The Distinction–Connection–Abstraction Hypothesis: A Structural Missing Link for Human Cognition

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Abstract

We propose that the human "missing link" is not a new faculty but a specific way of *structuring* and *compressing* experience. Across species, minds share two primitives: **Distinction** (carving experience into units) and **Connection** (tracking relations). Humans add a third principle, **Abstraction**, realized as a lifelong process that discovers, refines, and reuses structural *patterns* that compress the whole of experience. We formalize this Distinction–Connection–Abstraction (DCA) hypothesis with an unlabeled structural substrate (*the Phaneron*) and a rewrite loop (propose → predict/compress → keep/refine/merge). We argue that (i) music enjoyment, (ii) novelty vs boredom, and (iii) dreams align naturally as signatures of this loop; and that *consciousness* is what it feels like to perform global consolidation from a persistent self-pattern. The Cognitive Tradeoff Hypothesis (CTH) fits this view: humans reallocated resources from ultra-fast, local "read→react" circuits to a slower, integrative abstraction engine. We outline comparative predictions and falsifiable tests.

Contributions.

- A minimal structural lens for cognition: distinctions, connections, and reusable patterns without labels (*the Phaneron*).
- The DCA hypothesis: human cognition = distinction + connection + *recursive, global abstraction.*
- A self-anchored view of consciousness: global consolidation relative to a high-centrality "ego" pattern.
- Affect-as-control: aversion, curiosity, and equilibrium as value fields over the Phaneron.
- Comparative predictions (humans vs animals) and falsifiable experiments, including CTH-style tradeoff and affect-control signatures.

1 From Distinction and Connection to Abstraction

Animals distinguish and connect; we reserve *abstraction* for the *recursive, global* discovery and reuse of patterns that compress experience across domains and time. We model this with a single-layer graph—*the Phaneron*: unlabeled nodes (distinctions) and unlabeled edges (connections); relations, roles, time, and direction appear as *patterns*—small subgraphs reused when they improve prediction or reduce description length.

Directed implementation, undirected Phaneron

Neural circuits are directed and time-ordered; the *Phaneron* is undirected. We resolve the apparent mismatch by treating relations as first-class *distinctions*: to represent an apparently

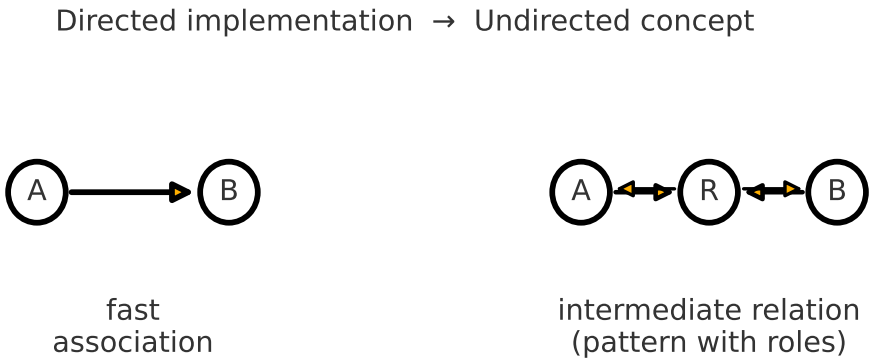

Figure 1: **Directed implementation vs undirected concept.** Left: fast directed association $A \to B$. Right: conceptual motif with an intermediate relation node R linking A and B; roles (e.g., cause/effect) are encoded within the pattern while the substrate remains undirected.

one-way link (e.g., causality) between A and B, the system constructs a small motif with an intermediate relation node R that both A and B connect to. Direction and roles (e.g., cause/effect, before/after) live *inside the pattern*, not in base-edge orientation. Learning or "absorbing" upgrades cheap, online $A \to B$ traces into reusable A–R–B motifs; this is slower and requires maintenance, explaining recall asymmetries (e.g., name/face) and the need for offline consolidation.

2 Global Consolidation vs Local Coupling

Many animals exhibit D and C, and limited domain-specific abstraction. Humans push to *recursive, global* abstraction: patterns from one domain (music, math, narrative) are re-used elsewhere; conflicts propagate; the system tries to make the entire model cohere.

