. The Superior Longitudinal System (SLS), encompassing the arcuate (AF) and the superior longitudinal fasciculi (SLF), becomes an illustrative example of this fundamental issue, being one of the most studied white matter association pathways of the brain. Vavassori et al. provided a complete illustration of this white matter fiber system's current definition, from its early descriptions in the nineteenth century to its most recent characterizations. They proposed a review of both in vivo diffusion magnetic resonance imaging-based tractography and anatomical dissection studies, enclosing all the information available up to date. Based on these findings, they reconstructed the wiring diagram of the SLS, highlighting a substantial variability in the description of its cortical sites of termination and the taxonomy and partonomy that characterize the system. They aimed to level up discrepancies in the literature by proposing a parallel across the various nomenclature. Consistent with the topographical arrangement already documented for commissural and projection pathways, they suggested approaching the SLS organization as an orderly and continuous wiring diagram, respecting a medio-lateral palisading topography between the different frontal, parietal, occipital, and temporal gyri rather than in terms of individualized fascicles. A better and complete description of the fine organization of white matter association pathways' connectivity is fundamental for a better understanding of brain function and their clinical and neurosurgical applications [1)].

The inferior parietal lobule, important in second Language (L2) learning success, is anatomically connected to language areas in the frontal lobe via the superior longitudinal fasciculus (SLF). The second and third branches of the SLF (SLF II and III) have not been examined separately in the context of language, yet they are known to have dissociable frontoparietal connections. Studying these pathways and their functional contributions to L2 learning is thus of great interest. Using diffusion MRI tractography, Sander et al. investigated individuals undergoing language training to explore brain structural predictors of L2 learning success. They dissected SLF II and III using gold-standard anatomical definitions and related prelearning white matter integrity to language improvements corresponding with hypothesized tract functions. SLF II properties predicted improvement in lexical retrieval, while SLF III properties predicted improvement in articulation rate. Finer grained separation of these pathways enables better understanding of their distinct roles in language, which is essential for studying how anatomical connectivity relates to L2 learning abilities [2)].

The aim of a study was to examine the arcuate fasciculus (AF) and superior longitudinal fasciculi (SLF), which together form the dorsal language stream, using fiber dissection and diffusion imaging techniques in the human brain.

Twenty-five formalin-fixed brains (50 hemispheres) and 3 adult cadaveric heads, prepared according to the Klingler method, were examined by the fiber dissection technique. The authors' findings were supported with MR tractography provided by the Human Connectome Project, WU-Minn Consortium. The frequencies of gyral distributions were calculated in segments of the AF and SLF in the cadaveric specimens.

The AF has ventral and dorsal segments, and the SLF has 3 segments: SLF I (dorsal pathway), II (middle pathway), and III (ventral pathway). The AF ventral segment connects the middle (88%; all percentages represent the area of the named structure that is connected to the tract) and posterior (100%) parts of the superior temporal gyrus and the middle part (92%) of the middle temporal gyrus to the posterior part of the inferior frontal gyrus (96% in pars opercularis, 40% in pars triangularis) and the ventral premotor cortex (84%) by passing deep to the lower part of the supramarginal gyrus (100%). The AF dorsal segment connects the posterior part of the middle (100%) and inferior temporal gyrus (76%) to the posterior part of the inferior frontal gyrus (96% in pars opercularis), ventral premotor cortex (72%), and posterior part of the middle frontal gyrus (56%) by passing deep to the lower part of the angular gyrus (100%).

This study depicts the distinct subdivision of the AF and SLF, based on cadaveric fiber dissection and diffusion imaging techniques, to clarify the complicated language processing pathways [3].

Classification

Superior longitudinal fasciculus classification.

1)
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2)
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