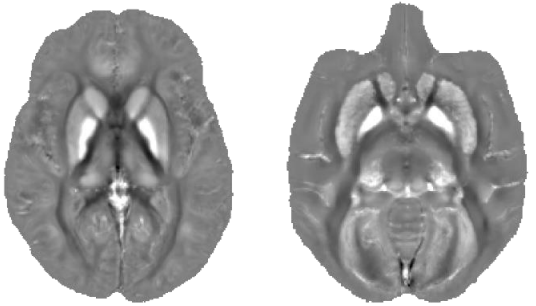
Quantitative Susceptibility Mapping (QSM): Echo time dependence in the human and nonhuman primate brain

Rakshit Dadarwal[1,2,3], Amir Moussavi[1], Susann Boretius[1,2]

[1]Functional Imaging Laboratory, German Primate Center, Göttingen, Germany

[2]Max Planck Institute for Experimental Medicine, Göttingen, Germany

[3]University of Göttingen, Göttingen, Germany



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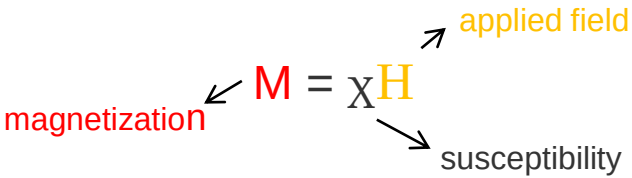
Abstract ID: A-1586

Magnetic Susceptibility

Magnetic susceptibility is a response of a material to an applied external magnetic field



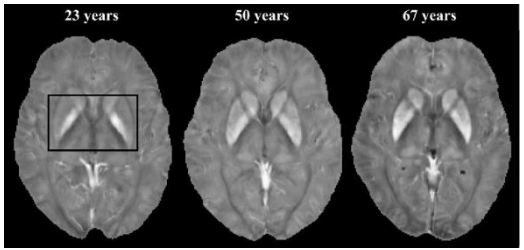
$$B = \mu_0(M + H)$$

dictates, NMR frequency ($w = \gamma B$)

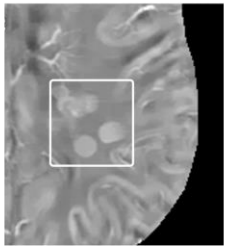
Quantitative Susceptibility Mapping

Quantitative measurement of magnetic susceptibility can be computed via QSM[1]

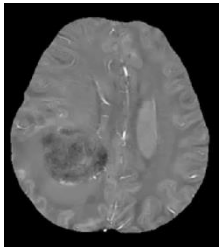
QSM can be used to detect brain tissue alteration in:



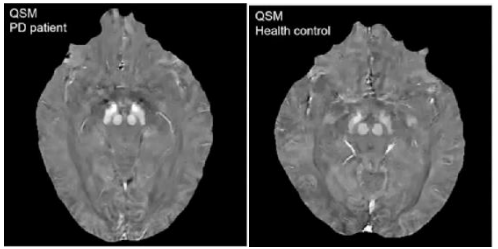
Healthy aging[2]



Multiple sclerosis[3]



Meningioma[4]

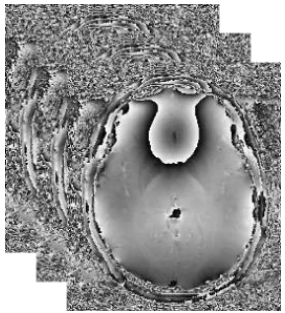


Parkinson's disease[5]

1. Haacke EM et al., 1995; 2. Persson Ninni et al. 2015; 3. Zhang Yan et al., 2016; 4 & 5. Eskreis-Winkler Sarah et al., 2017

Quantitative Susceptibility Mapping

Multi- GRE



Phase unwrapping

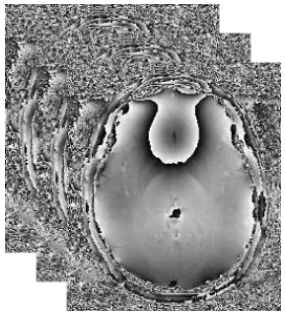
Background field extraction

Inversion

QSM map

Quantitative Susceptibility Mapping

Multi- GRE



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- Sood et al., “**Echo time-dependent quantitative susceptibility mapping contains information on tissue properties**”; MRM, 2017

