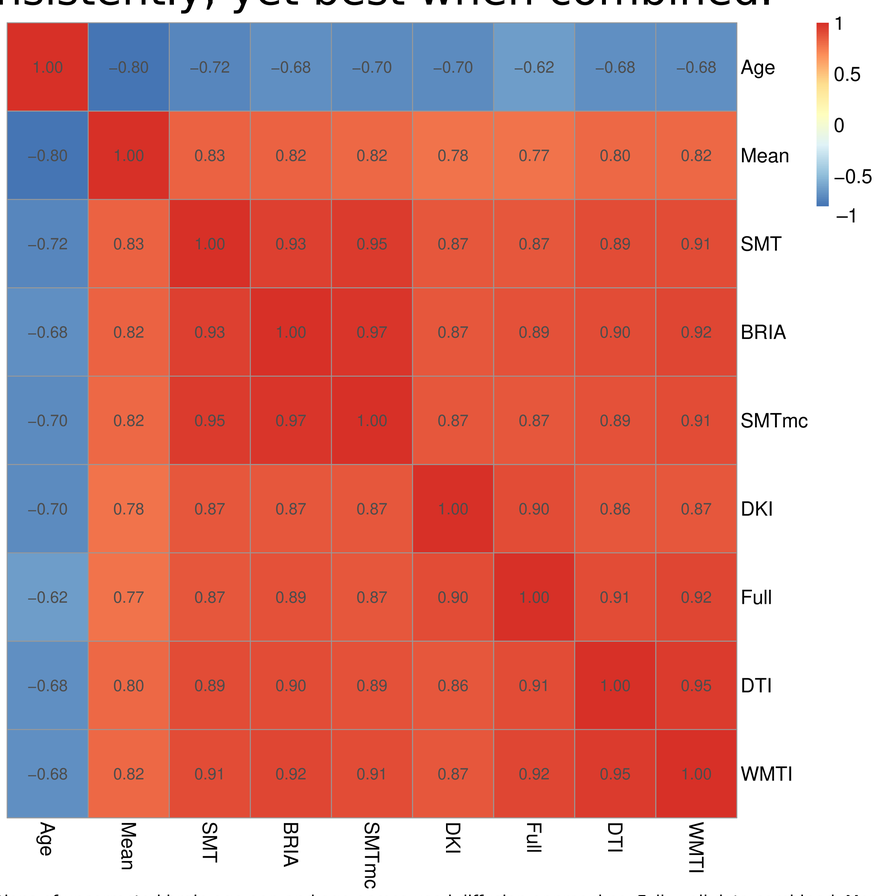
Fornix and forceps are key regions of white matter brain age

Brain-wide associations between white matter and age highlight the role of fornix microstructure in brain ageing

Background: Unveiling the details of white matter maturation throughout ageing is a fundamental question for understanding the ageing brain. In an extensive comparison of brain age predictions and age-associations of WM features from different diffusion approaches, we analyzed UK Biobank diffusion magnetic resonance imaging data across midlife and older age ($N = 35{,}749$, 44.6–82.8 years of age).

Result 1: Conventional and advanced diffusion MRI approaches predict brain age consistently, yet best when combined.

