

Short Association Bundle Atlas for Lateralization Studies from dMRI Data

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Abstract : Diffusion Magnetic Resonance Imaging (dMRI) allows the non-invasive study of human brain white matter. From diffusion data, it is possible to reconstruct fiber trajectories using tractography algorithms. Our previous work consists in an automatic method for the identification of short association bundles of the superficial white matter (SWM), based on a whole brain inter-subject hierarchical clustering applied to a HARDI database. The method finds representative clusters of similar fibers, belonging to a group of subjects, according to a distance measure between fibers, using a non-linear registration (DTI-TK). The algorithm performs an automatic labeling based on the anatomy, defined by a cortex mesh parceled with FreeSurfer software. The clustering was applied to two independent groups of 37 subjects. The clusters resulting from both groups were compared using a restrictive threshold of mean distance between each pair of bundles from different groups, in order to keep reproducible connections. In the left hemisphere, 48 reproducible bundles were found, while 43 bundles were found in the right hemisphere. An inter-hemispheric bundle correspondence was then applied. The symmetric horizontal reflection of the right bundles was calculated, in order to obtain the position of them in the left hemisphere. Next, the intersection between similar bundles was calculated. The pairs of bundles with a fiber intersection percentage higher than 50% were considered similar. The similar bundles between both hemispheres were fused and symmetrized. We obtained 30 common bundles between hemispheres. An atlas was created with the resulting bundles and used to segment 78 new subjects from another HARDI database, using a distance threshold between 6-8 mm according to the bundle length. Finally, a laterality index was calculated based on the bundle volume. Seven bundles of the atlas presented right laterality (IP_SP_1i, LO_LO_1i, Op_Tr_0i, PoC_PoC_0i, PoC_PreC_2i, PreC_SM_0i, y RoMF_RoMF_0i) and one presented left laterality (IP_SP_2i), there is no tendency of lateralization according to the brain region. Many factors can affect the results, like tractography artifacts, subject registration, and bundle segmentation. Further studies are necessary in order to establish the influence of these factors and evaluate SWM laterality.

Keywords : dMRI, hierarchical clustering, lateralization index, tractography

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