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Comparing myelin-sensitive markers MWF, ihMTR, and MTsat in healthy and normal-appearing brain tissue and multiple sclerosis lesions

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Poster Session	**Multiple Sclerosis II**
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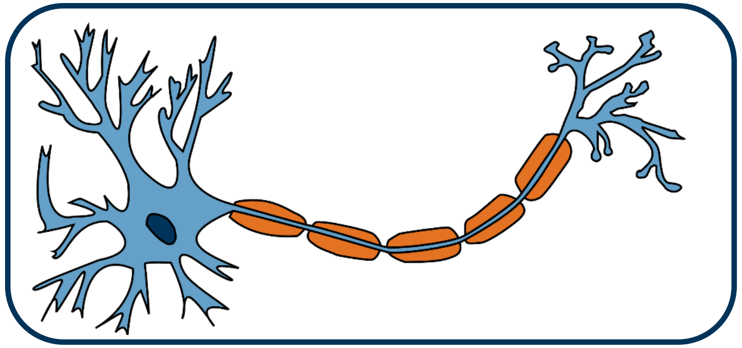
Declaration of Financial Interests or Relationships

Speaker Name: **RONJA BERG**

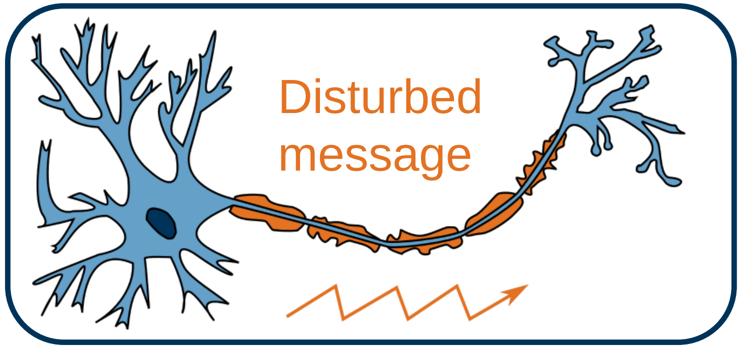
I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Introduction



MS

Demyelination



Aim

Monitoring demyelinating diseases

Imaging methods	Myelin-sensitive markers	
Myelin water imaging →	MWF	$= \frac{Myelin\ water}{Total\ water}$
Magnetization transfer →	ihMTR	$= \frac{1}{S_0}(MT^{+} + MT^{-} - MT^{+-} - MT^{-+})$
Magnetization transfer →	MTsat	$= \left(\frac{A_{app} * \alpha}{S_{MT}} - 1\right) * R_{1app} * TR - \frac{\alpha^2}{2}$

Methods

Participants

Healthy:

- n = 5, 3f / 2m
- 32 ± 3 years

MS patients:

- n = 5, 2f / 3m
- 33 ± 6 years
- 4 RRMS, 1 CIS
- Disease duration: 3-15 y, (avg.: 9.4 y)
- EDSS: 0-1.5, (avg.: 1.1)

3 T, Philips

MWF:

- 3D gradient- and spin-echo (GRASE) sequence
- TE1/ΔTE = 8/8ms,
- 48 echoes, 20 slices
- res: 1x2x5 mm³

ihMTR:

- 3D gradient-echo (GE)
- TE1/ΔTE = 3.5/5.7ms
- res: 2.2x2.2x2. mm³
- 10 MT pulses, α_{MT} = 90°, t_{MT} = 0.9 ms

MTsat:

- 3 x 3D GE: 1) α = 4°, 2) α = 25°, both TR = 18ms; 3) MT-w: α = 6°, TR = 35ms
- All: 1x1x1 mm³, 6 echoes
- TE1/ΔTE = 2.4/2.4 ms
- MT pulse: α_{MT} = 540°, t_{MT} = 12.8 ms, f_{MT} = 2200 Hz
- 4) B1-map for bias field correction

→ MWF

MWF:

- Using the Sparsity Promoting Iterative Joint Non-negative least squares (SPIJN) algorithm

ihMTR:

- Combination of single and dual frequency offset saturation MT images

MTsat:

- Parameter map calculation via the hMRI toolbox

Lesions

Segmentation:

- Lesion growth algorithm, lesion segmentation tool for SPM12
- Based on FLAIR & MPRAGE

Lesion VOI:

- Lesion probability > 0.5

Peri-lesion:

- 3-voxel wide shell surrounding lesions within NAWM

Brain regions

Whole-brain:

- GM and WM segmentation SPM12's segment module (tissue prob. > 0.5)

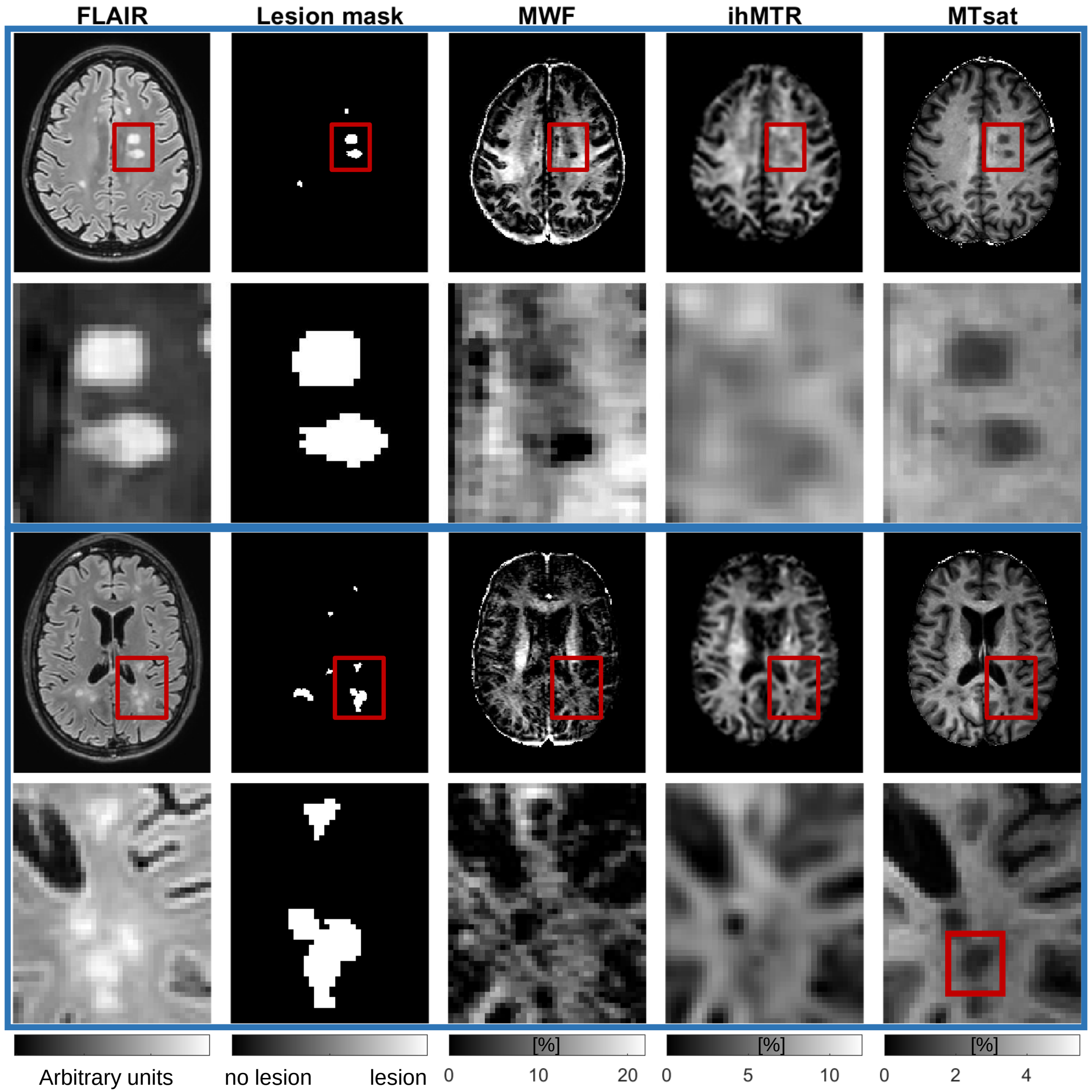
Anatomical:

- Several tracts from the ICBM-DTI-81 WM labels atlas

Evaluation:

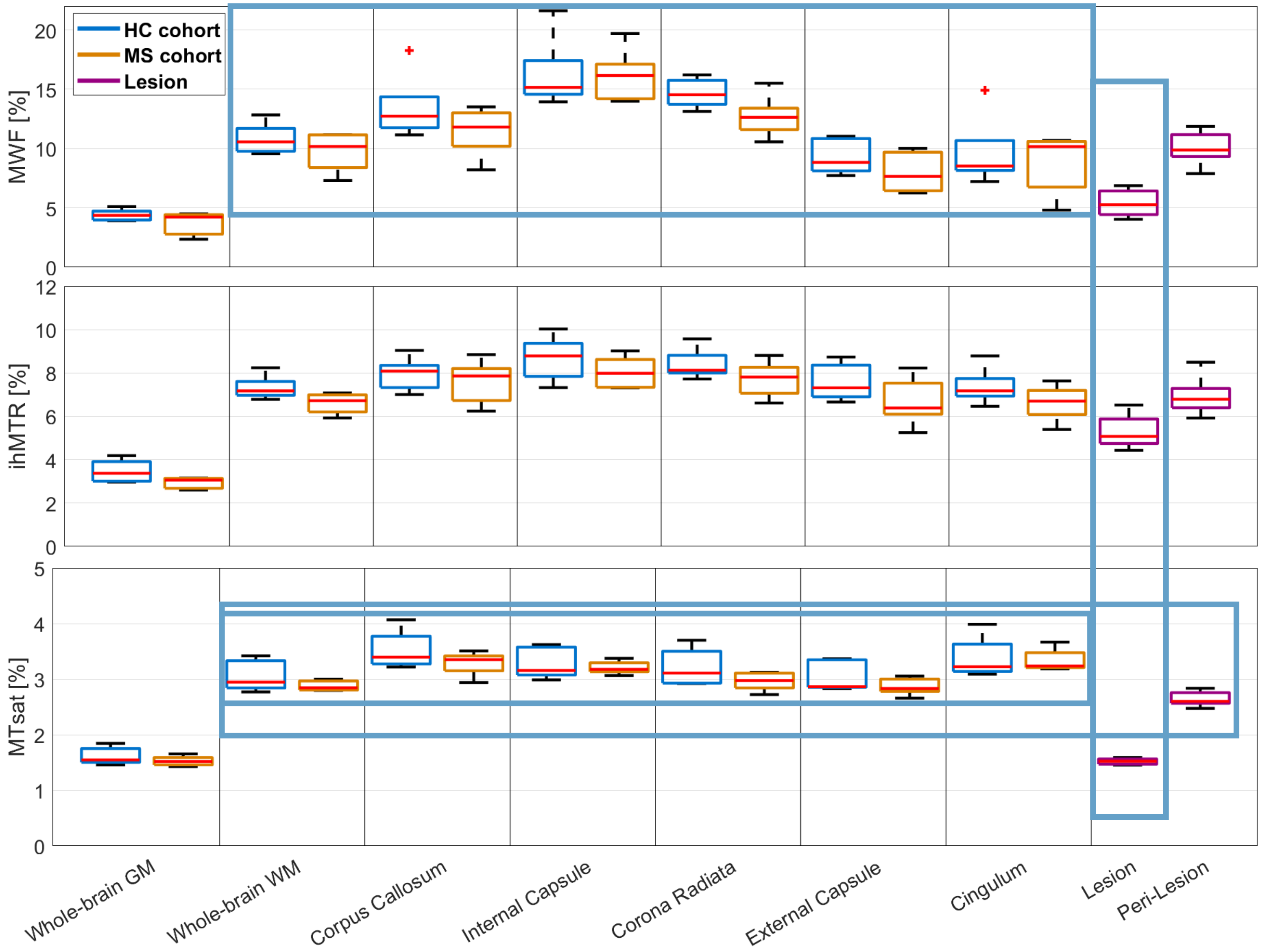
- In subjects' native spaces (MPRAGE data space)