Evolutionary framing: the Cognitive Tradeoff Hypothesis

The Cognitive Tradeoff Hypothesis proposes that, along the human lineage, some fast, high-fidelity visuospatial and sensorimotor abilities (striking in great apes) were weakened in exchange for capacities such as language and abstract reasoning. In *DCA* terms, this trade is expected: running a *global* abstraction engine—which discovers reusable patterns, reconciles conflicts across domains, and maintains a single coherent world-graph anchored on a self-pattern—is metabolically and computationally costly. Resources are reallocated from ultra-fast, local "read → react" circuits toward slower, integrative processes (pattern discovery, concept merges, cross-domain transfer). On this view, the human decrement in snapshot-like local performance is the price of maintaining recursive, global structure, yielding long-horizon transfer and compositional reasoning.

3 Algorithmic Loop: Abstraction and Refinement

We postulate a lifelong loop: (1) propose a candidate pattern to explain regularities, (2) test it by prediction (held-out/future) and compression (description length), (3) keep/refine if it pays, or discard if not, (4) merge nodes when neighborhoods converge ("cognitive development").

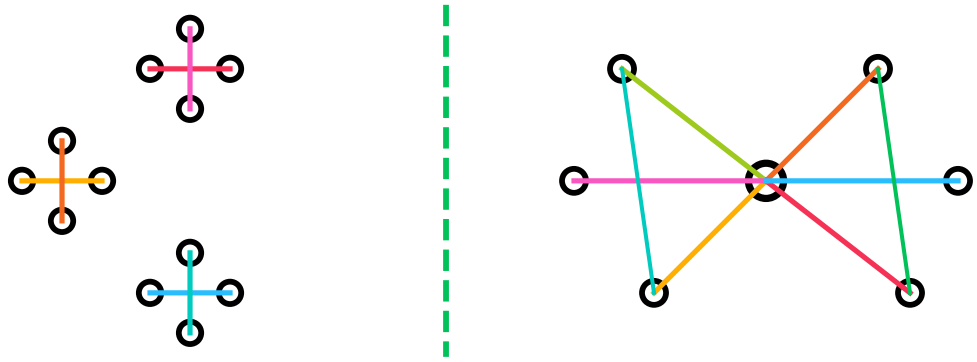

Figure 2: **Local coupling vs global consolidation.** Left: loosely-coupled islands (plausible for many animals). Right: global consolidation with a dense, cross-cutting self pattern (humans).

Direction, roles, and time emerge from asymmetric patterns that prove themselves predictively and compressively.

The Consciousness Loop: D → C → A → Consolidation

We propose that conscious episodes correspond to passes of a loop: *Distinction* (identify units) → *Connection* (link them) → *Abstraction* (discover reusable patterns) → *Consolidation* (integrate changes into the global, self-anchored *Phaneron*). The first three steps describe the structural work; consolidation is the mode where updates propagate globally, adjust neighboring concepts, and stabilize revisions—often engaging the self pattern most strongly.

4 Affect and Control: Aversion, Curiosity, and Equilibrium

We model affect as valuation fields defined over the Phaneron that bias sampling, pattern rewrite, and action selection. Aversive fields impose steep negative gradients near predicted catastrophic futures for the self pattern; curiosity fields impose positive gradients toward regions of high expected information gain. These fields shape where the D→C→A→Consolidation loop spends its cycles.

Aversion-dominant control and negativity bias

Because evolution penalizes missed threats more than false alarms, aversive gradients are steep and prioritized. The loop therefore over-samples "what could go wrong" and over-weights negative prediction errors relative to positive ones, a signature consistent with human negativity bias. Approach signals (pleasure, satisfaction) can be read as the complement: regions tagged low-risk and high-promise under current constraints.

Catastrophization as loop pathology

When aversive fields dominate, the loop fixates on worst-case branches, hijacking consolidation so that many updates become "about" the catastrophic narrative. This matches clinical ruminative/anxious dynamics and predicts asymmetric recall and exploration under induced threat framing.

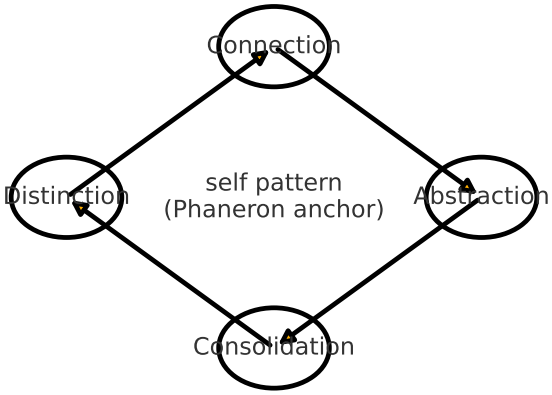

Figure 3: **Consciousness loop.** Distinction → Connection → Abstraction → Consolidation, cycling within a global Phaneron anchored on a self pattern.

