Creating an atlas of children brain connectivity

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Abstract

Diffusion imaging offers neuroscientists a unique opportunity for in vivo investigation of the white matter connectivity using 3D fiber reconstruction (tractography) techniques. It has a considerable potential for studying normal and abnormal brain development as diffusion parameters quantitatively reflect various maturation processes, while tractography enables studying regional maturation within distinct bundles. However, tractography datasets are extremely complex, containing millions of fibers of various shapes and lengths. Extracting individual white matter bundles from such datasets is a challenging task that has not been completely solved yet. Bundles are commonly extracted based on regions of interest (ROI) that are used to include or exclude certain fibers. These ROIs can be defined manually in individual subjects but this is very time-consuming and expert dependent. Alternatively, ROI atlases can be applied using affine or non-linear transformations, but results strongly depend on the transformation quality and do not take into account fiber shapes. Recently, fiber-clustering techniques have been proposed for automatic bundles identification (Guevara et al. 2012), based on an atlas of main bundles generated over a group of adult subjects. This approach has the advantage of taking into account fiber shapes and localization variabilities. Furthermore, it can be used to analyze white matter microstructural properties when it is not possible to perform reliable tractography (e.g. in case of white matter diseases, like demyelination) by projecting the atlas to the subject data. However, this atlas was generated for adults hindering its application to children as fiber shapes and lengths change during development. Thus, reliable bundle identification in children requires using dedicated atlases. In this work, we describe creation of such an atlas from a group of 17 children aged between 17 and 81 months and the way in which this atlas may help to extract new information about various pathologies of the white matter.

Keywords: Diffusion Imaging, white matter, tractography, atlas, clustering, children

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