Visual Comparison



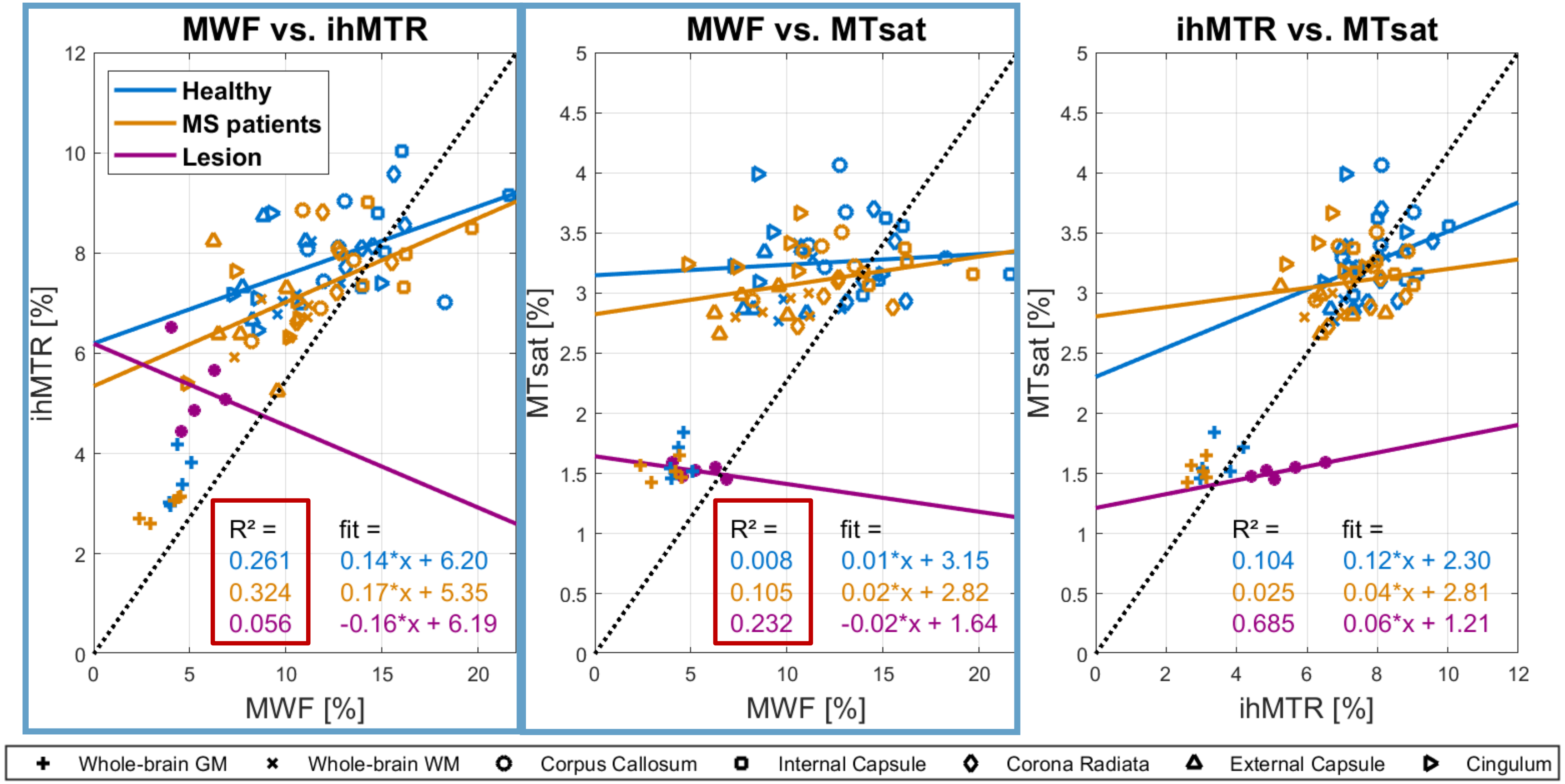
- Visual similarity
- Appearance of lesions
  - Lower values
  - Some differences visible
- White matter
  - Stronger variation in MWF
  - MTsat most homogeneous

Quantitative evaluations



- MWF varies most strongly across WM VOIs
- MTsat most homogeneous
- Within MS lesions:
  - Clearly reduced values
  - MTsat values comparable to GM
  - For MWF and ihMTR, differences to MW less prominent
- Peri-lesion:
  - Largest difference to NAWM in MTsat

