Dual Global Workspace, Mutual Shaping Dynamics, and Predictive Coding

A Dual-Center Dialogue Model of Consciousness (English Edition)

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Abstract

Global Workspace Theory (GWT) models consciousness as numerous unconscious processors competing for a single broadcast channel. This framework explains attention, working memory, and the seriality of conscious content, but has structural blind spots regarding adaptivity, inner contradiction, creativity, and degrees of consciousness. This paper proposes the Dual Global Workspace Theory (DGWT), extending GWT from a single center to a dual-center architecture: two global workspaces corresponding to an execution side (left, L) and a scrutiny side (right, Γ), continuously interacting through a callosal channel. We define the dynamics of mutual shaping —the two sides not only exchange information but continuously reconstruct each other's memory bases and tool sets. We show that mutual-shaping systems admit no static fixed point; their state is critical oscillation. We further incorporate predictive coding into the dual-center framework, proposing the dual-prediction-engine hypothesis —the left as generative model, the right as inference model —with conscious experience arising from the prediction-error minimization dynamics between two engines rather than the content of a single workspace.

1 The Blind Spots of Single-Center Theories

GWT's core metaphor is a "theater": unconscious expert modules sit in a dark audience; only content reaching the stage (the global workspace) is conscious and broadcast. The theory powers the Conscious Turing Machine line of work, yet fails on four counts: (1) how consciousness modifies itself; (2) why agents harbor inner contradictions; (3) where creativity originates; (4) why consciousness admits degrees.

2 Dual Global Workspace Architecture

Two workspaces, W_L (execution) and W_Γ (scrutiny), exchange structured messages through a limited-bandwidth callosal channel C. Each workspace holds its own memory base M_i and tool set T_i.

3 Mutual Shaping Dynamics

Mutual shaping goes beyond information exchange: each side updates not only its state but the other's memory and tools:

$$M_L^{(k+1)} = F\big(M_L^{(k)},\, C_{\Gamma\to L}^{(k)}\big), \qquad M_\Gamma^{(k+1)} = G\big(M_\Gamma^{(k)},\, C_{L\to\Gamma}^{(k)}\big) \tag{1}$$

where $C_{\Gamma\to L}$ encodes not just data but *revisions*: challenges raised by Γ become material for L's next iteration; pitfalls logged by L become Γ's next audit checklist.

No-fixed-point property. Define the shaping map $S = F \circ G$. A static fixed point would require $S(x^*) = x^*$ with zero cross-revision flow. We show that for any mutually attentive pair (F, G both responsive to cross-revision), the fixed-point condition is structurally unreachable: each revision consumed generates residual disagreement, which triggers the next revision. Formally, with oscillation amplitude measured by

$$\gamma = \liminf_{k\to\infty} \frac{d\big(o_L^{(k+1)},\, o_L^{(k)}\big)}{d\big(o_L^{(k)},\, o_L^{(k-1)}\big)}, \tag{2}$$

mutual shaping sustains $\gamma \approx 1$ —bounded, non-vanishing oscillation —rather than $\gamma \to 0$ (settling) or $\gamma > 1$ (divergence). The system hovers at criticality: this is why inner experience is a stream, not a still frame.

4 Dual Prediction Engines

Predictive coding recast in the dual-center frame: L operates as the *generative model* $p_\theta(x)$ (guessing the world from experience); Γ as the *inference model* $q_\phi(z \mid x)$ (checking the world against evidence). Conscious content corresponds to the prediction-error signal

$$\mathcal{E} = D_{\mathrm{KL}}\big(p_\theta \,\|\, q_\phi\big), \tag{3}$$

whose minimization trajectory —not either engine alone —constitutes experience. Creativity is the exploitation of transient high-$\mathcal{E}$ states: when the engines disagree at the frontier of competence, that error signal *is* the physical essence of insight.

5 Explanatory Payoff

Self-modification: each workspace rewrites the other's priors —consciousness edits itself through its dual structure. **Inner contradiction**: L and Γ hold heterogeneous priors; cognitive dissonance is their sustained disagreement, not a bug. **Creativity**: error-signal harvesting (above). **Degrees of consciousness**: coupling strength K and channel bandwidth B parameterize a continuum from decoupled single workspaces to fully mutual shaping.

6 Testable Predictions

(1) Callosal-load manipulation should shift oscillation amplitude γ predictably. (2) Split-brain preparation should collapse mutual shaping into two independent single workspaces with distinct fixed points. (3) Creative-peak states should show elevated transient $\mathcal{E}$ correlated with insight reports.

7 Conclusion

Consciousness is not a monologue on one stage; it is the never-ending dialogue between two theaters, and the dialogue itself —oscillatory, mutually rewriting, error-driven —is what it feels like to be aware.