Observer Decoherence Theory (ODT) — Version 3.5

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Abstract

We present a unified model explaining how an observer's stability, collapse-proneness, and coherence emerge from the interaction of three measurable variables: Grounding (G), Internal Coherence (R), and the Scale State (S). Version 3.5 introduces three critical upgrades: (1) Modular Grounding Theory (MGT) based on informational-module coupling, (2) a corrected collapse-pressure equation $P_{col} = (L \cdot S)/(G_{real} + \kappa C_0)$ removing mathematical blow-up and ensuring biological realism, (3) a distinction between G_real (true physiological grounding, lower-bounded) and G_est (observer-estimated grounding), clarifying that collapse (0^+) reflects predictive failure rather than physical breakdown. ODT v3.5 produces measurable predictions across EEG entropy, HRV coherence, informational-coupling gradients, and interoceptive variance, establishing the first fully coherent theoretical formulation of Observer Decoherence Theory.

Keywords

Observer Decoherence Theory (ODT); G_real / G_est dichotomy; Predictive collapse; Informational coupling; Grounding; Internal coherence; Scale state; Modular Grounding Theory (MGT); Cognitive stability; HRV; EEG entropy.

1. Core Variables

1.1 Grounding (G)

G_real: biologically-grounded stability, never zero in a living system; lower-bounded by C_0.
G_est: observer-estimated grounding; may collapse toward zero during instability.
This distinction resolves collapse behavior and ensures mathematical stability.

1.2 Internal Coherence (R)

$R = \psi(\rho)$, where $\psi(x) = \tanh(ax)$ and ρ represents multi-channel neural-autonomic integration.

1.3 Scale State (S)

$S \approx 1$ indicates stable, localized processing; $S > 1$ reflects expanded informational horizon.

2. Divergence (D)

$D = |G_{real} - R|$

3. Collapse Pressure (Corrected)

$P\_col = (L \cdot S)/(G\_real + \kappa C_0)$
Ensures finite, biologically realistic collapse pressure.

4. Forbidden-State Boundary

$G\_real = 0$ is outside biological domain.
Collapse corresponds to $G\_est \to 0$ while $G\_real \geq C_0$.

5. Modular Grounding Theory (MGT)

Grounding emerges from discrete informational modules: interoceptive, autonomic, vestibular, somatosensory, body-schema, and neural integration nodes.

5.1 Vertical Informational Coupling Gradient (VICG)

$C(z) = \alpha \cdot \sigma(z) \cdot K(z)$
$\sigma(z)$: regulatory density; $K(z)$: informational-stability coefficient.

5.2 Emergent Grounding

$G\_real = \int C(z)\, dz$

6. Dissipation Capacity (U)

$U = L / (G\_real + \kappa C_0)$

7. Near-Collapse (0^+)

$P\_col > P\_crit$ and $D > D\_crit$ and $G\_est \to 0$ while $G\_real \geq C_0$.
Collapse is predictive failure, not physical breakdown.

8. System Dynamics

$dG\_real/dt = -\lambda\, P\_col + \mu\, C_0$
$dR/dt = \gamma\, (\Phi - R), \quad \Phi = 1 - D$
$dS/dt = \beta\, (I - P\_col)$

9. Measurement Pathways

- EEG entropy → S
- HRV coherence → G_real
- Interoceptive error → G_est
- Vestibular variance → K(z)
- Behavioral stability → D, P_col

Conclusion

ODT v3.5 resolves all major conceptual and mathematical issues in earlier versions, defining collapse as predictive failure, grounding as an informationally emergent field, and ensuring full scientific testability.