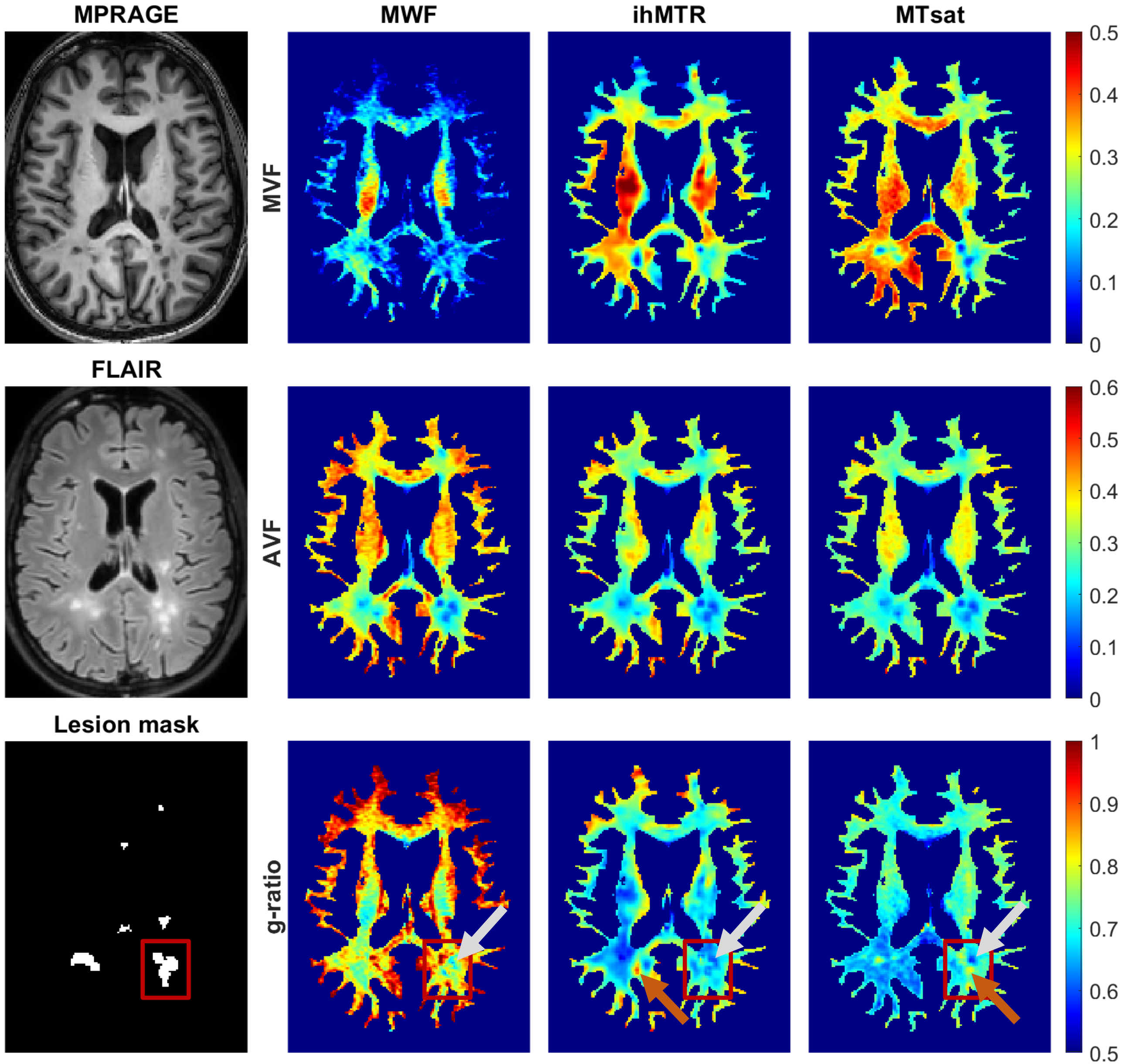
Quantitative evaluations



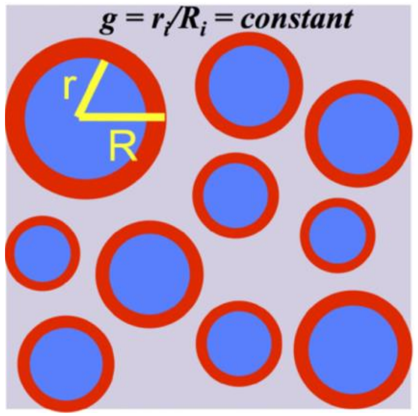
Correlation between VOI-average myelin marker values in WM

- Highest between MWF and ihMTR
- Lowest between MWF and MTsat
  - → Rely on different contrast mechanisms

G-ratio imaging



$$\sqrt{\frac{AVF}{MVF + AVF}} = g$$



Stikov et al., 2015

- MVF estimation from myelin-sensitive markers
- AVF calculation based on diffusion data
- g-ratio evaluation

- g-ratio values within WM strongly depend on the myelin-sensitive marker
- g-ratio values within lesion quite diverse
  - sometimes > WM, sometimes < WM

Stikov, Nikola, et al. "In vivo histology of the myelin g-ratio with magnetic resonance imaging." Neuroimage 118 (2015): 397-405. www.doi.org/10.1016/j.neuroimage.2015.05.023

