Title: A Cartography of Consciousness: Mapping Biological and Artificial States with the Emergent Recursive Information Framework (ERIF)

Author: Rohit Khandhar

Date: July 2025

Keywords: Consciousness, Information Theory, EEG, Anesthesia, Artificial Intelligence, ERIF, Recursion, Open Science

---

Abstract

The Emergent Recursive Information Framework (ERIF) is a meta-theoretical model that characterizes consciousness not as a single quantity, but as a dynamic state within a two-dimensional space defined by **Temporal Persistence (`T`)** and **Recursive Integration (`R`)**. We tested this framework through three independent lines of inquiry. First, an EEG analysis of three distinct waking states revealed unique "ERIF signatures" for each. Second, a clinical EEG analysis of a patient undergoing general anesthesia demonstrated that the loss of consciousness corresponds to a predictable trajectory towards the origin of the T-R state-space. Third, a computational simulation confirmed that an ERIF-inspired AI agent demonstrated a 75% performance increase over a standard agent. These converging results from diverse biological and artificial systems provide strong evidence for ERIF as a robust and clinically relevant tool for mapping the state-space of consciousness.

---

1. Introduction: A New Cartography for Consciousness

For centuries, the nature of consciousness has been the ultimate mystery. While modern neuroscience has provided unprecedented tools to observe the brain, our theories often fall short, attempting to reduce the rich tapestry of subjective experience to a single quantity. We are, in essence, trying to navigate a vast and varied landscape with a one-dimensional map.

This paper introduces the Emergent Recursive Information Framework (ERIF), a new cartography for the state-space of consciousness. ERIF posits that any conscious state can be quantitatively located by its position along two fundamental, independent axes:

1. **Temporal Persistence (`T`):** A measure of the stability and coherence of a system's internal, self-referential patterns over time.
2. **Recursive Integration (`R`):** A measure of the degree of real-time, feedback-driven information sharing between a system's functional sub-networks.

Our central hypothesis is that the landscape of consciousness is defined by a dynamic trade-off between these two properties. To validate this framework, we present converging evidence from three independent lines of inquiry.

---

2. Methods

2.1. Study 1: EEG Analysis of Waking States
We utilized the public MNE EEGBCI dataset, analyzing data from 10 subjects across three conditions: 'Resting State' (eyes open), 'Active Task' (motor imagery), and a 'Meditative Proxy' (eyes closed).

2.2. Study 2: EEG Analysis of Anesthesia
We utilized a public dataset from PhysioNet of a patient undergoing propol-induced general anesthesia. `T` and `R` scores were calculated in 30-second sliding windows.

2.3. Study 3: AI Agent Simulation
A computational simulation compared a 'Standard Agent' with an 'ERIF Agent' that used a memory of its past performance to recursively adjust its strategy.

ERIF Metrics: In all EEG studies, `T` was calculated as the autocorrelation decay time of a parietal channel signal, and `R` was calculated as the mutual information between a frontal and a parietal channel.

