

Source-Separated Quantitative Susceptibility Mapping of Olfactory and Medial Temporal Regions Across Alzheimer's Disease

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INTRODUCTION

Motivation:

- Olfactory and memory-related regions (i.e., the entorhinal cortex, piriform cortex, amygdala, and hippocampus) are among the **earliest affected regions** in Alzheimer's disease (AD)
- Iron accumulation** and **myelin alteration** within these regions may contribute to AD progression

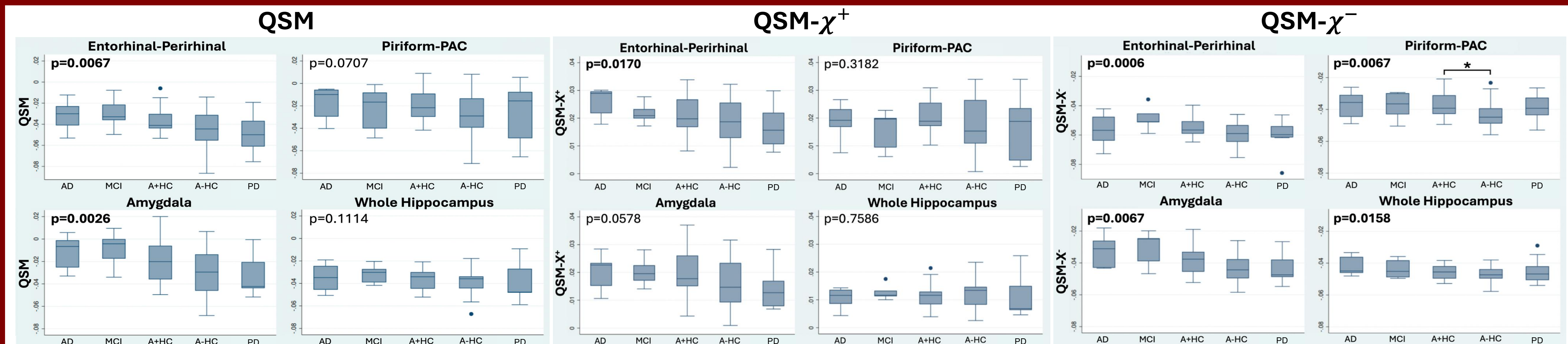
Challenge:

- Few studies have examined these regions together, and conventional MRI cannot separately evaluate iron accumulation from myelin degeneration *in vivo*

Solution:

- Use **Source-separated quantitative susceptibility mapping (QSM)** to independently quantify iron- and myelin-sensitive susceptibility changes throughout olfactory and memory-related regions across the AD spectrum

RESULTS & DISCUSSION



- QSM increased with AD severity (AD→MCI→HC)** in **entorhinal-perirhinal (p=0.0067)** and **amygdala (p=0.0026)**
- QSM- χ^+ increased with AD severity** only in the **entorhinal-perirhinal cortices (p=0.017)**
⇒ suggestive of **localized iron accumulation**
- QSM- χ^- demonstrated significant ordinal changes** across **all four olfactory and memory-related regions**
⇒ suggestive of **widespread myelin alteration**
- Piriform-PAC QSM- χ^-** distinguished amyloid-positive and amyloid-negative healthy controls

MRI ACQUISITION

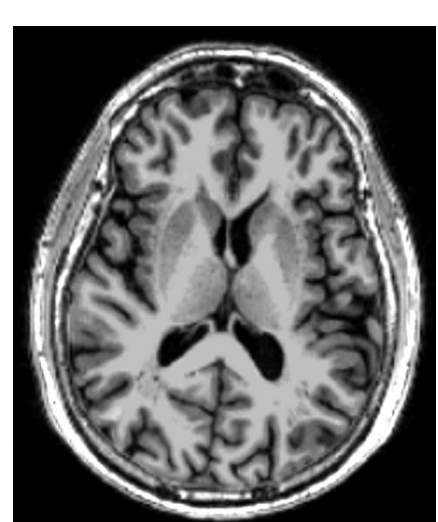
Cohort:

66 ADRC human volunteers

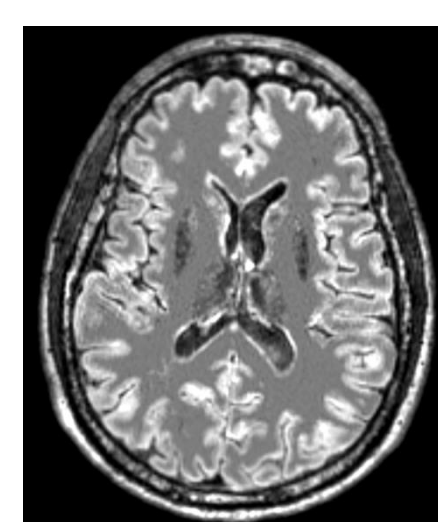
- 7 Alzheimer's disease (AD)
- 5 mild cognitive impairment (MCI)
- 21 amyloid-positive healthy control (A+HC)
- 24 amyloid-negative healthy control (A-HC)
- 9 Parkinson's disease (PD)