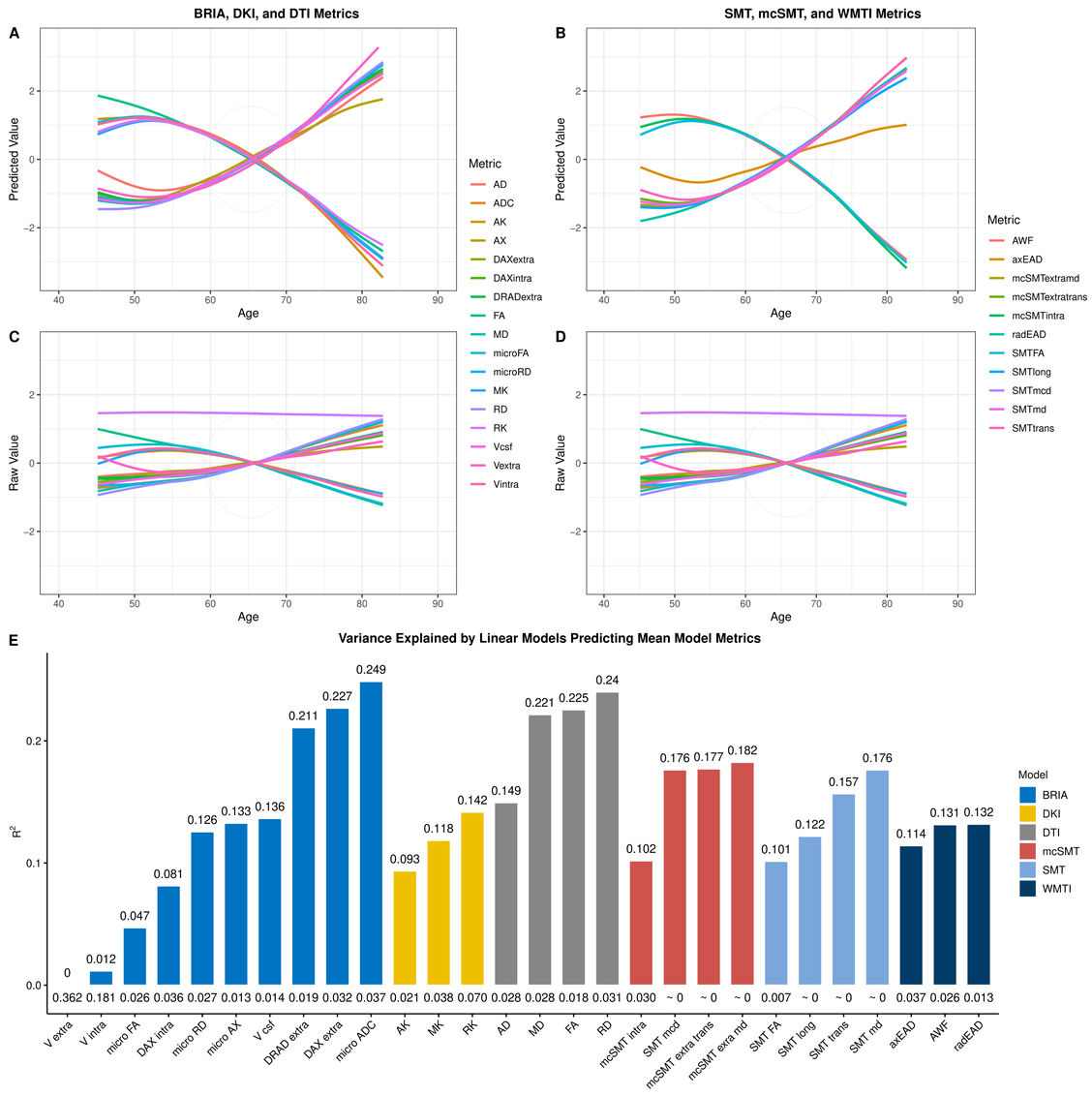


Correlations of uncorrected brain age gap and age across used diffusion approaches. Full = all data combined. Mean = multimodal whole-brain averaged metrics.

Result 2: Fornix and forceps minor features explained most variance in age across diffusion approaches.

BRIA	DKI	DTI	SMT	mcSMT	WMTI	Multimodal
Micro FA fornix 0.1954±0.0027	AK right anterior limb of internal capsule 0.0984±0.0014	MD fornix 0.0712±0.0013	MD fornix 0.0795±0.0018	Extratrans fornix 0.0498±0.0013	AWF fornix 0.1699±0.0023	Micro FA fornix 0.0914±0.0011
Vextra forceps minor 0.0278±0.0007	RK fornix 0.0884±0.0016	FA forceps minor 0.0533±0.0011	FA right superior longitudinal fasciculus 0.0267±0.0007	Intra forceps minor 0.0444±0.0009	radEAD fornix to right striaterminalis 0.0283±0.0007	AK anterior limb of internal capsule 0.0055±0.0011
Vextra body of the corpus callosum 0.0261±0.0007	MK left external capsule 0.0259±0.0006	RD fornix to right Striaterminalis 0.0462±0.0009	Longitudinal fornix 0.0251±0.0006	Intra fornix 0.0289±0.0009	AWF forceps minor 0.0194±0.0005	FA forceps minor 0.0219±0.0006
Micro FA fornix to right Striaterminalis 0.0203±0.0006	MK right superior longitudinal fasciculus 0.0214±0.0006	FA right superior cerebellar peduncle 0.0221±0.0006	Trans fornix to right striaterminalis 0.0204±0.0006	Extratrans fornix to right Striaterminalis 0.0201±0.0006	axEAD forceps minor 0.0193±0.0007	RD right fornix stria terminalis 0.0214±0.0006
Vintra right superior cerebellar peduncle 0.0194±0.0006	RK forceps minor 0.0208±0.0005	FA body of the corpus callosum 0.0218±0.0006	FA fornix 0.0192±0.0006	Extratrans right external capsule 0.0163±0.0007	axEAD left posterior limb of internal capsule 0.0173±0.0006	AK Genu corpus callosum 0.0095±0.0003

Result 3: We present general patterns of white matter deterioration for higher ages in fornix, forceps minor, and across the brain.



Panels A–D show age curves for each standardized (z-score) diffusion metric's mean skeleton value (y-axis) plotted as a function of age (x-axis). Diffusion metrics in panels A-B were corrected for sex and scanner site.

Conclusion: We encourage the application of multiple dMRI approaches for detailed insights into WM, and the further investigation of fornix and forceps as potential biomarkers of brain age and ageing.

Western Norway University of Applied Sciences
NORMENT

Max Korbmacher (makor@hvl.no), Ann Marie de Lange, Dennis van der Meer, Dani Beck, Eli Eikefjord, Arvid Lundervold, Ole A. Andreassen, Lars T. Westlye, Ivan I. Maximov

To the paper