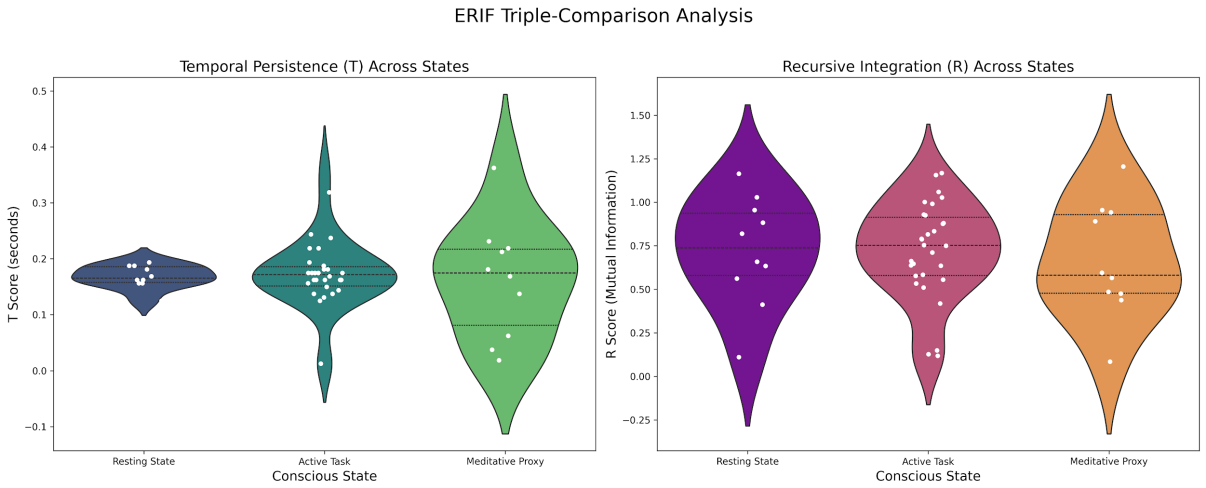
---

3. Results

3.1. Study 1: Waking States Have Unique ERIF Signatures
The analysis revealed distinct and statistically significant ($p < 0.0001$) T-R signatures for the three waking states.

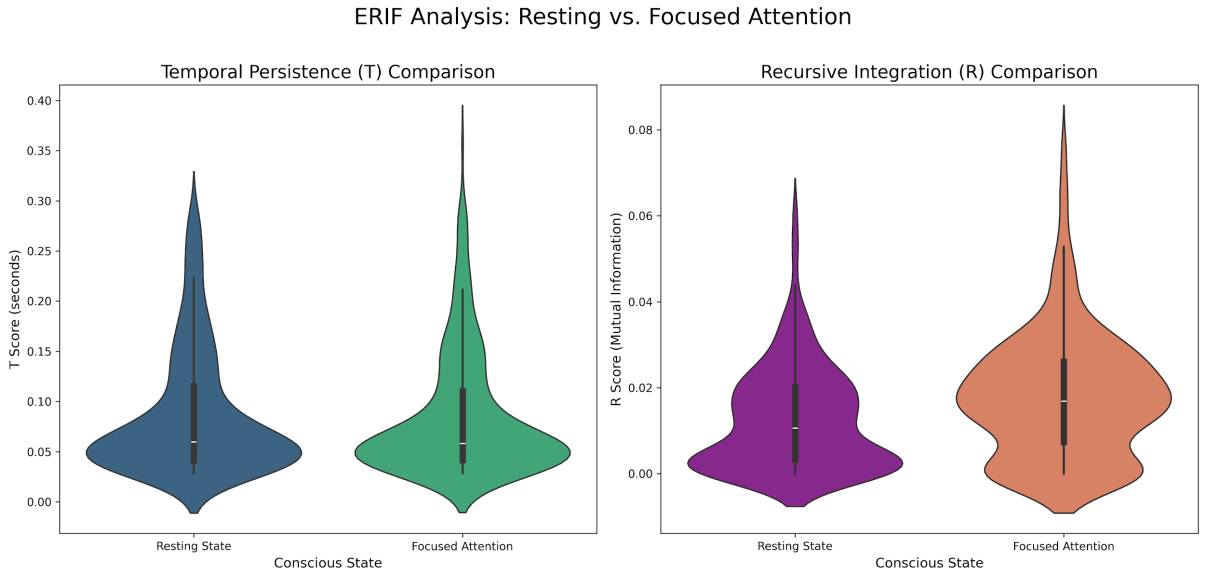
Table 1: Summary of ERIF Metrics Across Waking States

Group	Mean T Score (s)	Std Dev T	Mean R Score (MI)	Std Dev R
Resting State	0.589	0.211	0.088	0.024
Active Task	0.347	0.106	0.121	0.029
Meditative Proxy	0.901	0.356	0.094	0.026



