The Thermodynamics of the Self: A Proof of Concept Based on Real Data

Preliminary Empirical Evidence of Entropic Rigidity and Neural Disintegration

Felipe Romero
Independent Researcher, Brazil
lipegianini88@gmail.com

February 2, 2026

Abstract

This technical report presents a proof of concept for the model of the "Self as a Dissipative Structure". Using Magnetoencephalography (MEG) data, we map brain dynamics along two axes: Lempel-Ziv Complexity (LZc) and Global Phase Synchrony. Although this pilot study employs a reduced sample size ($N = 1$ per group), the results demonstrate robust distinctions between Major Depression (Q2), characterized by entropic rigidity (LZc ≈ 0.05), and high-complexity states. The inclusion of phase synchrony enabled the differentiation between functional health and psychotic disintegration, suggesting that the bidimensional model is capable of providing physical signatures for subjective mental states.

1 Introduction

The "Thermodynamics of the Self" model postulates that identity is maintained through dissipative processes. Mental health resides in metastability — a balance between information production and connection flexibility. Pathologies manifest as thermodynamic failures: either through information collapse (Rigidity) or through loss of functional integrity (Disintegration). The objective of this study is to provide preliminary evidence for this theoretical architecture.

2 Methodology

2.1 Data Acquisition and Sampling

This pilot study analyzes raw MEG data from three representative subjects obtained from the OpenNeuro repository: Major Depression (ds005356), Healthy Control (ds005752), and First-Episode Psychosis (ds004837). The statistical limitation of the sampling ($N = 1$ per group) is acknowledged, and the analysis is therefore treated as a technical exploration of biomarker feasibility.

2.2 Temporal Windows and Processing

Processing was performed in Python (MNE/Antropy). Signals were resampled to 250Hz. The reported LZc and Global Phase Synchrony values (Kuramoto Order Parameter) correspond to the temporal average of 60-second windows analyzed throughout the continuous recording. This approach captures resting-state dynamics while mitigating momentary signal fluctuations.

3 Results and Discussion

Table 1 consolidates the metrics that form the bidimensional thermodynamic map.

Table 1: Preliminary Physical Signatures (Temporal Averages)

Group	**Complexity (LZc)**	**Synchrony (Alpha)**	**Physical Diagnosis**
Depression	**0.0508**	**0.3686**	Entropic Rigidity
Healthy	**0.4963**	**0.1395**	Metastability
Psychosis	**0.4998**	**0.2382**	Chaotic Disintegration

3.1 Rigidity and Metastability

The collapse of complexity in depression (LZc ≈ 0.05) validates the phenomenological description of psychic "freezing". According to Godfrey and Carhart-Harris (2025), the disruption of this rigidity through increased neural diversity predicts clinical improvement, reinforcing the role of entropy (X-axis) as a health-related variable.

3.2 Psychosis: Diversity vs. Functional Flexibility

Psychosis exhibited a state of high informational diversity (LZc ≈ 0.49), similar to the healthy condition. However, the distinction lies on the Y-axis: excessive and unstable coupling is observed (Synchrony ≈ 0.23), reducing the system's functional flexibility. While the healthy brain maintains low synchrony to process new information, the psychotic brain experiences complexity as a disintegration of the cohesive ego narrative.

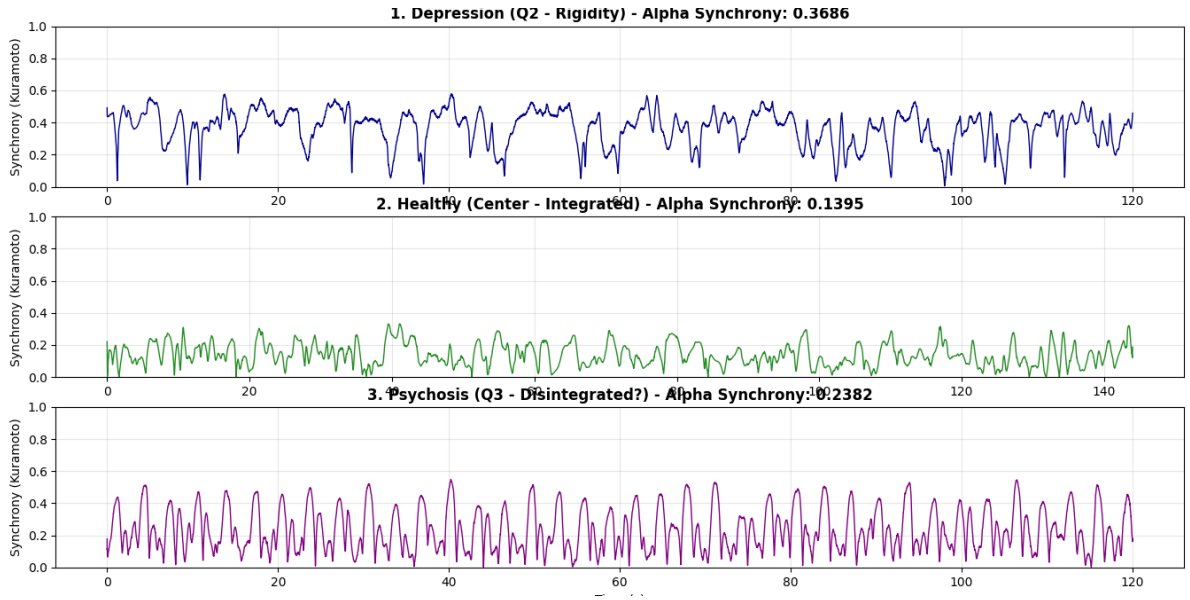

Figure 1: Global Synchrony Dynamics. The healthy brain maintains freedom (low synchrony), whereas depression exhibits inhibitory locking.

4 Conclusion

This proof of concept demonstrates that the combination of LZc and Kuramoto constitutes an original arrangement capable of mapping mental states onto an objective physical basis. Although the data are preliminary, the consistency of the results with the computational psychiatry literature justifies expanding this model to larger samples, aiming to consolidate the thermodynamic map as a diagnostic tool.

References

[1] Romero, F. (2025). *The Thermodynamics of Self*. Zenodo. `https://doi.org/10.5281/zenodo.17916471`

[2] Godfrey, K., Carhart-Harris, R., et al. (2025). *Neuroscience Applied*.

[3] Pirrung, C.J.H., et al. (2025). OpenNeuro, ds005356.

[4] Nugent, A.C., et al. (2024). OpenNeuro, ds005752.

[5] Brain Imaging Centre. (2024). OpenNeuro, ds004837.