# Advanced diffusion modeling characterizes FLAIR white matter hyperintensity types in an aging cohort

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# Background

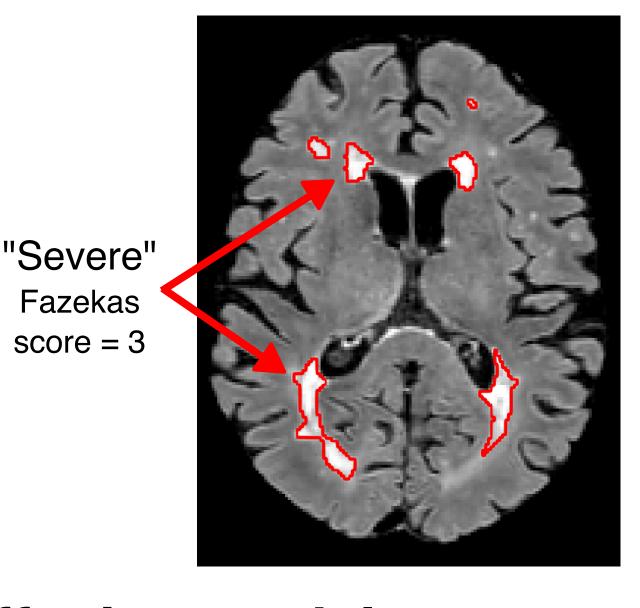
- White matter hyperintensities (WMH) in fluid-attenuated inversion recovery (FLAIR) MRI images are used as an indicator of clinical conditions ranging from multiple sclerosis to cerebrovascular disease<sup>[1,2]</sup>.
- Diffusion MRI (dMRI) and diffusion modeling provides biophysically interpretable tissue properties.

Goal: Use diffusion modeling to characterize the underlying biophysical properties of FLAIR WMH.

### Methods

#### FLAIR processing:

- FLAIR WMH were segmented with a convolutional neural network, HyperMapp3r<sup>[3]</sup>.
- · WMH regions of interest were categorized as either periventricular (left) or deep (right) WMH.





"Moderate" Fazekas score = 2

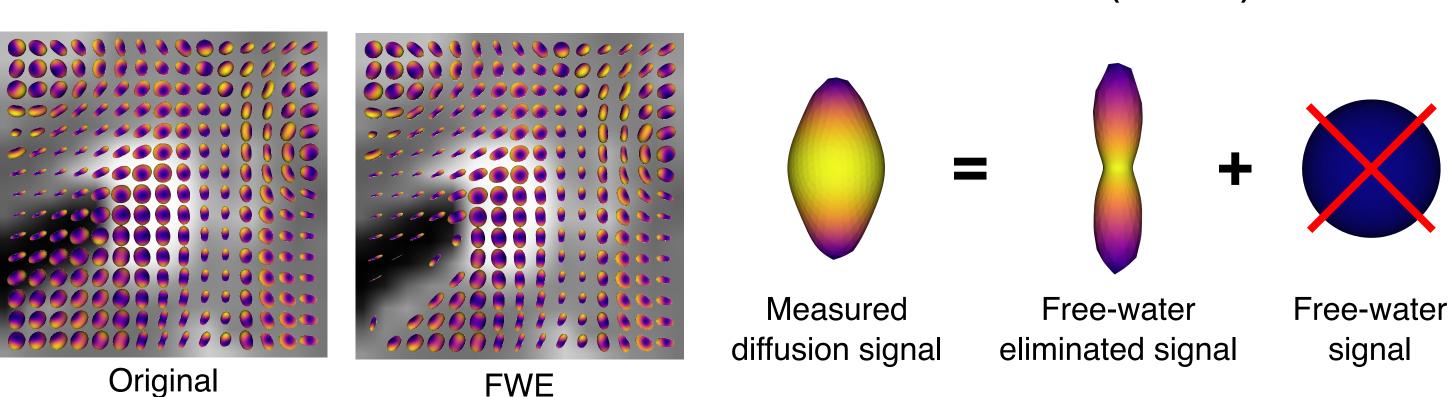
#### **Diffusion models:**

- Diffusion kurtosis imaging (DKI) and its White Matter Tract Integrity extension<sup>[4]</sup>.
- Free-water diffusion tensor imaging (FWDTI)<sup>[5]</sup>.
- Mean apparent propagator MRI (MAPMRI)<sup>[6]</sup>.
- Neurite orientation dispersion and density imaging (NODDI)<sup>[7]</sup>.