Quantitative Susceptibility Mapping

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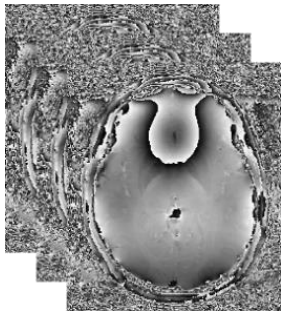

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Quantitative Susceptibility Mapping

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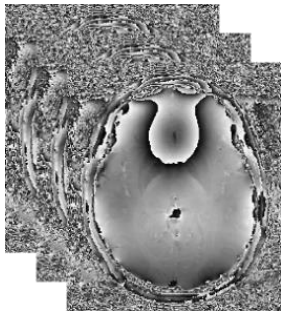

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- Lancione et al., “**Echo-time dependency of quantitative susceptibility mapping reproducibility at different magnetic field strengths**”; NeuroImage, 2019

Objective

Assessment of echo-time dependence in healthy human and monkey brain

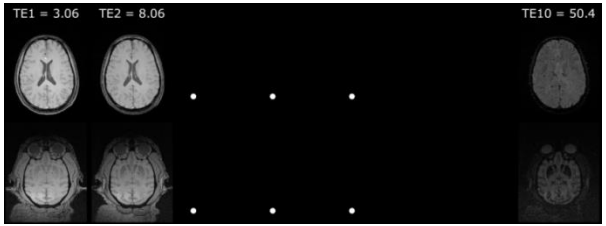
Data acquisition

Magnetic field strength = 3T (MAGNETOM Prisma, Siemens)

Subjects: 6 humans and 5 macaque monkeys

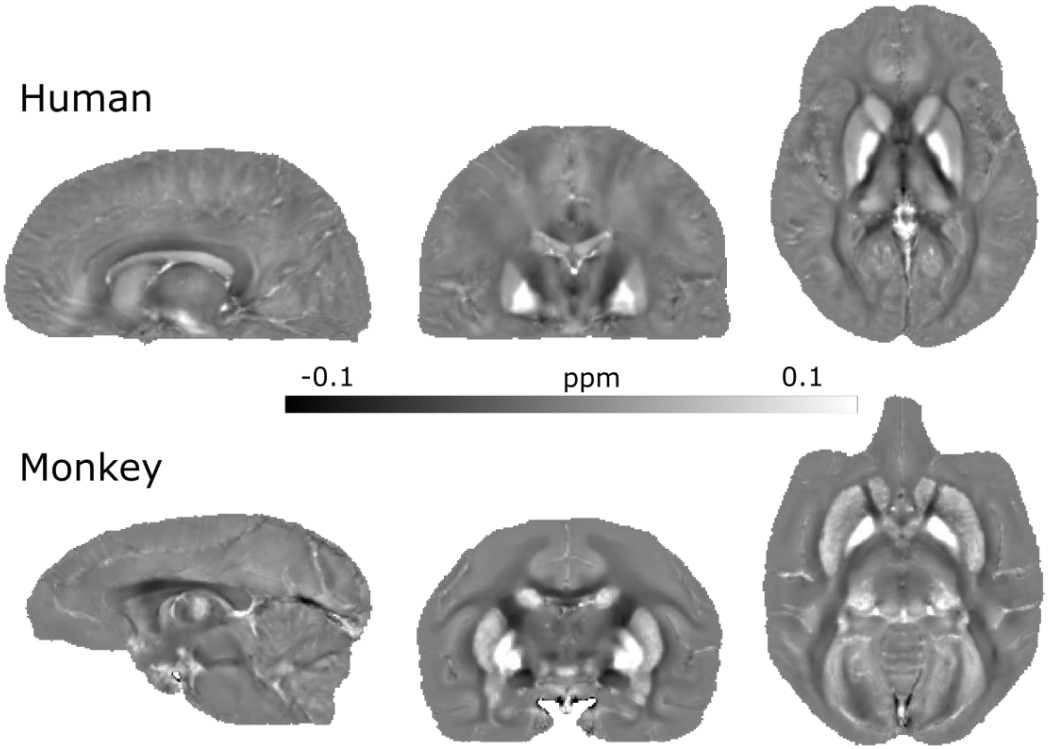
Pulse sequence = 3D Gradient echo

Echo times: 3 – 50 ms (10 TEs)