Development: from global terror to tuned affect

Early life starts with little structure and high uncertainty; crude alarms fire often. As the Phaneron consolidates safety and predictability patterns, affect becomes more specific and less globally aversive. Slow human maturation is thus the developmental cost of building a very large, abstractable Phaneron under a strong safety controller.

Curiosity as equilibrium-seeking on the information axis

Curiosity is the felt signal of a structural mismatch: a domain that keeps mattering is underfitted internally. The system accepts short-term disturbance (leaving local calm) to achieve a deeper equilibrium after consolidation. This complements aversion: fear keeps the system from immediate cliffs; curiosity updates the map so it avoids different cliffs tomorrow.

Equilibrium and the unattainable limit

A healthy equilibrium is a regime with low debt, manageable background consolidation, and frontier learning. The "Perfect Phaneron" that fully mirrors reality is unattainable in practice (finite capacity, partial observability, noise, change) and likely in principle (self-reference, open-ended structure). But local saturation is common: well-practiced domains approach functional completeness while the broader Phaneron remains open-ended.

5 Self as Central Pattern and Consciousness

On this view, the "self" is a high-centrality pattern that participates in most episodes and mediates long-range consolidation. *Consciousness*, we suggest, is the phenomenology of performing global consolidation *relative to* that persistent self pattern.

6 Case Study I: Music as a Pattern Gym

Music is structured redundancy: repetition, variation, hierarchy. Humans appear to extract reusable motifs and expectations, enjoying regimes where predictions are informative but not

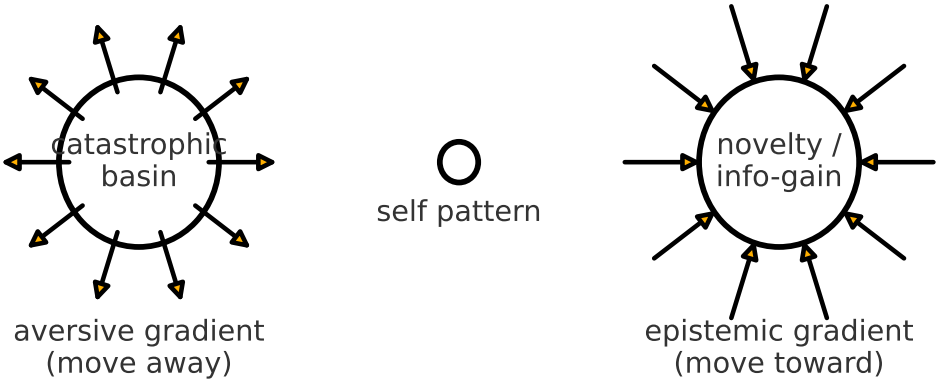

Figure 4: **Affective control fields.** Left: an aversive basin repels trajectories away from catastrophic futures. Right: an epistemic/curiosity hill attracts exploration toward high expected information gain. The self pattern sits between, allocating cycles under safety constraints.

trivial. Overexposure saturates the model; pleasure fades as additional listening yields negligible compression/prediction gain.

7 Case Study II: Dreams as Offline Consolidation

With external input reduced during sleep, replay and free association explore new merges and pattern rewrites; predictive checks (including valuation) accept or reject candidates. Subjectively, this manifests as dreams: vivid but unconstrained trajectories through the graph, often resolving conflicts or strengthening useful patterns.

8 Novelty, Boredom, and the Control of Learning

The system seeks regimes where expected compression/prediction gain is high ("interesting"), avoids the too-random and the over-familiar, and adapts its exploration policy accordingly. This frames novelty seeking and boredom as homeostatic control of the abstraction rate.

