

The Phoenix Hypothesis: Subjective Time as an Emergent Property of Information Processing

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Abstract

This paper presents a mathematical model of subjective time (τ) as an emergent phenomenon arising from information processing in conscious systems. We propose that τ depends nonlinearly on the density of processed information (I) within a given processing volume (V_{eff}). The model explains time perception differences across species and predicts relativistic effects in conscious experience. The fundamental equation:

$$\tau = \frac{K}{V_{\text{eff}}} \ln \left(1 + \frac{I}{I_0} \right) \quad (1)$$

where K is the system-specific efficiency factor (default = 1), I_0 is the consciousness threshold, and V_{eff} is the effective processing volume, provides a unified framework for understanding subjective time from neurobiological to cosmological scales.

1 Introduction

The nature of time has been debated since antiquity [1]. While physics describes time as a dimension in spacetime, subjective experience suggests it's

an emergent property of information processing [2]. Recent neuroscientific studies [3] have demonstrated that subjective time dilation occurs during threatening situations, supporting our model’s prediction about V_{eff} compression.

2 The Model

2.1 Core Equation

The subjective time τ experienced by any information-processing system is:

$$\tau = \frac{K}{V_{\text{eff}}} \ln \left(1 + \frac{I}{I_0} \right) \quad (2)$$

where:

- K : System efficiency factor (dimensionless, default = 1) accounting for:
 - Metabolic efficiency (α_{met})
 - Neurochemical modulation (β_{neuro})
 - Other undiscovered factors
- V_{eff} : Effective processing volume (m^3)
- I : Total processed information (bits)
- I_0 : Consciousness threshold (bits)

2.2 Parameter Estimation

For adult humans:

$$\begin{aligned} &\approx 3 \times 10^{-4} \text{ m}^3 \text{ (conscious cortex)} \\ I_0 &\approx 10^{24} \text{ bits} \\ K &\approx 1.0 \text{ (baseline for humans)} \end{aligned}$$

3 Applications

3.1 Cross-Species Comparison

Table 1: Subjective Time Perception Across Biological Systems

System	V_{eff} (m ³)	I_0 (bits)	K	$\tau/1\text{s}$
Human	3.0×10^{-4}	10^{24}	1.0	1.0
Mayfly	1.0×10^{-10}	10^{18}	1.5	34.5
Octopus	3.0×10^{-7}	10^{20}	1.2	0.019

4 Discussion

4.1 Key Improvements

The revised model now:

- Distinguishes V_{eff} from total volume
- Treats K as a dimensionless efficiency factor
- Provides realistic cross-species comparisons

References

- [1] Carlo Rovelli. *The Order of Time*. Physics of time from relational perspective. Riverhead Books, 2018.
- [2] Giulio Tononi. *Phi: A Voyage from the Brain to the Soul*. Fundamental work on Integrated Information Theory. Pantheon Books, 2012.
- [3] David M Eagleman. “Human time perception and its illusions”. In: *Current Opinion in Neurobiology* 18.2 (2008), pp. 131–136.