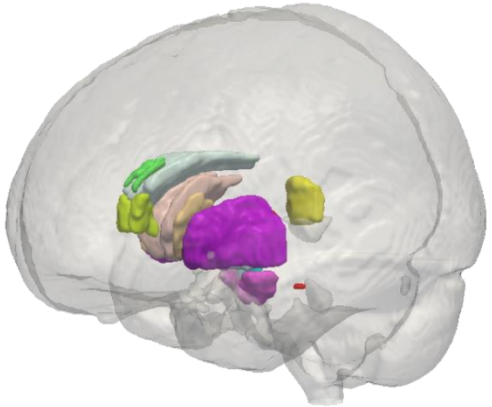
Voxel size (isotropic): 750 µm (Human)
310 µm (Monkey)

Human and monkey brain QSM

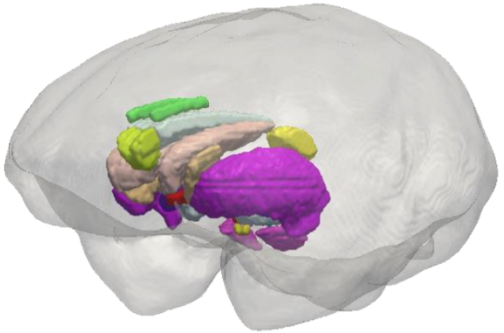


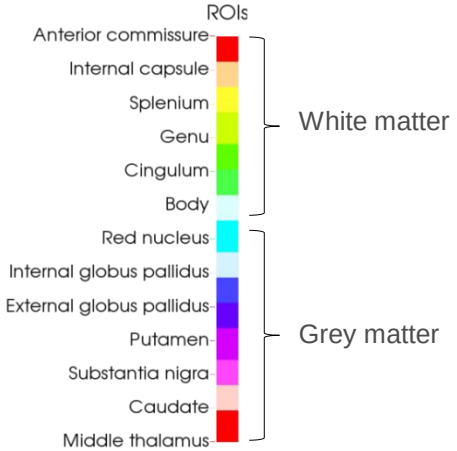
Regions of interest

Human

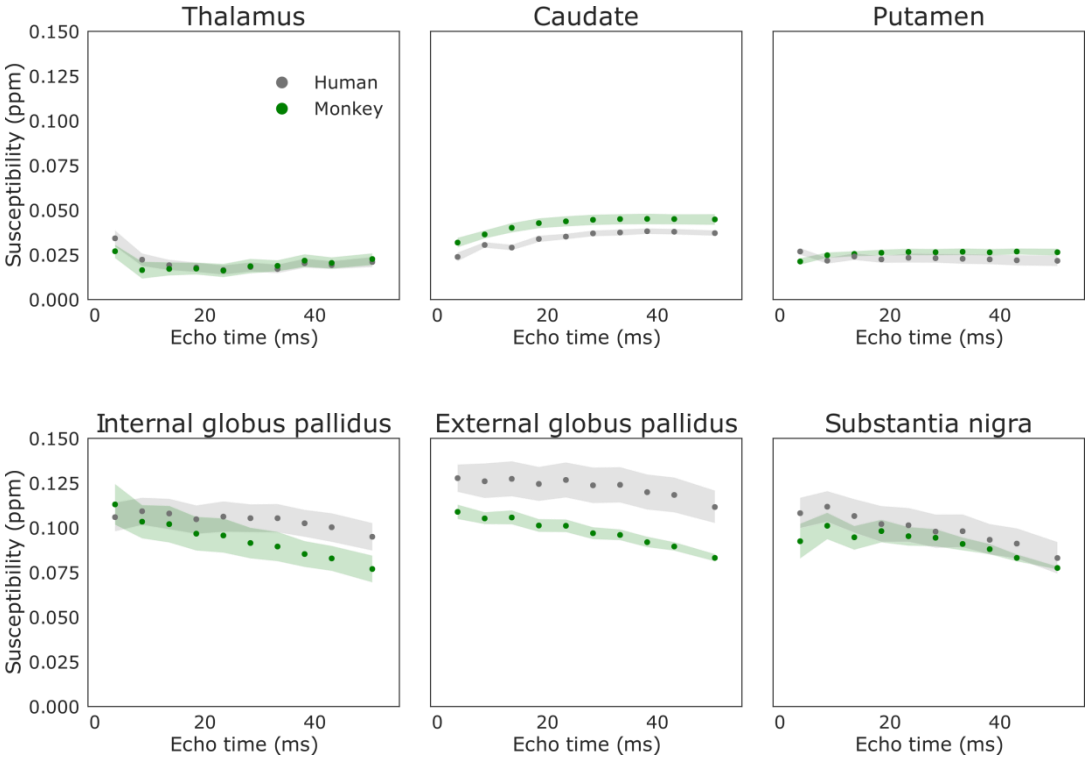


Monkey

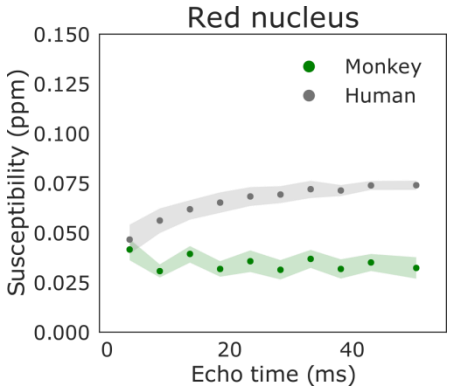




Grey matter TE dependence



Red nucleus TE dependence



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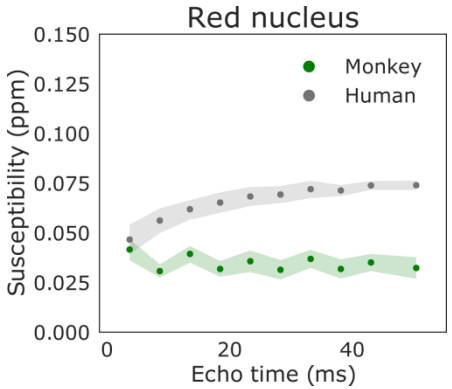

