

Multimodal analysis of fMRI-derived excitation/inhibition balance against MEG electrophysiology in the aging hippocampus

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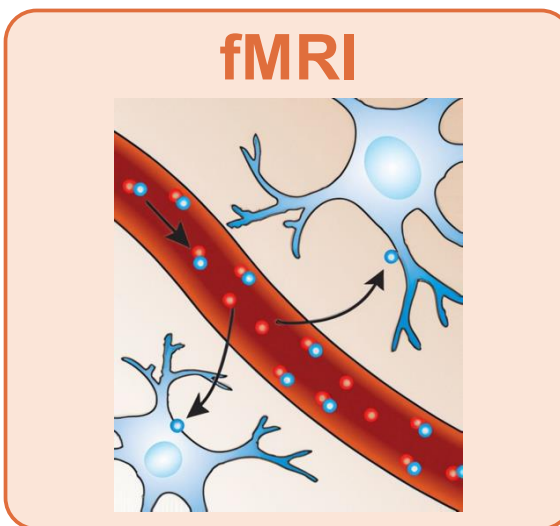
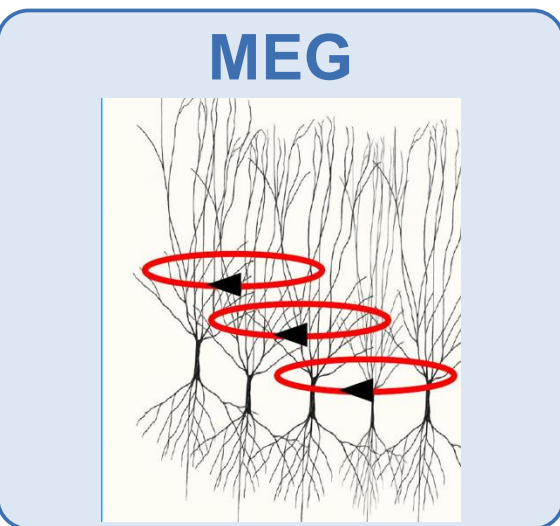
The fMRI Hurst exponent converges with MEG electrophysiology and couples with hippocampal structure → emerging as a scalable fMRI proxy for E/I balance in aging.

INTRODUCTION

Hippocampal E/I (im)balance may be an early Alzheimer's signal.

MEG measures brain activity directly by recording magnetic fields, but is scarce.

fMRI measures indirectly by imaging blood, and is widely available.



Both may index hippocampal E/I balance

Two candidate fMRI proxies

Multiscale Neural Model Inversion (MNMI)
Based on functional connectivity

Hurst exponent
Based on regional temporal auto-correlation

THE QUESTION

Does either fMRI-derived proxy of E/I balance converge with the MEG gold standard? This has not been tested in the aging hippocampus.