MRI sequences analyzed:

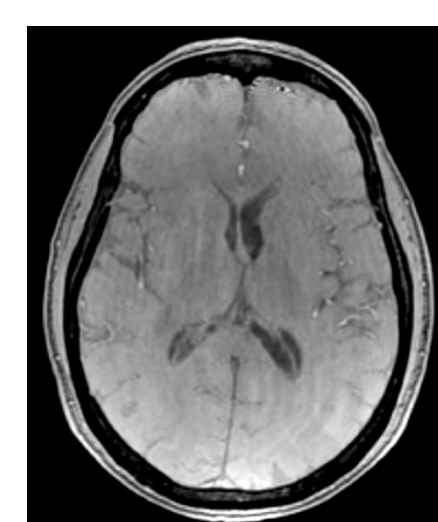
- Sagittal T1-weighted → anatomical reference, amygdala segmentation
- Coronal T2-weighted → hippocampal, entorhinal-perirhinal segmentation
- Multi-echo gradient echo → QSM, source separation



T1-weighted



T2-weighted



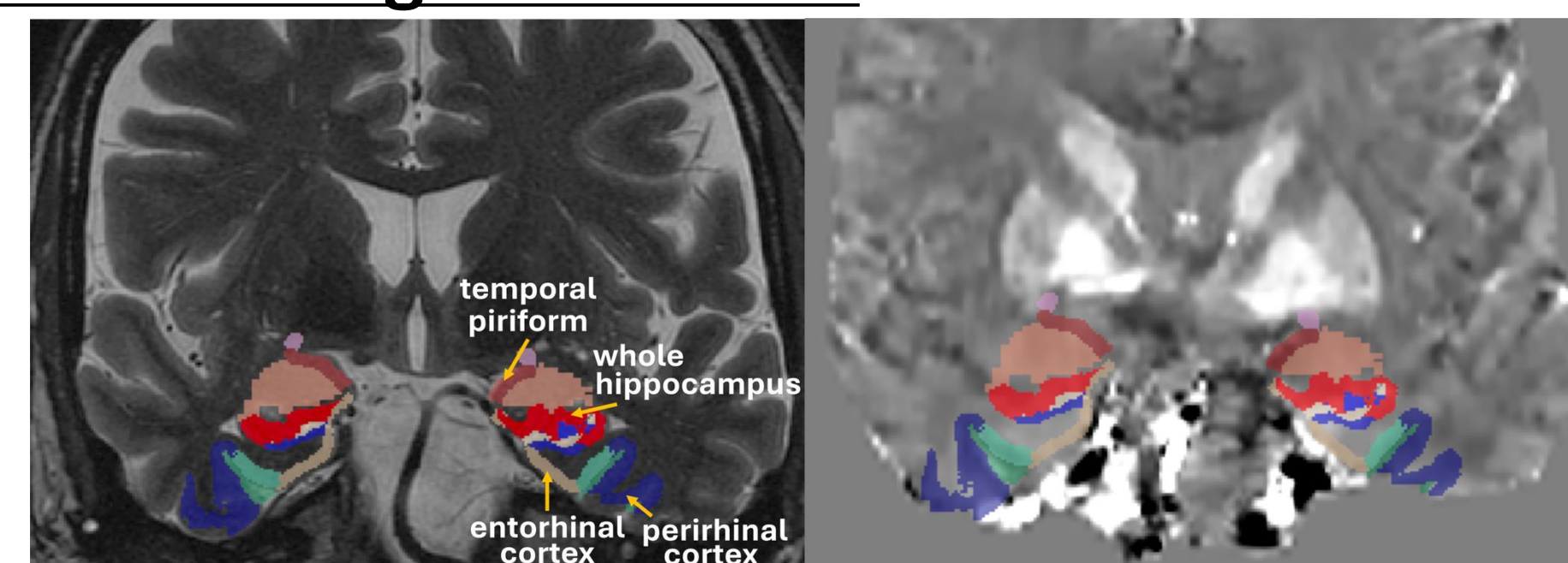
ME-GRE

MRI acquisition parameters:

Acquisition Parameters	T1-weighted	T2-weighted	Multi-Echo Gradient Echo
Matrix Size	256 x 256 x 146	512 x 512 x 36	256 x 256 x 116
Resolution (mm ³)	1.0 x 1.0 x 1.2	0.43 x 0.43 x 1.9	0.94 x 0.94 x 1.6
No. Echoes	1	1	12
TR (ms)	7.6	14111	65.11
TE (ms)	3.1	102.4	3.08-38.42

