Being, Becoming, and the Architecture of Experience: A Dual-Sector Monistic Ontology of Consciousness

Emiliano Shea

December 19, 2025

Abstract

We propose a unified framework for consciousness based on a dual-sector monistic ontology and empirically testable organizational constraints. Metaphysically, we distinguish an *unmeasurable sector* that provides the universal ground of phenomenal presence from a *measurable sector* of spatiotemporal, action-governed dynamics. Rather than asking why experience exists, we ask when and where this undifferentiated presence becomes *individuated* as bounded, perspectival consciousness.

At the structural level, we identify five jointly necessary organizational constraints for phenomenal individuation: integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence. We formulate a *composite threshold postulate* according to which systems in the measurable sector that satisfy these constraints above appropriate joint levels *nomologically* instantiate individuated phenomenal presence, without reducing consciousness to any single structural quantity.

Finally, we outline an *action-first* research program that seeks to formalize these constraints in terms of action over histories, treating information-theoretic quantities as derived ledgers of how action is distributed and constrained. The framework avoids the category error of deriving the existence of presence from structure alone, dissolves the panpsychist combination problem by denying micro-experiences in parts, and recasts the hard problem as a question about lawlike patterns of individuation that bridge metaphysical ground and empirical science.

1 Introduction

Despite centuries of inquiry, a fundamental disconnect endures between the immediacy of first-person experience—what philosophers call *phenomenal consciousness* [6, 19]—and third-person descriptions of physical processes. Neuroscience has uncovered increasingly detailed structural and dynamical regularities in the brain, yet no amount of structural description seems to *explain*

why these structures give rise to subjective experience at all. This is not merely a gap in empirical knowledge; it suggests an asymmetry in the very categories through which we access reality [17].

The central contention of this paper is that consciousness cannot be understood solely within the measurable, structural domain typically described by the physical sciences. To make progress, we propose that any adequate account of consciousness must acknowledge the intersection of two complementary aspects of a single reality:

1. **The structural domain:** the domain of physical states, causal processes, and informational patterns amenable to measurement and mathematical description, often identified with the extrinsic properties of matter [21].

2. **The experiential ground:** not a further substance or hidden variable, but the ontological condition in virtue of which structural patterns are ever *present* at all—the domain in which there is something it is like for any state to be realized. This domain is "unmeasurable" not because it is supernatural, but because it provides the very condition for measurability and description.

These are not two worlds or two interacting substances. They are complementary modes of one reality: structure provides *form and organization*; presence provides *actuality*. The working hypothesis of this paper is that consciousness arises precisely at the *interface* where certain organized structures in the measurable domain meet the universal ground of presence.

Three motivations anchor this view:

1. **Explanatory asymmetry:** Structural descriptions specify *how* systems behave, but not *why* certain organized structures are phenomenally realized at all. Treating presence as a primitive condition rather than a derived property makes this asymmetry explicit.

2. **Organizational constraint:** Consciousness does not appear in arbitrary physical systems, but only when they reach specific thresholds of integration, differentiation, recursion, boundary formation, and temporal coherence. Any adequate theory must explain *which* organizational profiles support a conscious perspective and why.

3. **Causal-closure coherence:** Phenomenal character does not add new forces to the physical world. Instead, it is the experiential mode of certain causally closed physical processes. This suggests a dual-aspect, rather than dual-substance, picture [2].

What "interface" means: experiential individuation

In this framework, an *interface* is not a spatial boundary between two realms, but a locus of organization where the experiential ground becomes *individuated* as a bounded perspective. A lens focuses undifferentiated light into an image; analogously, suitably organized physical systems focus undifferentiated presence into a particular, contentful stream of experience. The main question of this paper is therefore not why there is presence at all, but under what structural and dynamical conditions presence manifests as a conscious *subject*.

Dual aims. The first aim is to clarify the relationship between structural description in the measurable sector and experiential instantiation in the unmeasurable sector. The second is to identify the organizational thresholds that govern when and where phenomenal presence is individuated as bounded, perspectival consciousness.

Roadmap. Section 2 develops the dual-sector ontology distinguishing the unmeasurable ground of presence from the measurable, action-structured domain of physics. Section 3 introduces five organizational constraints and a composite threshold postulate for phenomenal individuation. Section 4 situates the framework within contemporary philosophy of mind and consciousness science, addressing major objections and comparing it to leading theories such as Integrated Information Theory, Global Workspace Theory, and predictive processing. Section 5 sketches an action-first research program for formalizing the constraints in dynamical terms and outlines directions for empirical and formal work.

2 The Two-Sector Ontology

This section develops the ontological framework required to address the structural limits identified in the Introduction. Specifically, we distinguish between (i) a *measurable sector* governed by spacetime, dynamics, and empirical accessibility, and (ii) an *unmeasurable sector* that constitutes the condition under which phenomenal presence is possible. The measurable sector provides structure; the unmeasurable provides presence. Neither reduces to the other.