METHODS

24 cognitively normal adults
Aged 56-81 [70 ± 7] years

Resting-state MEG

Resting-state multi-echo fMRI

Three modalities → one comparison

rs-MEG

Spec-param

Aperiodic exponent

rs-fMRI

AFNI

MNMI

Hurst

T1w

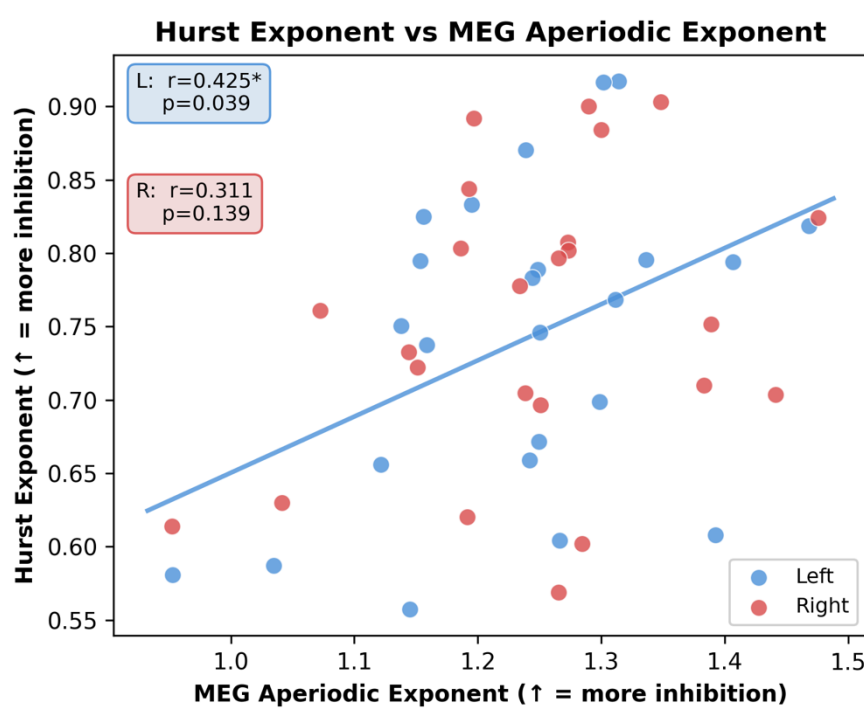
Free-Surfer

Volume

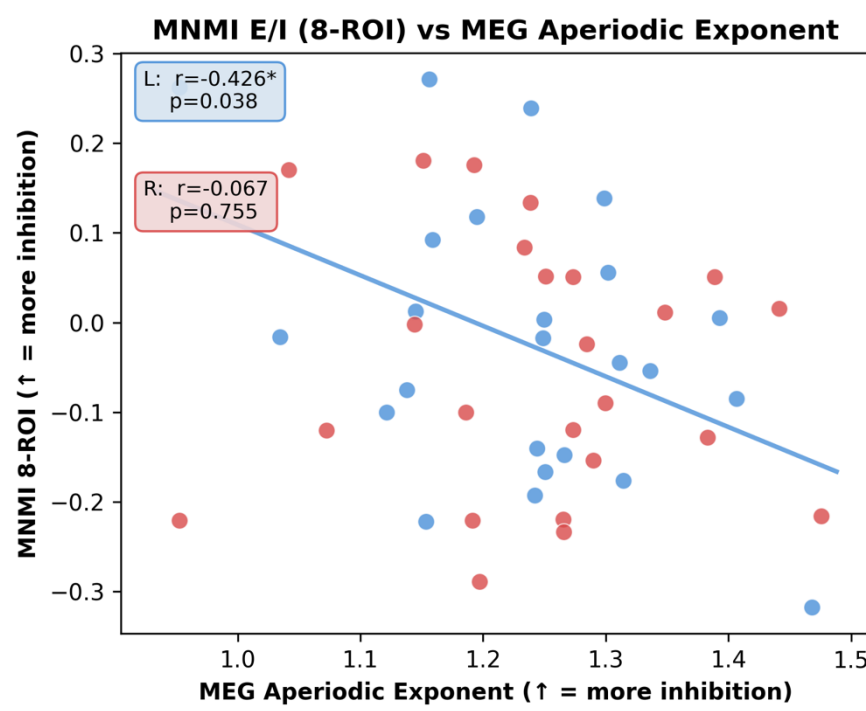
Correlation: Pearson r; volume corrected for age + eTIV

