

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

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# Background

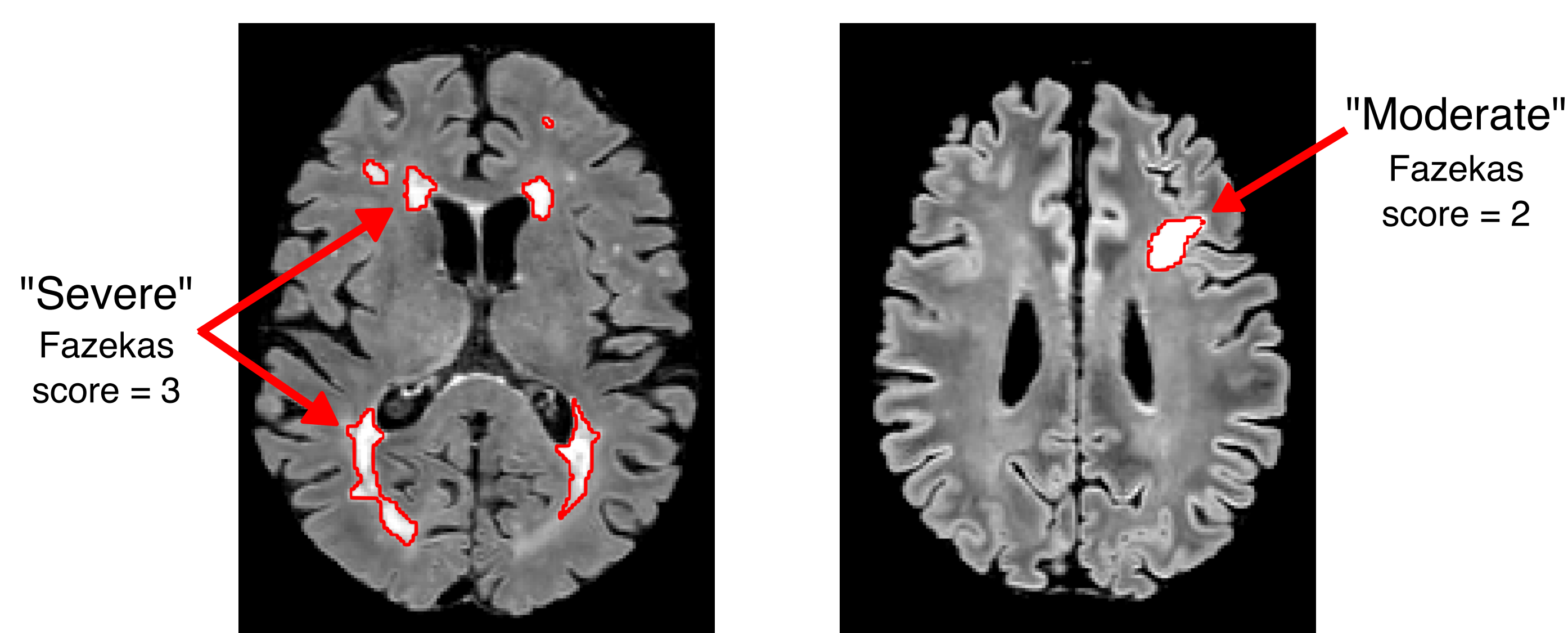
- White matter hyperintensities (WMH) in fluid-attenuated inversion recovery (FLAIR) MRI images are used as an indicator of clinical conditions ranging from multiple sclerosis to cerebrovascular disease<sup>[1,2]</sup>.
- Diffusion MRI (dMRI) and diffusion modeling provides biophysically interpretable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