## **Extracellular water** Intracelluar directionality / mk Baseline at 0 non-Gaussian = NAWM fwdtinoddi-

#### **Tractography methods:**

 Tractography was performed with pyAFQ<sup>[8]</sup> on the original diffusion data and after free-water elimination (FWE)[9].



# Acknowledgements

**FWE** 



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#### References

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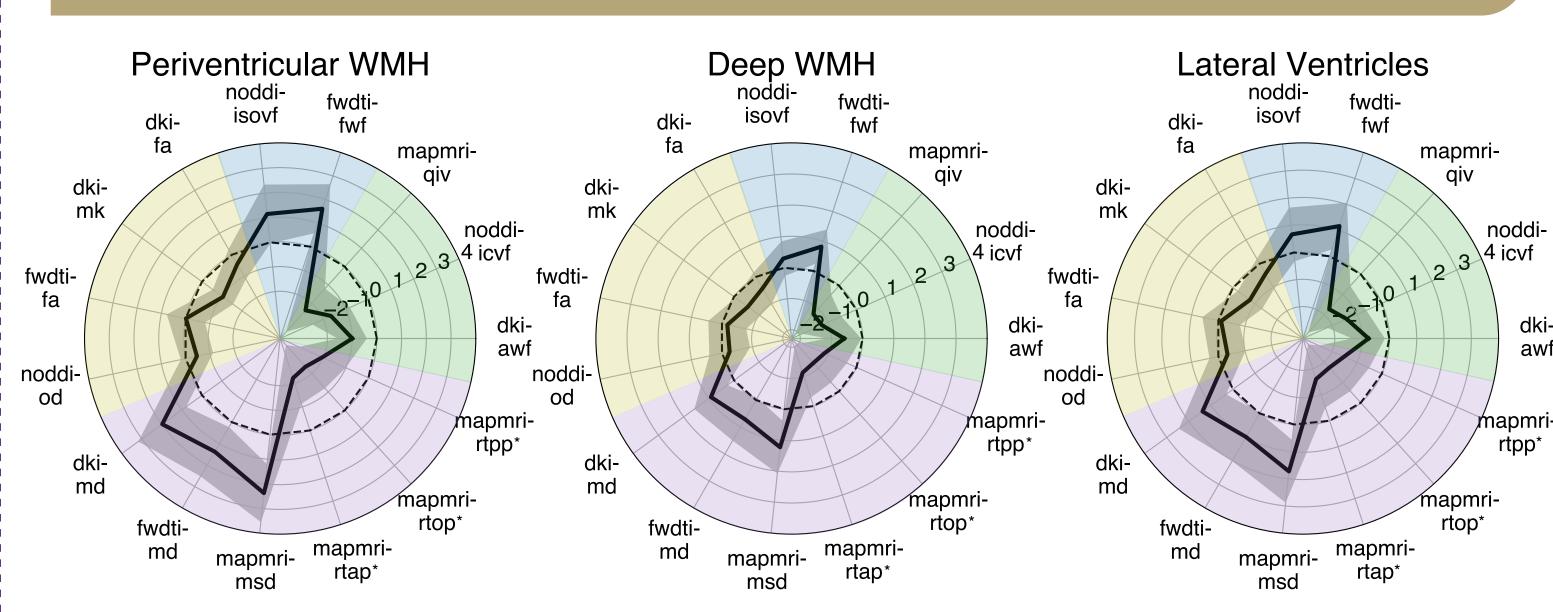
[6] Özarslan et al. (2013). Neurolmage. [7] Zhang et al. (2012). Neurolmage. [8] Kruper et al. (2021). Aperture Neuro. [9] Henriques et al. (2017). bioRxiv.