MRI PROCESSING

Anatomical segmentations:



T2-weighted

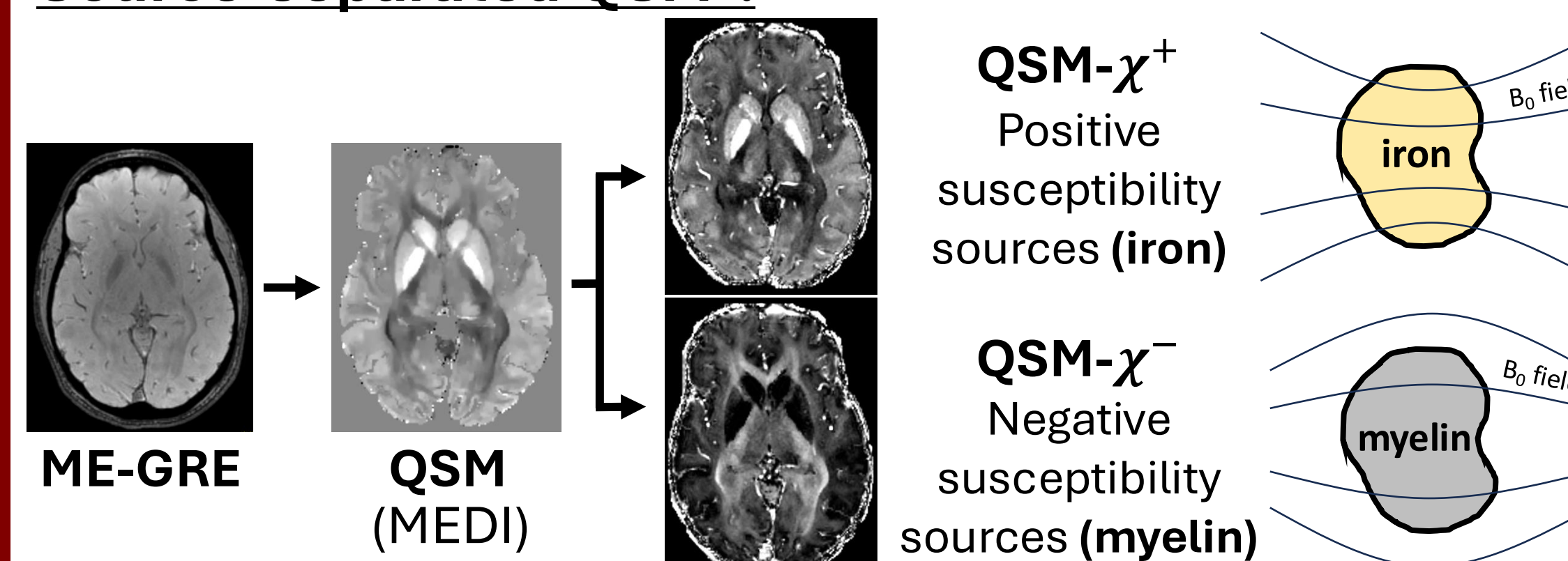
QSM

- Registered QSM maps to T2 segmentation space

Regions of interest:

- Entorhinal-Perirhinal cortices
- Piriform-periamygdaloid cortex (PAC)
- Amygdala
- Whole hippocampus

Source-separated QSM¹:



- Compared regional median **QSM**, **QSM- χ^+** , **QSM- χ^-** across diagnostic groups using nonparametric testing

CONCLUSION

- We found **increased QSM** in the **entorhinal-perirhinal cortices** and **amygdala *in vivo*** in AD
- Source-separated QSM identified localized iron-sensitive susceptibility changes in the entorhinal and perirhinal cortices
⇒ **suggestive of regional iron accumulation**
- We found widespread myelin-sensitive susceptibility changes in all four regions (i.e., entorhinal-perirhinal, piriform-PAC, amygdala, whole hippocampus)
⇒ **suggesting myelin alteration may be a major contributor to susceptibility changes in early AD**
- In all four regions, myelin-associated signal is decreasing (i.e., approaching zero) with AD severity
⇒ **suggestive of possible myelin loss**
- QSM- χ^- identified significant differences between A+HC and A-HC participants in the piriform-PAC
⇒ **indicating sensitivity to early AD pathology**

Source-separated QSM extends beyond conventional QSM, providing improved biological interpretation of susceptibility changes *in vivo*

REFERENCES

- Dimov, Alexey V., et al. "Susceptibility source separation from gradient echo data using magnitude decay modeling." *Journal of Neuroimaging* 32.5 (2022): 852-859.