Project

Reduced white matter integrity related to proprioceptive impairment due to age: A Diffusion Weighted Imaging (DWI) study.

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Micro-structural changes in the brain associated with aging have been investigated with the use of Diffusion MRI, enabling the characterization of white mater integrity under the Diffusion Tensor Imaging (DTI) model and Fiber tractography. We aimed to study age-related changes in white matter micro-structure, linked to functional alterations in proprioceptive skills for hand movements, previously reported in a psychophysical (Landelle et al. 2018) and a fMRI (Landelle et al. 2020) study. To do so, we compared 20 Young and 20 Old participants' diffusion images, using DTI-metrics (e.g., Fractional anisotropy (FA), diffusivity measures) along the center of white mater tracts (TBSS, Smith et al. 2006), the Corpus Callosum as our region of interest, and inter-hemispheric fiber-tracts connecting sensorimotor areas.

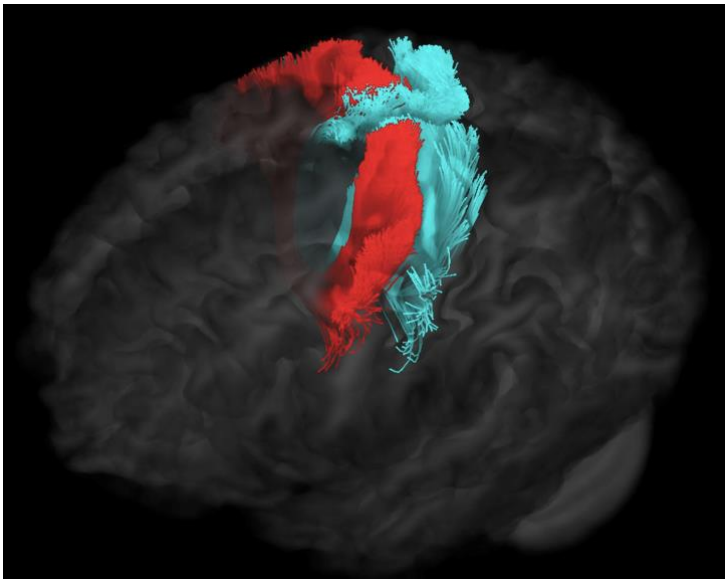

Figure. Reconstruction of the Motor tract (connecting bilateral primary motor cortices, in red) and Sensory tract (connecting the primary somatosensory cortices, in light blue). The motor tract crosses at the 4th segment of the Corpus callosum, with the somatosensory crosses at the 5th .

Diffusion images were preprocessed, following B.A.T.M.A.N tutorial recommendations (Tahedl et al. 2020), using the FMRIB Software Library (*FSL*) and *MRtrix3* software packages. Calculation of anisotropy and diffusivity maps was done with FSL FDT (*ditfit* fucntion), and fiber tractography was implemented with both MRtrix and Tractseg packages. Probabilistic fiber tracking was done by following the TractSeg Pipeline (Wasserhelt et al., 2018), using the Constrained Spherical Deconvolution (CSD) method for tract segmentation.

NOTE: FSL packages need a GPU system to analyze images. MRtrix package is able to manage image file with nii.gz, .mif, and other formats, interchangeably. TractSeg requires the installation of both FSL and MRtrix software.

References:

Landelle, C., Ahmadi, A.E. & Kavounoudias, A., (2018) Age-related impairment of hand movement perception based on muscle proprioception and touch. *Neuroscience 381*, 91–104.

Landelle C, Anton JL, Nazarian B, Sein J, Gharbi A, Felician O & Kavounoudias A. (2020) Functional brain changes in the elderly for the perception of hand movements: A greater impairment occurs in proprioception than touch. *NeuroImage* Jun 17: 117056. doi: 10.1016/j.neuroimage.2020.117056 .

Smith SM, Jenkinson M, Johansen-Berg H, Rueckert D, Nichols TE, Mackay CE, Watkins KE, Ciccarelli O, Cader MZ, Matthews MP & Behrensa T (2006) Tract-based spatial statistics: Voxelwise analysis of multi-subject diffusion data. NeuroImage 31, 1487 – 1505.

Tahedl M. (2020) B.A.T.M.A.N.: Basic and Advanced Tractography with MRtrix for All Neurophiles. *OSF*. DOI 10.17605/OSF.IO/FKYHT

Wasserthal J, Neher P, Maier-Hein KH. (2018). TractSeg-Fast and accurate white matter tract segmentation *NeuroImage, 183, p. 239-253*. https://doi.org/10.1016/j.neuroimage.2018.07.070

Wasserthal J, Neher PF, Hirjak D, Maier-Hein KH. (2019). Combined tract segmentation and orientation mapping for bundle-specific tractography. *Medical image analysis 58, 101559.* https://doi.org/10.1016/j.media.2019.101559