RESULTS

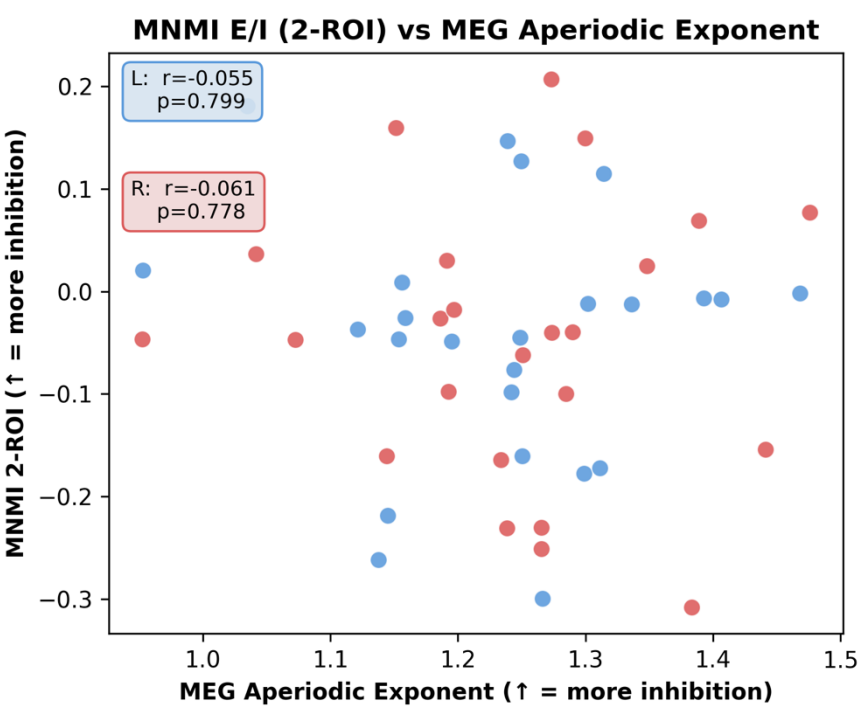
Only Hurst converges with MEG



Hurst and MEG each say more inhibition ✓

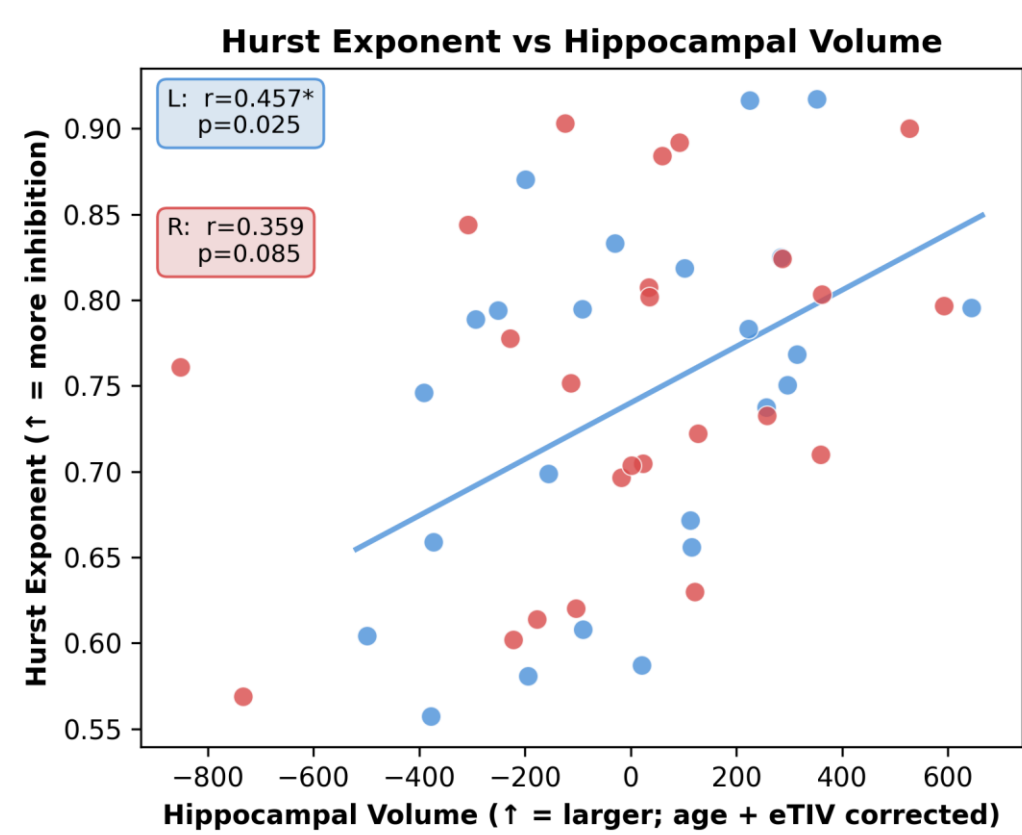


MNMI says less inhibition, MEG says more inhibition ✗



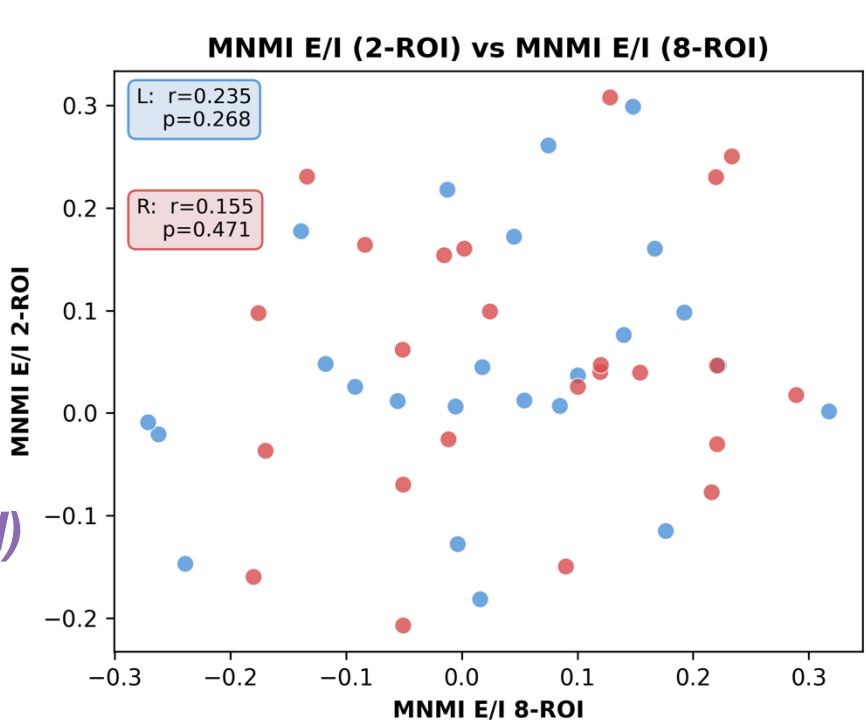
No relationship

Only Hurst couples with structure



Hurst says more inhibition, volume says larger hippocampus ✓

MNMI hippocampal E/I estimates depend on regions modeled: bilateral hippocampi (2-ROI) vs embedded in a memory network (8-ROI)



REFERENCES

1. Maestú Ageing Res Rev 2021; 2. Gao NeuroImage 2017; 3. Donoghue Nat Neurosci 2020; 4. Trakoshis eLife 2020; 5. Li Commun Med 2025.

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CONCLUSIONS

● HURST = SCALABLE PROXY

Hurst tracks MEG in the expected direction, both measures increase with more stable, inhibition-associated neural dynamics.

● WHY NOT MNMI?

MNMI does not converge with MEG as an E/I proxy. The 8-ROI arrangement paradoxically shows higher excitation with higher MEG inhibition, while the 2-ROI arrangement shows no relationship. Further, the 8- and 2-ROI arrangements do not agree with each other.

● STRUCTURE-FUNCTION LINK

Only Hurst E/I couples with hippocampal volume, and MEG E/I, positioning it as a fMRI biomarker candidate for E/I-related hippocampal vulnerability in aging and Alzheimer's disease risk.