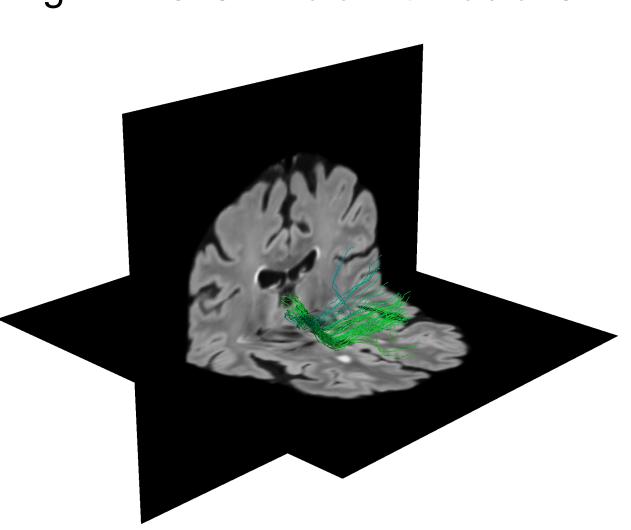
### Results

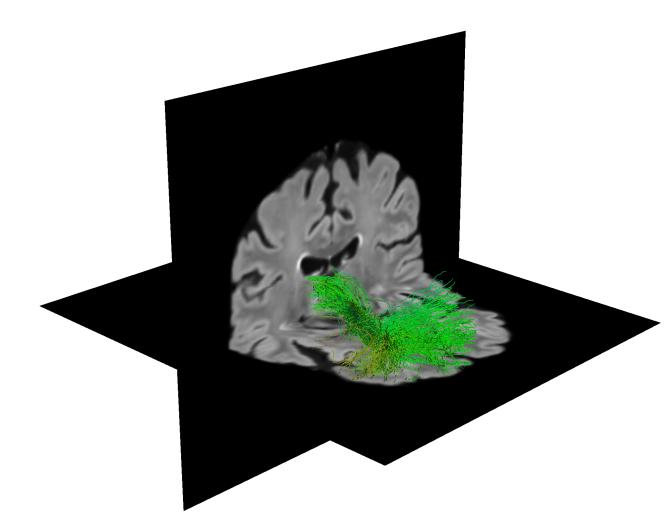


- FLAIR WMH are characterized by increased mean diffusivity and extracellular water, especially in periventricular WMH.
- Periventricular WMH's dMRI metric pattern resembles those of the lateral ventricles

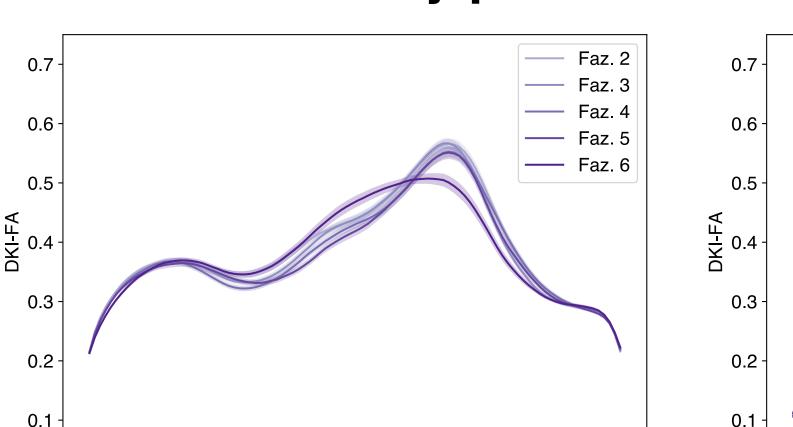
Original Tractography Right Anterior Thalamic Radiation