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

## Methods

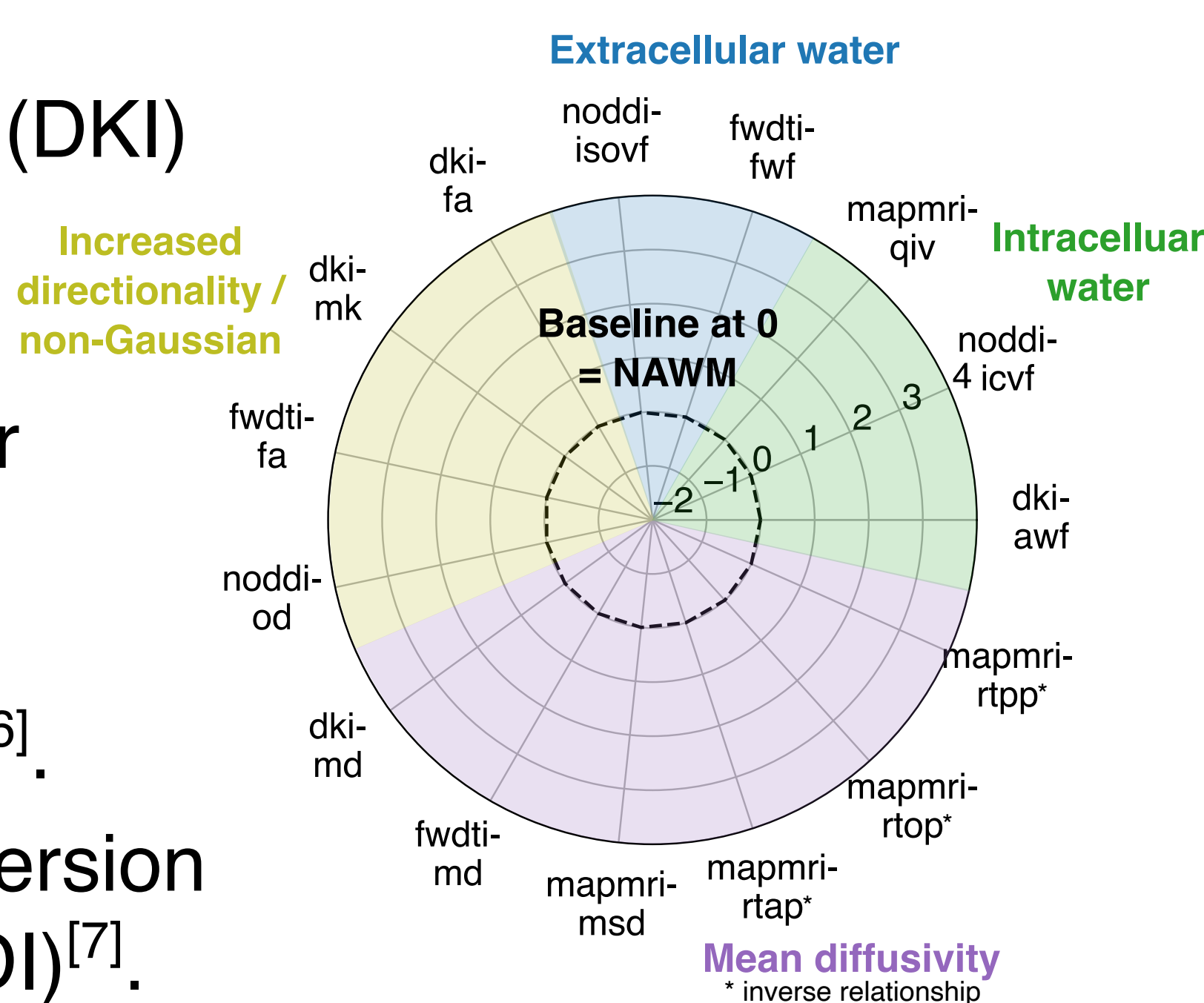
## FLAIR processing:

- 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.



