Supplementary Table 1. Detailed imaging parameters.

	Ultra-high gradient strength MRI				**Ultra-high field strength MRI**
Scanner, field and gradient strength	Siemens MAGNETOM Skyra CONNECTOM, 3 T, G_{max} 300 mT/m, slew rate 200 T/m/s				Siemens MAGNETOM, 7 T, G_{max} 80 mT/m, slew rate 800 T/m/s
Sequence	***3D MEMPRAGE***	***3D T2 SPACE***	***3D T2 SPACE FLAIR***	***2D single-shot EPI***	***2D FLASH***
Resolution (mm)	1.0 isotropic	1.0 isotropic	1.0 isotropic	1.5 isotropic	0.33 × 0.33 × 1.0, 25 % gap
Number of slices	176	176	176	96	40+40 slices (5 overlapping)
Flip angle (°)	7	T2 variable	T2 variable	90	55
Echo/repetition/inversion times (ms)	1.15, 3.03, 4.89, 6.75 / 2530 / 1100	560 / 3200 / -	393 / 5000 / 1800	57 / 8800 / -	21.8 / 1700 / -
Diffusion encoding b-value (s/mm^2)*,	-	-	-	15 b0, 1000, 64 / 5000, 128; 140	-

directions; EPI factor					
Acceleration: GRAPPA factor, reference lines; Partial Fourier	2, 32; -	2, 32; -	2, 24; 7/8	3, 84; 6/8	2, 32; -
Acquisition time (min)	6:02	4:46	6:32	11:44 / 21:51	15:14

EPI = echo planar imaging; FLAIR = fluid-attenuation inversion recovery; FLASH = fast low-angle shot T_2*-weighted spoiled gradient-echo; GRAPPA = generalized auto-calibrating partially parallel acquisitions; MEMPRAGE = multi-echo magnetization-prepared rapid gradient-echo; T_2-weighted sampling perfection with application optimized contrasts using different flip angle evolution (T2-SPACE). *Diffusion gradient pulse duration/diffusion time (δ/Δ): 12.9/21.8 ms; gradient amplitude: G = 62 mT/m for b = 1000 s/mm^2, G = 146 mT/m for b = 5000 s/mm^2.

Supplementary Table 2. Scan-rescan reproducibility of diffusion metrics in four healthy subjects.

		Intracellular volume fraction	Isotropic volume fraction	Orientation dispersion index	Fractional anisotropy	Mean diffusivity
Cortex at mid-cortical depth (surface-based)	Mean ± standard deviation	0.425 ± 0.046	0.024 ± 0.003	0.543 ± 0.057	0.184 ± 0.039	0.805 ± 0.010
	Absolute difference	0.0065	0.0036	0.0080	0.0056	0.0145
	Coefficient of variation	1.09%	10.5%	1.04%	2.14%	1.26%
Cortex (volume-based)	Mean ± standard deviation	0.432 ± 0.004	0.116 ± 0.004	0.530 ± 0.005	0.191 ± 0.003	0.842 ± 0.010
	Absolute difference	0.0058	0.0063	0.0066	0.0044	0.0140
	Coefficient of variation	0.96%	3.70%	0.87%	1.60%	1.17%
White matter (volume-based)	Mean ± standard deviation	0.635 ± 0.006	0.149 ± 0.019	0.305 ± 0.002	0.428 ± 0.005	0.767 ± 0.018
	Absolute difference	0.0084	0.0264	0.0025	0.0074	0.0258
	Coefficient of variation	0.95%	12.4%	0.57%	1.23%	2.36%

Mean diffusivity reported as $\mu m^2/s$. All values were calculated per subject and are reported as the average across all four healthy controls. Surface-based metrics were extracted as the mean value at mid-cortical depth and then averaged across the left and right hemisphere. Mean ± standard

deviation was calculated across Scan 1 and Scan 2. The absolute difference was calculated as: |(Scan 1 − Scan 2)|. The within-subject coefficient of variation was calculated according to the following equation: Standard deviation (Scan 1, Scan 2) / Mean (Scan 1, Scan 2).