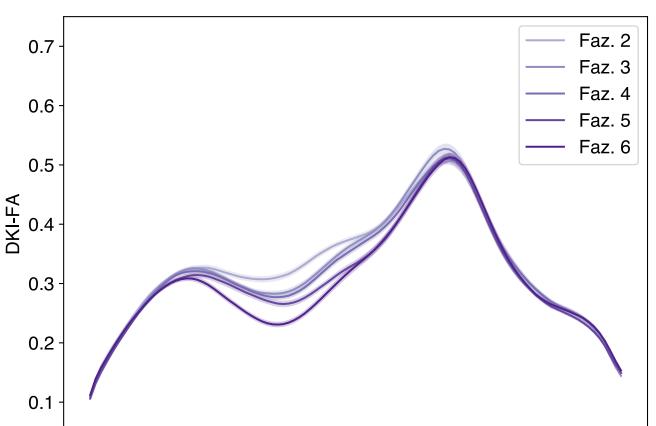
FWE Tractography Right Anterior Thalamic Radiation



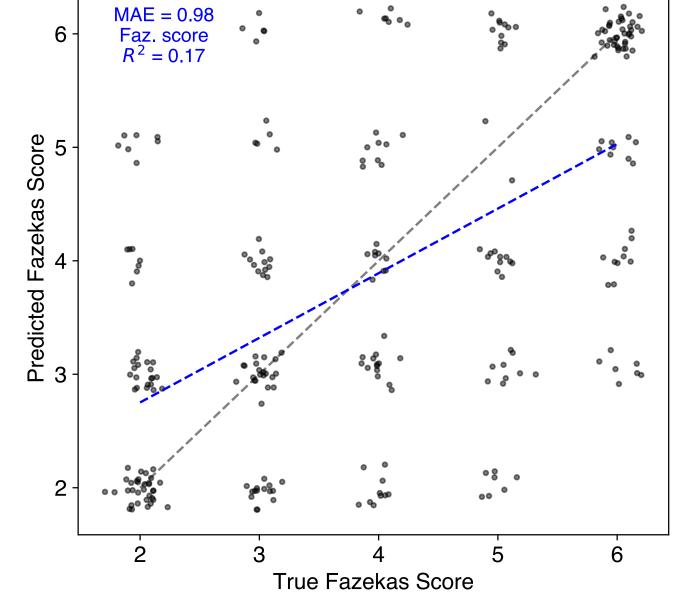


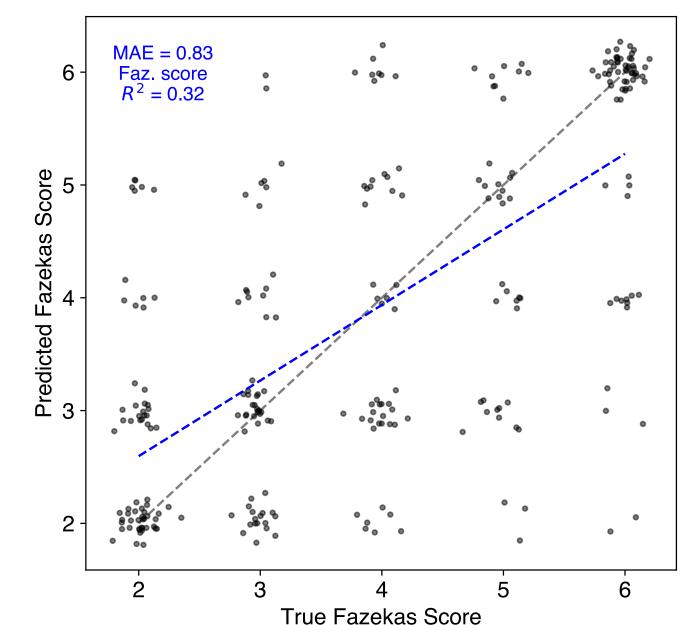
FWE tractometry produced fuller tractography results.





FWE tractometry produced tract profiles that better represent Fazekas scores.





FWE tract profiles predict Fazekas scores accurately than original tract profiles.

### Conclusions

- The patterns observed indicate that periventricular and deep WMH tissue begins to resemble ventricles more than NAWM, particularly in the case of periventricular WMH.
- Free-water elimination in aging brains prior to tractometry increases the reliability in all steps of tractometry and improves the accuracy in classification phenotypes.