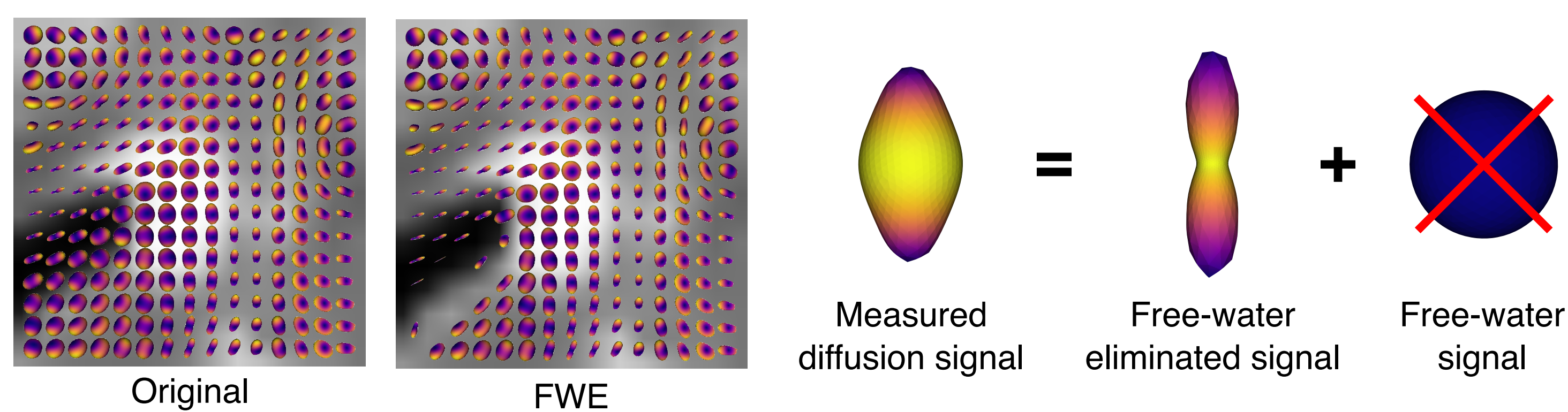
## Diffusion models:

- Diffusion kurtosis imaging (DKI) and its White Matter Tract Integrity extension<sup>[4]</sup>. Increase directional non-Gaussianity
- 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>.



## Tractography methods:

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



## Acknowledgements



Acknowledgements.  
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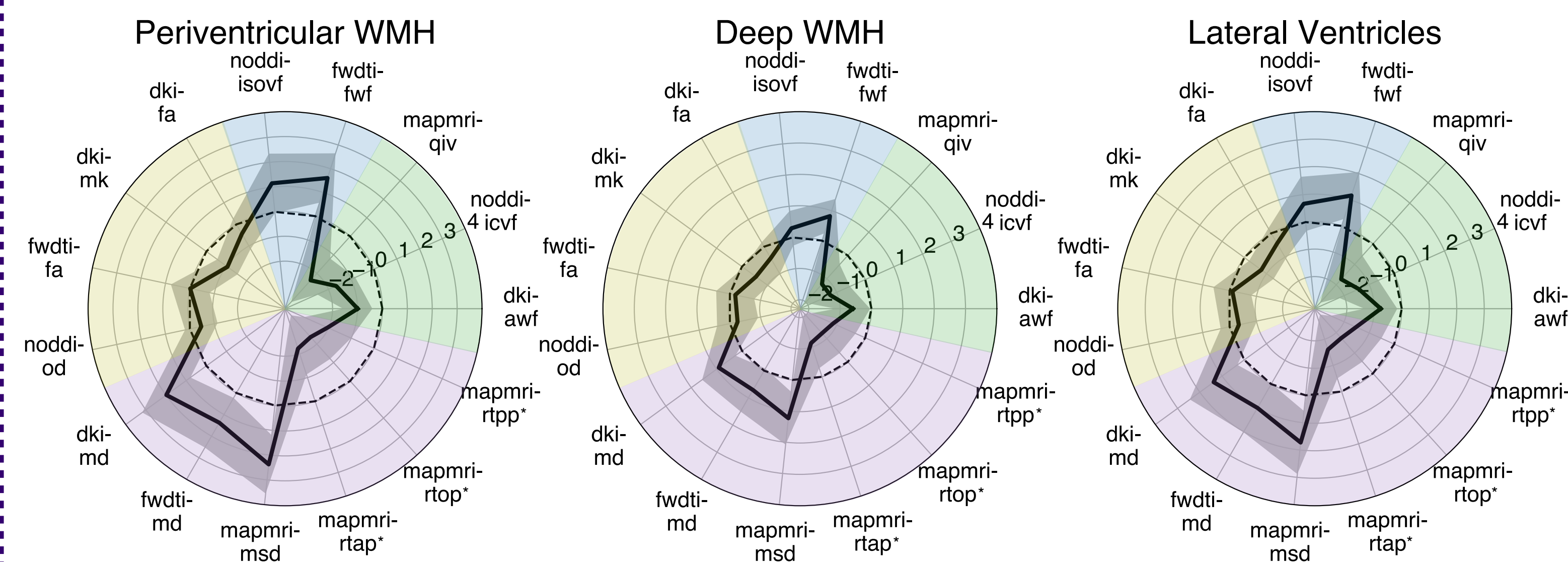