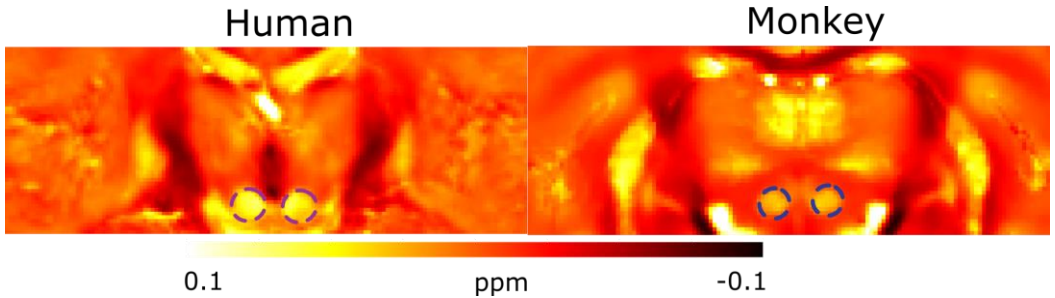

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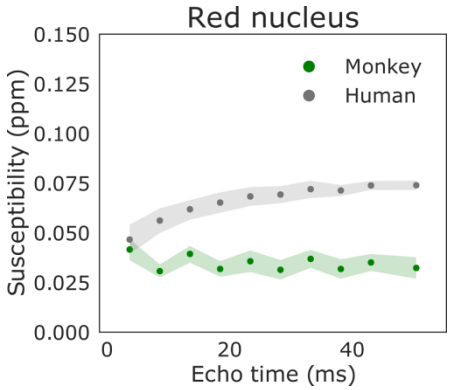
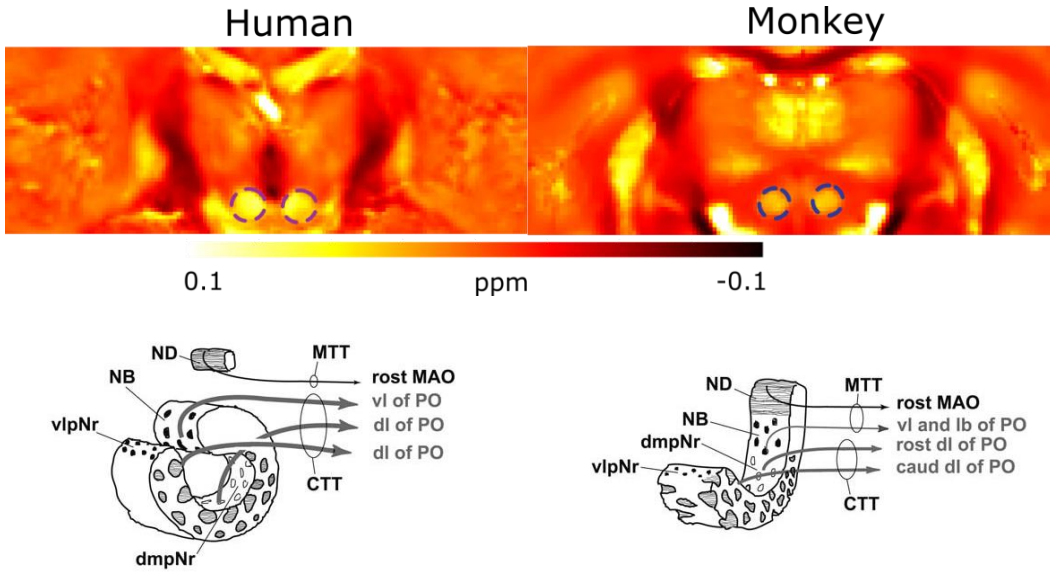
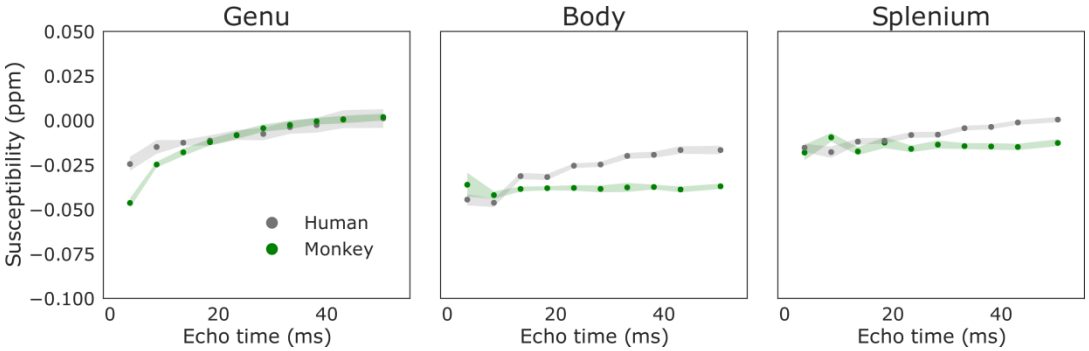