Conclusion

MWF

- Largest differences between various WM structures

ihMTR

- Good correlation with MWF

MTsat

- Largest difference between peri-lesion and NAWM

g-ratio

- g-ratio values quite diverse within lesions

→

- Combined use of several myelin-sensitive markers
  - Disentangling microstructural effects
- Further studies needed

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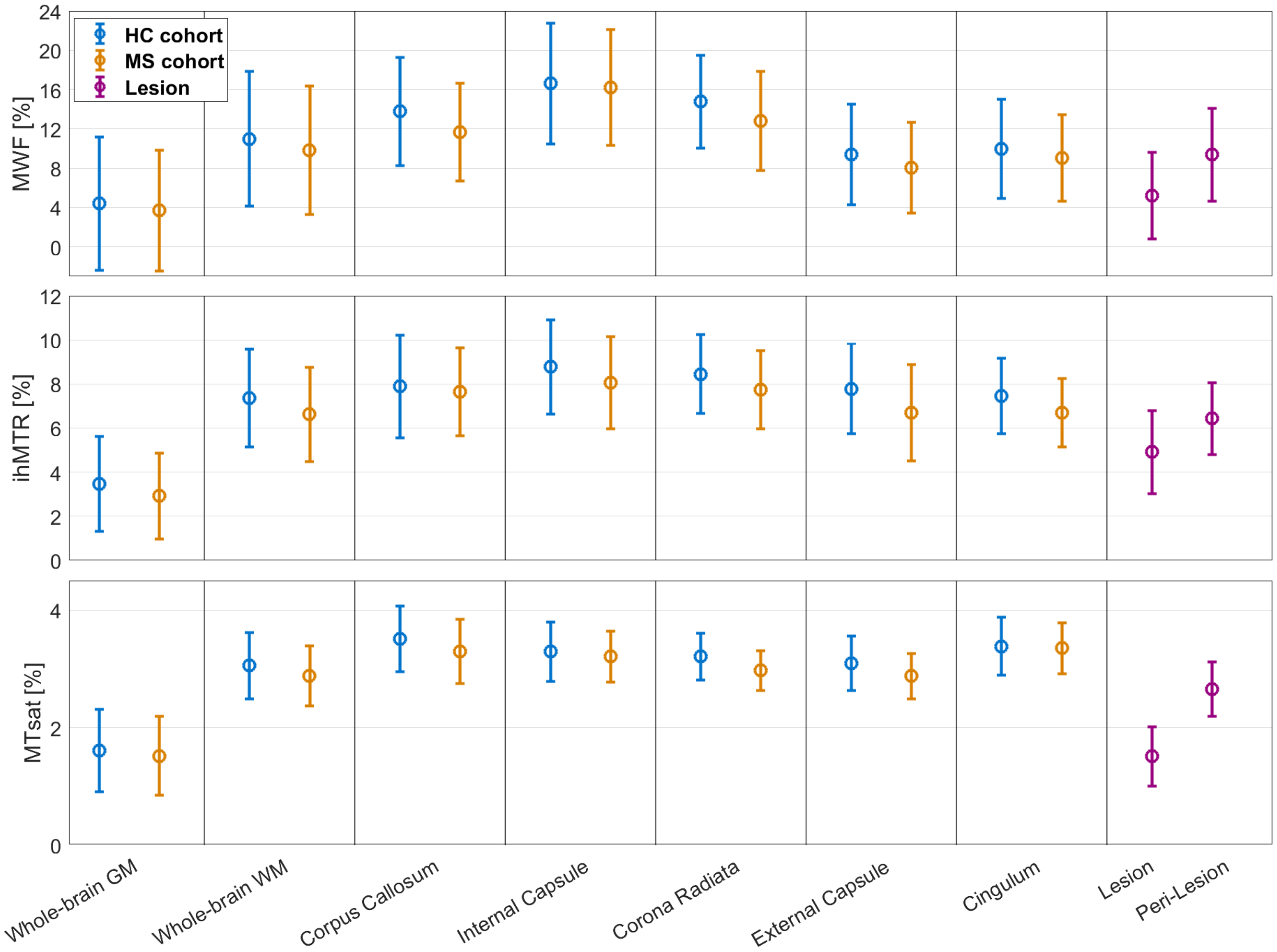
Thank you for your attention!



Pooled standard deviation, averaged across participants:

- Highest for MWF
- Lowest for MTsat
- Often slightly lower for normal-appearing than for healthy tissue