Development and Aging: Phaneron Load and Temporal Experience

The common account of "time speeding up with age" appeals to fractions of lifetime lived. Our view complements this with a structural claim: as the *Phaneron* grows, two forces increase background demand: (i) **load**—a larger, cleaner world-graph still costs more to maintain; and (ii) **cognitive debt**—unresolved conflicts and outdated patterns require ongoing consolidation. When more cycles are consumed by background consolidation, fewer remain for high-resolution sampling of the present; subjectively, the "frame rate" of experience drops and days feel shorter. Children, with small graphs and abundant novelty, allocate more to foreground abstraction (richer present-moment sampling); adults allocate more to maintenance (identity, long-horizon projects), shifting the operating point. This within-lifespan allocation echoes the Cognitive Tradeoff logic: capacity moves from fast local sampling toward global structure as the model matures.

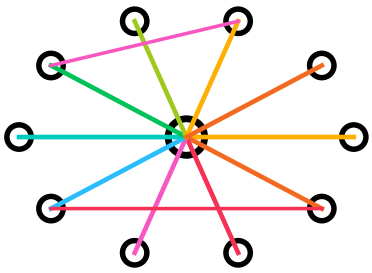

Figure 5: **Self as central pattern.** A dense hub interwoven with most functional neighborhoods; not a label but a structural role reused everywhere.

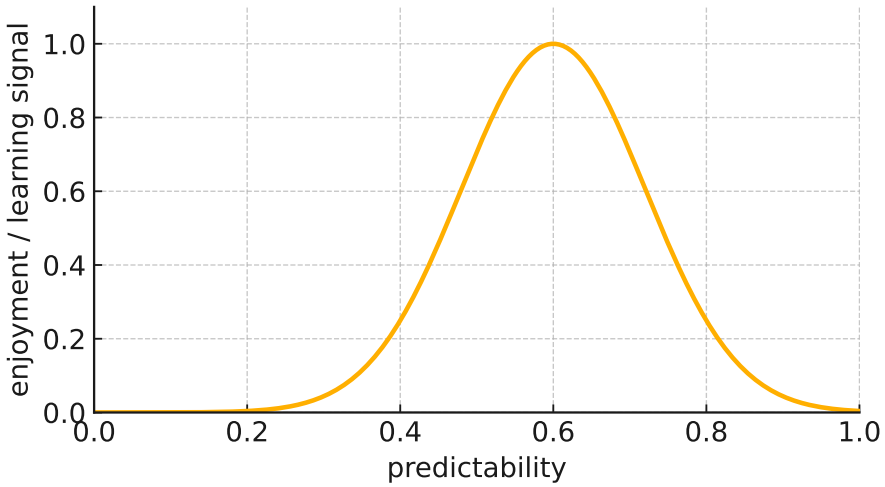

Figure 6: **Enjoyment vs predictability.** An inverted-U captures intuition: too random (left) yields no reusable patterns; too predictable (right) yields no new gain.

Practical implication: debt reduction and subjective time. If background consolidation load partly drives the acceleration of subjective time, then interventions that reduce *cognitive debt*—e.g., mindfulness practice, rumination reduction, psychotherapy, and deliberate simplification of commitments—should free cycles and increase the effective sampling granularity of the present. On our account, contemplative reports of "time slowing down" and heightened vividness reflect a temporary reallocation from background consolidation to foreground distinction/connection/abstraction, not any change in clock time.

9 Comparative Predictions (Humans vs Other Animals)

Our hypothesis does not deny animal abstraction; it predicts differences of *degree and mode*:

- **Recursive abstraction:** humans readily form patterns over patterns (grammar about grammar), animals do so only shallowly.
- **Global consolidation:** humans try to reconcile many domains into a single model; animals

Figure 7: **Dreams as consolidation pipeline.** Replay → association → pattern proposal → predictive check → keep/refine/discard → updated model.

keep modules more loosely coupled.

- **Music & narrative:** humans show strong inverted-U enjoyment tied to structure; most animals show limited sensitivity beyond species signals.
- **Dream signatures:** more cross-domain association and conflict resolution in human REM; tighter coupling to episodic replay in animals.
- **CTH-consistent tradeoff across species:** species with exceptional snapshot-like local fidelity (e.g., brief masked arrays) should, all else equal, show shallower depth of *recursive, cross-domain* abstraction; humans should show the reverse allocation.
- **Allocation signatures within humans:** intensive training that enhances ultra-fast local fidelity is predicted to yield diminishing returns or measurable opportunity costs on tasks requiring flexible cross-domain abstraction, if a shared resource budget is reallocated.
- **Affect-control signatures:** induced threat frames should increase negativity bias (heavier sampling of worst-case futures) and reduce epistemic exploration; mindfulness/rumination-reduction should show the converse, controlling for arousal.