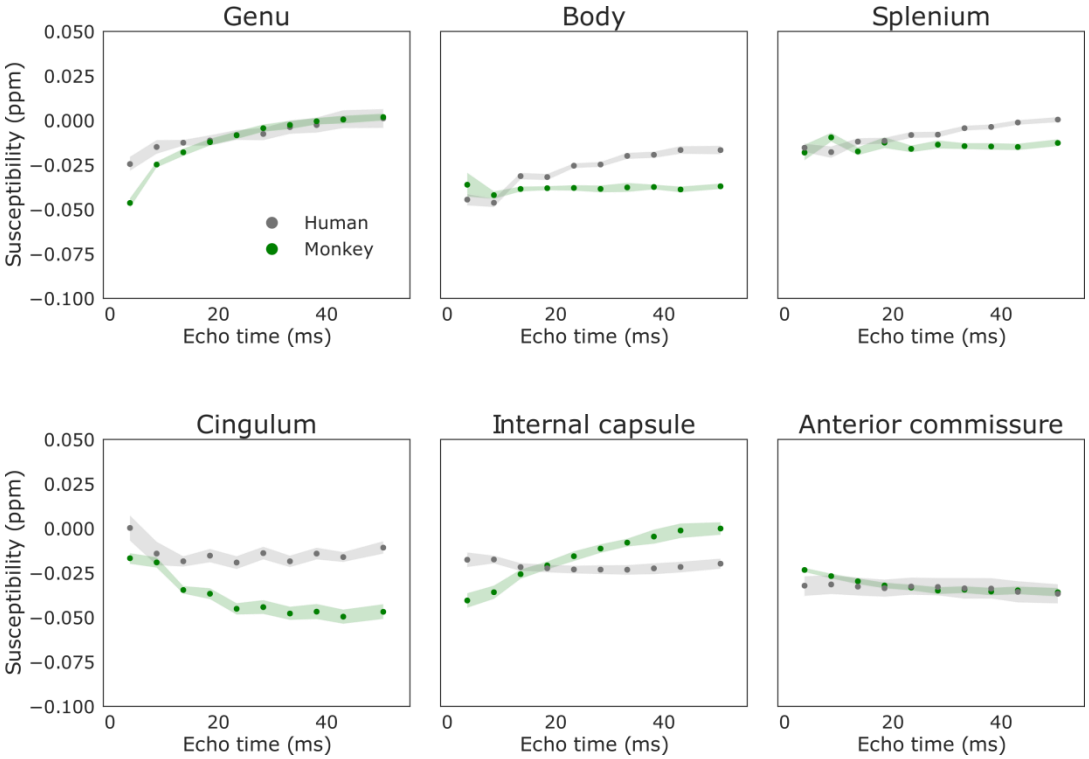
Neural sheet model of red nucleus

Onodera and Hicks, 2009

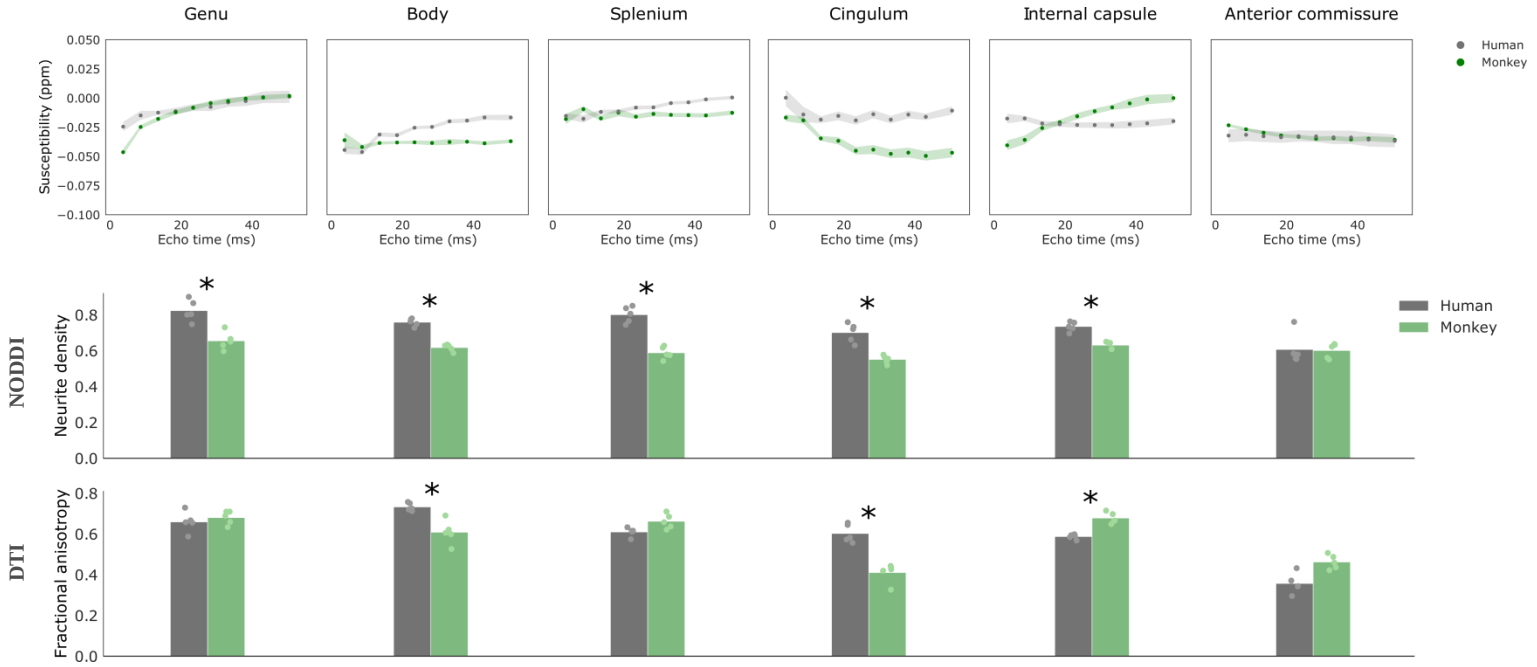
White matter TE dependence



White matter TE dependence



White matter TE dependence



$p < 0.008$ (Bonferroni corrected)

Conclusion

- QSM TE dependence was observed in the human and monkey brain
- TE dependence temporal profiles varied between the brain regions
- Larger structures showed heterogeneity within the structure
- Diffusion MRI results confirmed intrinsic tissue structural differences
- We are currently working to validate these observed results using quantitative histology measurements