

A scalable fMRI marker of hippocampal excitation-inhibition balance that tracks MEG electrophysiology in aging



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These findings position the Hurst exponent as a scalable fMRI proxy for hippocampal E/I balance and a candidate biomarker of E/I-related hippocampal vulnerability

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.

MEG

fMRI

Two candidate fMRI E/I proxies

Multiscale Neural Model Inversion (MNMI)

Based on functional connectivity

Hurst exponent

Based on regional temporal autocorrelation

THE QUESTION

Does either fMRI-derived E/I proxy converge with the MEG-derived electrophysiological benchmark? 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 Exponent vs MEG Aperiodic Exponent

Hurst and MEG each say more inhibition ✓

MNMI E/I (8-ROI) vs MEG Aperiodic Exponent

MNMI says less inhibition, MEG says more inhibition ✗

Only Hurst converges with structure

Hurst Exponent vs Hippocampal Volume

Hurst says more inhibition, volume says larger hippocampus ✓

Hurst relationships were significant on the left, and in the same direction but non-significant on the right.

CONCLUSIONS

- HURST = SCALABLE, REGIONAL E/I PROXY**
Hurst estimates hippocampal E/I balance from resting-state fMRI alone, extending E/I analysis to any existing or planned cohort with these data. Computationally light.
- MNMI = NETWORK E/I PROXY**
MNMI estimates E/I balance from how the hippocampus couples with other regions, making it a network measure, not a readout of local hippocampal E/I. Computationally heavy.
- A MARKER OF VULNERABILITY?**
Greater inhibitory tone was associated with larger hippocampi, suggesting Hurst-derived E/I reflects hippocampal integrity.

Next: does declining inhibitory tone signal vulnerability as hyperactivity emerges in at-risk adults?

REFERENCES

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