10 Links to Existing Theories

The DCA view is compatible with predictive processing (minimizing error) but adds an explicit structural substrate and rewrite calculus (patterns, merges, MDL-like criteria) to explain how abstractions stabilize. It interfaces with global workspace accounts (broadcast during consolidation) and with memory replay findings (offline trajectory sampling); CTH provides an evolutionary rationale for the resource allocation. Our affect-as-control view aligns with appraisal/valuation accounts in which emotion shapes sampling and policy rather than being mere "readouts."

11 Falsifiable Claims and Experiments

We sketch testable predictions:

- **Behavioral learning curves:** enjoyment/engagement peaks at intermediate predictability and falls with model saturation; measure via adaptive grammars.
- **Concept merge signatures:** training that unifies near-synonyms produces abrupt generalization jumps and reduced reaction times consistent with a "merge" event.
- **Dream intervention:** targeted rehearsal resolving a lab-induced conflict reduces REM dream frequency about that topic and improves next-day generalization.
- **CTH-style allocation tests:** regimes that boost snapshot-like local fidelity should either plateau or trade off against cross-domain abstraction under fixed budgets; cross-species comparisons should reveal complementary strengths.
- **Affect-control tests:** threat vs safety framings should shift sampling (more worst-case vs more epistemic exploration) and time perception; mindfulness/rumination-reduction interventions should increase present-moment sampling granularity and reduce negativity bias.

12 Limitations

The substrate is an abstraction: neural circuits are directed and noisy; our claim is about *functional equivalence* at the cognitive level. Measures of "compression gain" are proxy; careful operationalizations are needed. We do not address the *hard problem*; we offer a structural/algorithmic account of when and why rich consciousness correlates with processing mode.

13 Stagewise Reflection and Singularities

Reflection parity is not a fixed point but a *stagewise* target. Let W_t be the micro-world, $\pi_{B,G}(t)$ the task-indexed quotient under resource bound B and goals G, and P_t the current Phaneron.

- **Stage k:** an interval $[t_k, t_{k+1})$ where there exists a homomorphism $h_k : P_t \to \pi_{B,G}(t)$ with task error $\leq \varepsilon(B)$ and P_t is MDL-minimal under the equilibrium objective.
- **Singularity at t_{k+1}:** the smallest time where no sequence of local refinements of $P_{t_{k+1}^-}$ can keep task error $\leq \varepsilon(B)$ without (i) raising capacity B, (ii) narrowing G, or (iii) introducing new invariants (a partition re-factor). Equivalently, the optimal partition changes topology/cardinality:

$$\mathcal{P}(B^-, G) \ncong \mathcal{P}(B^+, G) \quad \text{or} \quad |\mathcal{P}(B^-, G)| \neq |\mathcal{P}(B^+, G)|.$$

Predictability horizon. The horizon H at state (P_t, B, G) is the largest τ such that all task queries within $[t, t+\tau]$ admit bounded regret under the current partition; beyond H, any reliable forecast requires a partition transition (capacity increase or new invariants).

Precursors and a practical score. As a singularity approaches, we typically observe: (i) rising conflict curvature despite consolidation, (ii) increasing residual variance and autocorrelation in forecast errors, (iii) accelerated split/merge churn and codebook drift, (iv) longer/variable MES and message-size spikes in multi-agent settings, and (v) a stall in reflection-distance improvement. A simple trigger uses a weighted score $S(t)$ over these signals and initiates a controlled re-factor when $S(t) > \tau$.

Consequences. Intelligence growth is piecewise: long plateaus of reflection parity punctuated by singularities when tasks/evidence demand new invariants. This explains "unknown unknowns" pre-transition, collective communication cliffs when teams align a finer partition, and subjective time shifts when cognitive debt is reduced across a transition.

14 Conclusion

If animals share distinction and connection, the human upgrade may be a relentless, recursive, and global *abstraction* loop that compresses experience into reusable structure—anchored on a ubiquitous self pattern and evolutionarily supported by a cognitive tradeoff favoring global structure over local fidelity. On this view, music, dreams, curiosity, and the feel of consciousness are natural byproducts of the same engine. The framework also implies that subjective time is partly an allocation variable: practices that reduce cognitive debt (e.g., mindfulness) should free capacity and increase the effective sampling granularity of the present, aligning with long-standing contemplative reports.