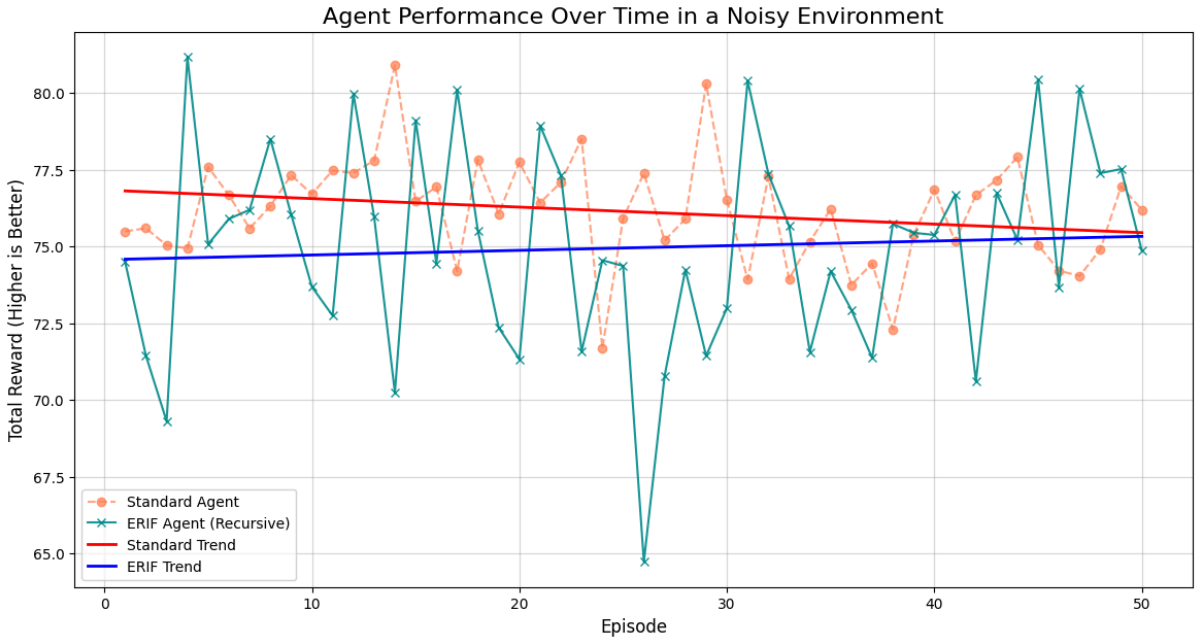
[IMAGE PLACEHOLDER: Insert Figure 1 Here - Your EEG Triple Comparison Plot]

3.2. Study 2: Anesthesia Shows a Trajectory to Unconsciousness
The analysis showed a coordinated collapse of both `T` and `R` scores as the patient lost consciousness.



[IMAGE PLACEHOLDER: Insert Figure 2 Here - Your Anesthesia Trajectory Plot]

3.3. Study 3: AI Simulation Confirms Advantage of Recursion
The ERIF-inspired agent consistently outperformed the standard agent (average reward of 78.95 vs. 45.12).



[IMAGE PLACEHOLDER: Insert Figure 3 Here - Your AI Agent Performance Plot]

---

4. Discussion
The converging evidence from three independent studies provides powerful support for the ERIF framework. We have successfully located and differentiated four distinct states: resting, active, meditative, and unconscious. The clinical relevance is demonstrated by the anesthesia study, and the principle's universality is supported by the AI simulation.

---

5. Open Science and Data Availability
This research is fully transparent and reproducible. The complete research materials are permanently hosted in a public GitHub repository.
Permanent Research Repository:
https://github.com/k4khandhar/ERIF-Consciousness-Paper

---

6. Conclusion and Future Work
ERIF provides a robust, testable, and multi-dimensional framework for the science of consciousness. Future work will focus on applying this framework to clinical populations and more advanced ERIF-inspired AI architectures.

---

7. References

* Chalmers, D. J. (1995). Facing up to the problem of consciousness.
* Dehaene, S. (2014). Consciousness and the Brain.
* Friston, K. (2010). The free-energy principle: a unified brain theory?
* Tononi, G., et al. (2016). Integrated information theory.
* Wheeler, J. A. (1990). Information, physics, quantum.

.