## References

- [1] Ferris et al. (2022). *Brain Communications*.  
 [2] Preziosa et al. (2023). *Journal of Neurology*.  
 [3] Forooshani et al. (2022). *Human Brain Mapping*.  
 [4] Jensen et al. (2005). *Magn Reson Med*.  
 [5] Hov et al. (2014). *NeuroImage*.  
 [6] Özarslan et al. (2013). *NeuroImage*.  
 [7] Zhang et al. (2012). *NeuroImage*.  
 [8] Kruper et al. (2021). *Aperture Neuro*.  
 [9] Henriques et al. (2017). *bioRxiv*.



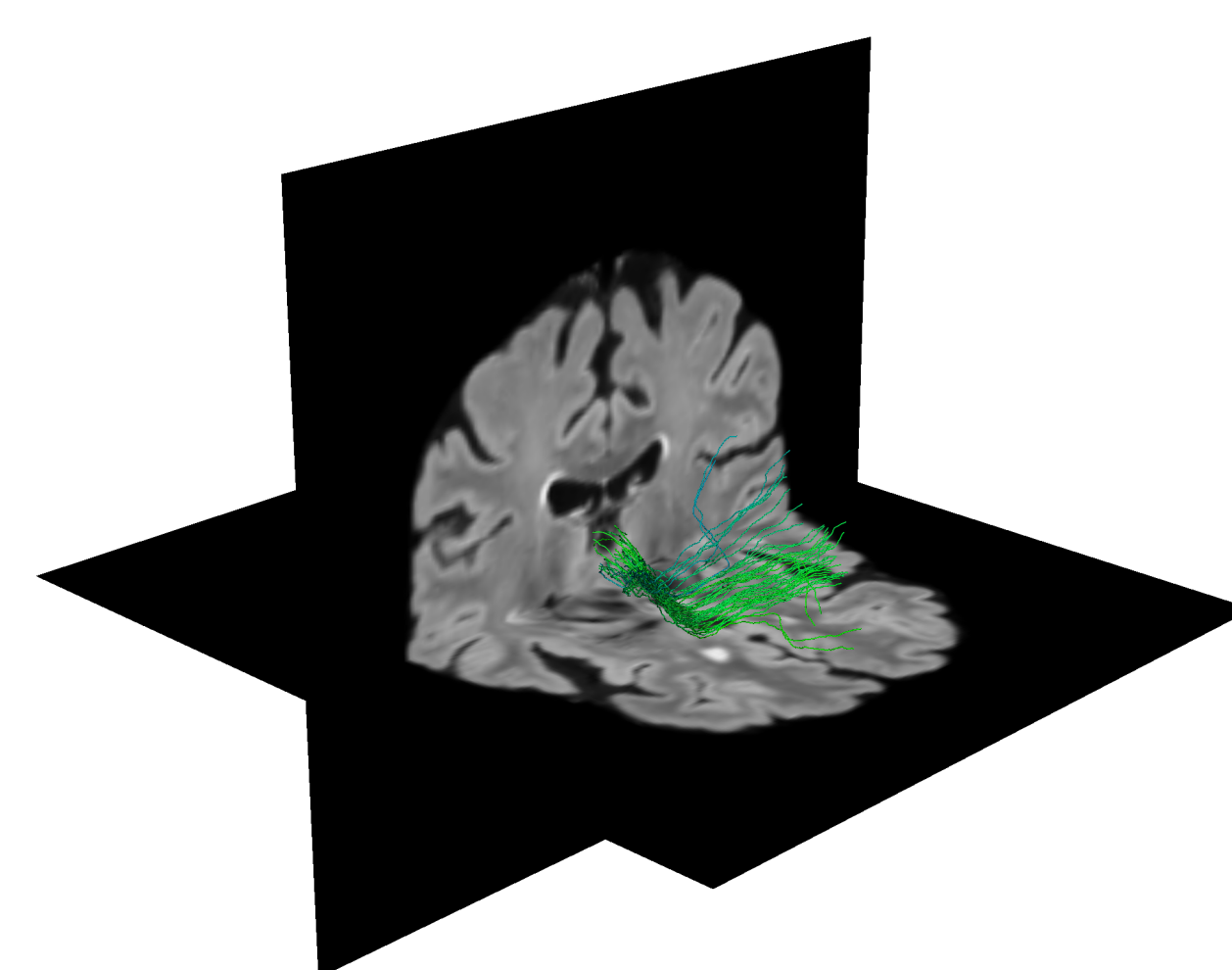
## Results



- **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

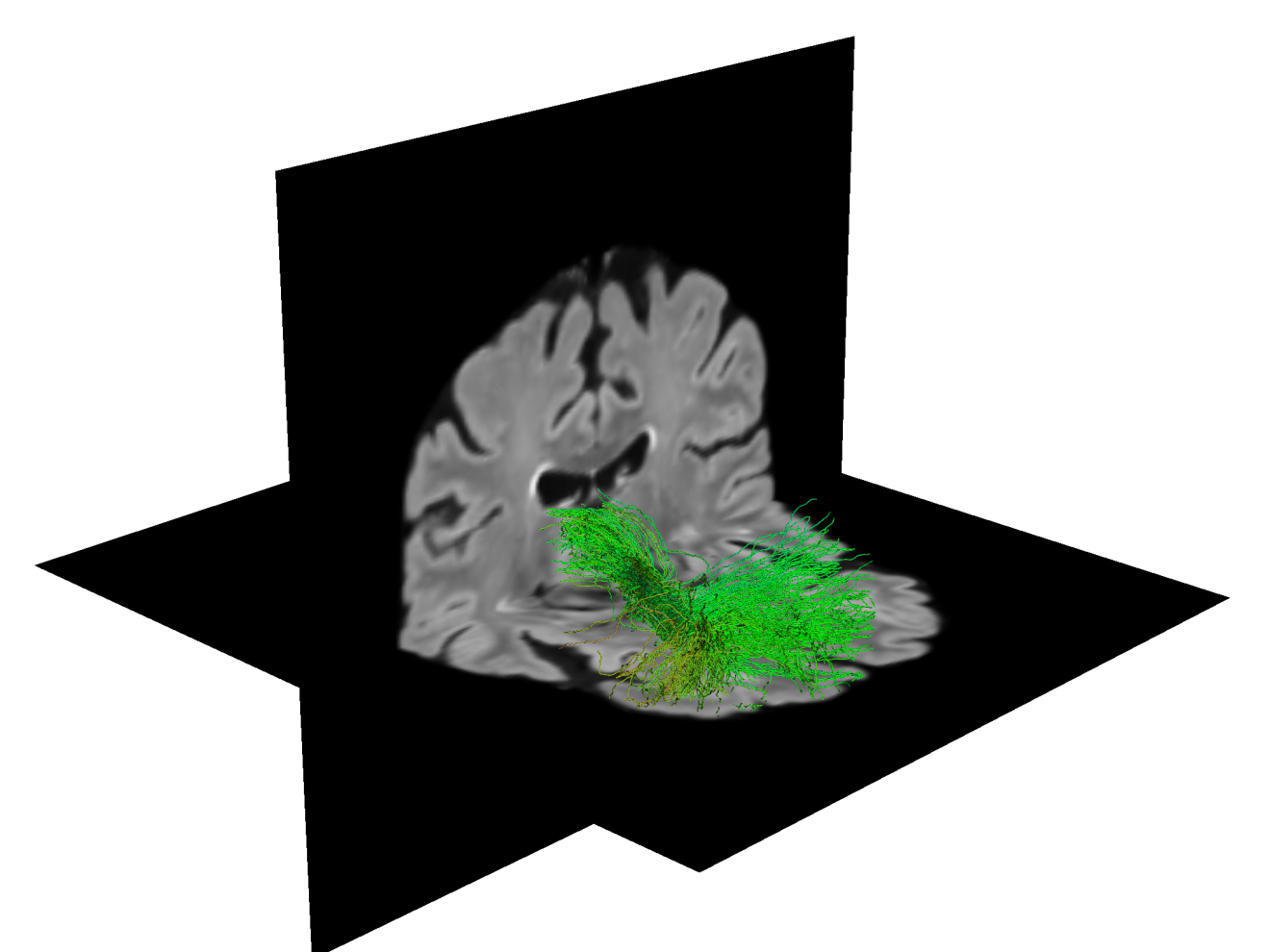