2.1 The Measurable Sector

Definition 2.1 (Measurable Sector)**.** The measurable sector is the domain in which spacetime exists; physical laws operate; uncertainty, entropy, and temporal evolution occur; and complex systems undergo state transitions. It contains all empirically accessible phenomena, including biological organisms, neural dynamics, and the physical substrates of consciousness. It is the domain of *becoming*, accessible to third-person observation and measurement.

Remark. The measurable sector provides the *organizational substrate* through which phenomenal presence becomes *individuated* and *contentful*. It supplies form, boundaries, and differentiation—but not presence itself.

2.2 The Unmeasurable Sector

Definition 2.2 (Unmeasurable Sector)**.** The unmeasurable sector is outside spacetime: timeless, changeless, containing no processes, metrics, or information flow. It is not a Platonic space of possibilities nor a hidden physical domain. It is the *condition of phenomenal presence*: the pure "that-it-is" underlying every possible experience.

Remark. The unmeasurable sector has no spatial location or geometry. It is a universal precondition that becomes phenomenally instantiated when the measurable sector realizes

appropriate organizational forms. Structure does not reveal hidden phenomenal content; it *creates* the possibility of a bounded experiential perspective.

2.3 Sector Independence and Dependency

Proposition 2.1 (Non-Reduction)**.** *Neither sector reduces to the other. Structure cannot entail presence, and presence cannot generate structure.*

Proposition 2.2 (Asymmetrical Enablement)**.** *The unmeasurable sector provides the condition of presence; the measurable sector provides the organizational conditions for individuated, contentful experience.*

Proposition 2.3 (Causal Orthogonality)**.** *Physical processes unfold entirely within the measurable sector. Phenomenal presence does not violate causal closure; it is the experiential aspect of physical processes.*

Proposition 2.4 (Explanatory Necessity)**.** *Single-sector ontologies (physicalism, panpsychism, idealism, neutral monism) each fail on structural grounds. The two-sector ontology is the minimal framework that preserves both physical autonomy and phenomenal actuality.*

2.4 Illustration: Pain

A nociceptive event has:

- a structural aspect: neural activity within spacetime,
- an experiential aspect: the "what-it-is-like" of pain.

These aspects are not separate causes but two sides of one realized process. The next section develops the organizational conditions that enable phenomenal individuation within the measurable sector.

3 Organizational Constraints for Phenomenal Individuation

Having established the two-sector ontology (Section 2), we ask the empirically tractable question implied by that ontology: *which organizational properties of physical systems in the measurable sector enable phenomenal presence—the universal condition grounded in the unmeasurable sector—to be instantiated as individuated, contentful, perspectival experience?* Note the category distinction: the *unmeasurable sector* itself is not instantiated; rather, organisation in the measurable sector creates the structural conditions under which undifferentiated presence can become individuated consciousness.

3.1 Core idea and strategy

The central thesis is this: phenomenal individuation requires a physical system to implement an *organizational architecture* that supplies the structural features which presence lacks. Presence (the unmeasurable ground) is ontologically prior but structureless; measurable organization supplies *form, unity, boundaries, perspective,* and *temporal continuity.* When these features co-occur at sufficient levels, the universal condition of presence can appear (as a matter of fact in our world) in the form of a bounded, contentful, perspectival experience.

Our strategy in this section is:

1. Precisely state the candidate organizational constraints.
2. Motivate why each constraint matters for the phenomenology of consciousness.
3. Provide operational suggestions (candidate metrics and proxies).
4. State an empirically actionable nomological postulate and predictions.
5. Identify key caveats, limitations, and falsification routes.

3.2 Constraint 1: Integration (Unified Information)

Definition 3.1 (Integration)**.** A system exhibits *informational integration* when the joint dynamics of its components encode dependencies that cannot be factorized into independent subsystems without loss of functionally relevant information.

Integration supplies *unity*: the structural basis for a single, attributable perspective rather than disconnected fragments of processing.

Remark. Formal measures include multi-information, global mutual information, and integrated-information families ("Φ") [1, 24]. Practical proxies include perturbational complexity indices (PCI) [5] and synergy/redundancy decompositions. Each measure has limits; we treat them as operational starting points.

Proposition 3.1 (Integration Necessity)**.** *High informational integration is necessary (though not alone sufficient) for phenomenal individuation: without integration there is no unified field for content to be attributed to a single perspective.*

3.3 Constraint 2: Differentiation (Rich Repertoire)

Definition 3.2 (Differentiation)**.** A system is *differentiated* when it supports a large repertoire of reliably producible informational states, enabling fine-grained variation of representational content.

Differentiation supplies *content*: the distinct qualitative distinctions (qualia-like differences) that fill a unified field.

