**SUPPLEMENTARY MATERIAL**

**Supplementary Methods**

*MRI Acquisition Parameters*

MRI experiments were conducted on a 3T Siemens Prismafit MRI (Siemens Medical Solutions, Erlangen, Germany) with a 32-channel head coil. The acquisition parameters for the patient are as follows: 1) 3D T1-weighted imaging using an MPRAGE sequence with these parameters: TR/TI1/TI2/TE=5000/700/2500/2.98 ms, FOV=256x256 mm2, a generalized auto-calibrating partially parallel acquisition (GRAPPA) factor of 3, 1 x 1 x 1 mm3 voxels (scan duration: 8 min, 52 s). 2) T2-FLAIR sequence with these parameters: TR/TI/TE = 9000/2500/92.0 ms, FOV=220x220 mm2, a GRAPPA factor of 2, voxel size 0.9 x 0.9 x 2.0 mm3 (scan duration: 3 min, 2 s). 3) FBI was acquired using single-shot, twice-refocused echo planar imaging, with these parameters: 4 b-values (0, 1000, 2000, 6000 s/mm2) along 128 diffusion-encoding directions, TR/TE = 5300/110 ms, FOV=222x222 mm2, voxel size 3.0 x 3.0 x 3.0 mm3, one average with an extra 11 b = 0 images gathered per b-value, slice and phase accelerations of 2 and 2, respectively, with Full Fourier encoding with gradients in performance mode (total scan duration: 37 min, 43 s).

The acquisition parameters for the control are as follows: 1) 3D T1-weighted imaging using an MPRAGE sequence with these parameters: TR/TI/TE=2300/900/2.26 ms, FOV=256x256 mm2, GRAPPA factor of 2, 1 x 1 x 1 mm3 voxels (scan duration: 5 min, 21 s). 2) T2-FLAIR sequence with these parameters: TR/TI/TE = 9000/2500/92.0 ms, FOV=220x220 mm2, a GRAPPA factor of 2, voxel size 0.9 x 0.9 x 2.0 mm3 (scan duration: 3 min, 2 s). 3) FBI was acquired using single-shot, twice-refocused echo planar imaging, with these parameters: 2 b-values (0, 6000 s/mm2) along 128 diffusion-encoding directions, TR/TE = 4800/95 ms, FOV=222x222 mm2, voxel size 3.0 x 3.0 x 3.0 mm3, one average with 10 extra b = 0 images, slice and phase accelerations of 2 and 2, respectively, with Full Fourier encoding with gradients in performance mode (total scan duration: 11 min, 26 s). 4) Diffusional kurtosis imaging (DKI) data were gathered at 3 b-values (0, 1000, and 2000 s/mm2) with 30 diffusion encoding directions per b-value. TR/TE = 4800/95 ms, voxel size 3.0 x 3.0 x 3.0 mm3, one average with 10 extra b = 0 images, slice and phase accelerations of 2 and 2, respectively, with Full Fourier encoding with gradients in performance mode (total scan duration: 5 min 51 s).

*Diffusion Image Processing*

For each subject, raw diffusion imaging data were denoised with a principal component analysis approach (Veraart et al., 2016), the method of moments (Gudbjartsson & Patz, 1995) was utilized to reduce Rician noise bias, and a Gibbs ringing correction (Kellner, Dhital, Kiselev, & Reisert, 2016) was applied. A DKI (Jensen & Helpern, 2010; Jensen, Helpern, Ramani, Lu, & Kaczynski, 2005) analysis was performed with the *b*-values of 0, 1000 and 2000 s/mm2. Diffusional Kurtosis Estimator (DKE) (<http://www.nitrc.org/projects/dke/>) was used to obtain the diffusion tensor along with the fractional anisotropy (FA), mean diffusivity (MD), and mean kurtosis (MK) (Tabesh, Jensen, Ardekani, & Helpern, 2011). A white matter (WM) mask, used to seed fiber tractography (WMFT), was defined as all voxels with MD < 1.5 µm2/ms and MK > 1 (Yang et al., 2013). Using the *b*-values of 0 and 6000 s/mm2, a fiber ball imaging (FBI) (Jensen, Glenn, & Helpern, 2016; Moss, McKinnon, Glenn, Helpern, & Jensen, 2019) analysis was performed with spherical harmonic coefficients, up to *l* = 6, with the dMRI signal determined voxel-wise using linear least-squares fitting (Descoteaux, Angelino, Fitzgibbons, & Deriche, 2007; Hess, Mukherjee, Han, Xu, & Vigneron, 2006). A fiber orientation density/distribution function (fODF) in each voxel and the FBI axon-specific measures (ζ and FA-axonal, FAA) were calculated. Diffusion Tensor Imaging (DTI) ellipsoids and FBI fODFs are visualized here using MRTrix3 ([www.mrtrix.org](http://www.mrtrix.org)). Whole-brain deterministic WMFT was performed (Jeurissen, Descoteaux, Mori, & Leemans, 2019) with the directions in each voxel being determined from the DTI ellipsoid or the FBI fODF. A total of 250,000 seed points were distributed randomly throughout the WM mask with a step size of 0.1 mm and a minimum track length of 30 mm. Tracks were terminated whenever the FA dropped below 0.1 or the angular change in direction was greater than 35°. WMFT was segmented using WM regions-of-interest from the Johns Hopkins WM atlas in TrackVis ([www.trackvis.org](http://www.trackvis.org)). WM tracts were then transformed into MNI space for visualization with SurfIce (<https://www.nitrc.org/projects/surfice/>).

*Cortical Thickness Analysis*

The T1 images were segmented using FreeSurfer 6.0, a widely available image analysis suite for generating cortical thickness measurements (http://surfer.nmr.mgh.harvard.edu/). All images were processed using the “recon-all -all” pipeline with the default set of parameters. The resultant .aseg file was uploaded to the program developed by Potvin et al. (2017) that derives normative morphometric data for FreeSurfer-segmented cerebral cortical areas, adjusting for age, sex, and estimated total intracranial volume, using data from cross-sectional scans from 2,713 healthy individuals ages 18 to 94 years obtained from 21 independent research groups. Their NormsCalculator.app is downloaded through the paper’s supplementary material: doi:10.1016/j.neuroimage.2017.05.019. The cortical thickness z-scores were then plotted using the ggplot2 library in R (Figure 2.D), where the region of interest data points are organized in the legend according to the lobar designations per Desikan et al. (2006).

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