## Original Tractography

### Right Anterior Thalamic Radiation

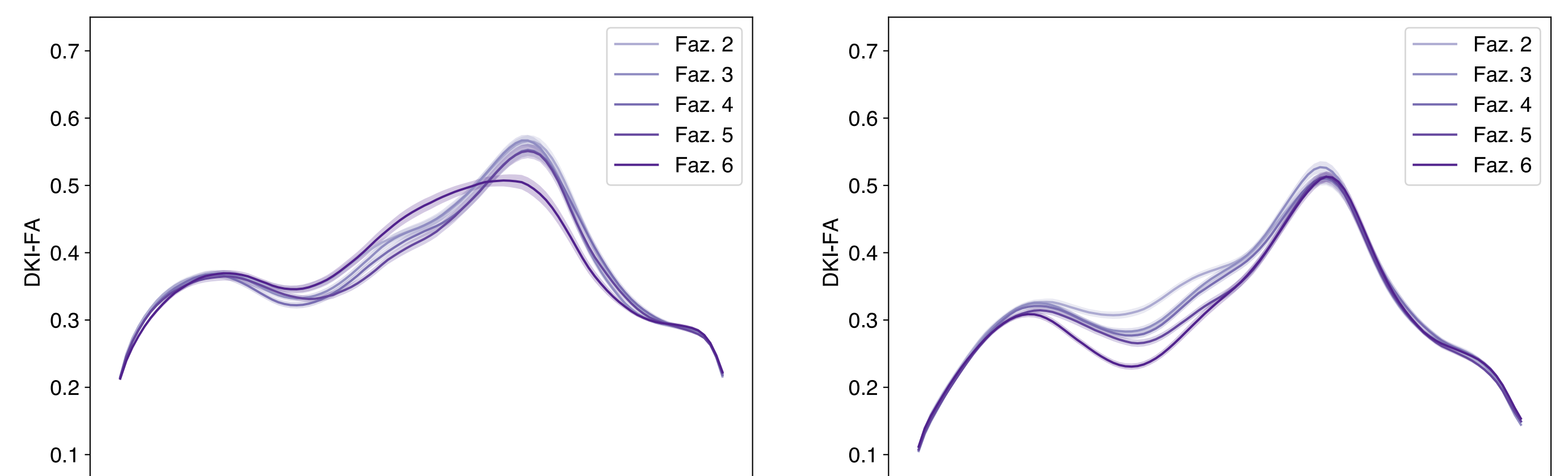


## FWE Tractography

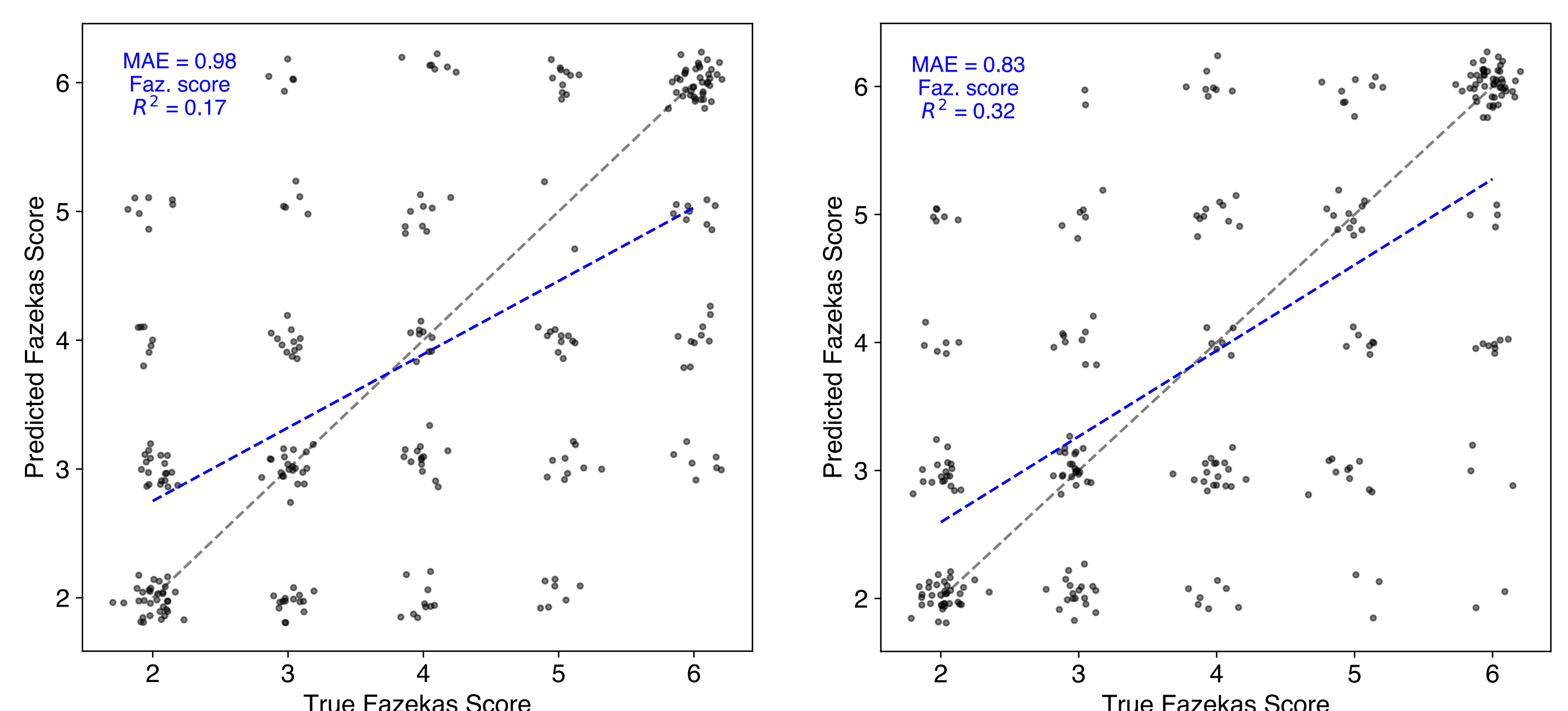
### Right Anterior Thalamic Radiation



- **FWE tractometry produced fuller tractography results.**



- **FWE tractometry produced tract profiles that better represent Fazekas scores.**



- **FWE tract profiles predict Fazekas scores more 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 of aging brains is a *necessary* step prior to tractometry to reconstruct more reliable and accurate bundle profiles, especially in the presence of WMH.