Proposition 3.2 (Integrated Differentiation)**.** *Phenomenal individuation requires both integration and differentiation: unity without content yields a blank field; content without unity yields disconnected processing. The co-presence of both supports a rich, unified experiential field.*

3.4 Constraint 3: Recursive Self-Reference (Re-entrant Self-Modeling)

Definition 3.3 (Recursive Self-Reference)**.** A system exhibits *recursive self-reference* when it implements internal generative or predictive models that include (functionally) the system itself, and uses those models in ongoing regulation and selection of its behavior.

Recursion supplies *perspectival structure*: the functional fact that processing is organized as "for a system" rather than merely distributed operations without a center of subjectivity. This is closely related to the formation of a Phenomenal Self-Model (PSM) [18].

Remark. In neuroscience this is closely related to re-entrant connectivity, hierarchical predictive coding [10], and mechanisms supporting self-monitoring and metacognition [13, 16]. Operational proxies include measures of top-down feedback strength, Granger causality in re-entrant loops, and prediction-error dynamics localized to self-representational subsystems.

Proposition 3.3 (Perspective Requirement)**.** *Recursive self-reference is necessary for a system to sustain a stable, attributable point-of-view: without it, processes may be complex yet lack the functional conditions for a persisting "for-whom" structure.*

3.5 Constraint 4: Boundary Maintenance and Autonomy

Definition 3.4 (Boundary Maintenance)**.** A system satisfies *boundary maintenance* when it actively preserves a distinguishable interface (statistical, informational, metabolic, or control-theoretic) that marks internal states from external states across relevant timescales.

Boundary maintenance supplies *individuation*: it establishes which physical degrees of freedom constitute the system that could bear an experiential perspective.

Remark. In active inference and related frameworks this is formalized via Markov blankets or conditional independence relations [7, 10, 15]. Empirical proxies include information-flow asymmetries across a putative boundary and energetic separation indices.

Proposition 3.4 (Autonomy Requirement)**.** *Phenomenal individuation requires physical and informational autonomy: absent maintained boundaries, there is no determinate locus to which presence can be attributed [25].*

3.6 Constraint 5: Adaptive Coherence Across Timescales

Definition 3.5 (Adaptive Coherence)**.** Adaptive coherence denotes the capacity to integrate and regulate information and control across multiple temporal scales (fast sensory loops, intermediate working-memory timescales, slow learning/plasticity) so that organized patterns persist while remaining responsive.

Adaptive coherence supplies *continuity*: it stabilizes a perspective over time and supports temporally extended content (memory, continuity of self).

Proposition 3.5 (Temporal Continuity)**.** *Sustained phenomenal presence requires adaptive coherence: transient, noise-like patterns—however integrated at a moment—do not suffice to produce temporally extended subjectivity [9].*

3.7 Why these five constraints? (Motivation and interdependence)

The five constraints are motivated both phenomenologically and ontologically.

Phenomenological grounding

- Conscious experience is *unified* → requires integration.
- It is *contentful* → requires differentiation [22].
- It is *perspectival* → requires recursion/self-reference.
- It is *attributable to an individual subject* → requires boundary maintenance.
- It is *temporally extended* → requires adaptive coherence.

Ontological link to Section 2 The unmeasurable sector provides the universal, undifferentiated condition of presence. Physical organization supplies what presence lacks: form, boundary, perspective, and persistence. Thus the five constraints jointly provide the structural preconditions under which undifferentiated presence can be instantiated (in the sense of becoming individuated, bounded, and contentful) within the measurable sector.

Interdependence These constraints form a *mutually supporting architecture* rather than a simple checklist. For example, robust recursion typically presupposes coherent boundaries and sufficient integration; differentiation provides the content that recursion operates on; adaptive coherence stabilizes the whole. Empirically, we therefore expect multivariate signatures (covariation among metrics) rather than independent, single-measure thresholds.

3.8 Composite threshold: Phenomenal Instantiation

Definition 3.6 (Phenomenal Instantiation Threshold)**.** A physical system meets the *Phenomenal Instantiation Threshold* when it simultaneously achieves sufficiently high levels of: integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence.

Proposition 3.6 (Nomological Postulate)**.** *We propose, as a nomological postulate for our universe, that systems meeting the Phenomenal Instantiation Threshold instantiate bounded, perspectival, contentful phenomenal presence. The postulate is methodological: it frames a law-like correlation between organizational topology and phenomenal instantiation that is empirically testable via observable correlates (behavioral, neural, and functional signatures), while acknowledging that presence itself is not directly observable from the third-person.*

Remark. Why adopt a nomological postulate? Because structure alone cannot logically entail presence (Section 2)—the relationship must be treated as a contingent, law-like pattern in our world that science can confirm or refute by its empirical consequences.

3.9 Operationalization: candidate metrics and caveats

Important caveats. Many formal measures remain contested, computationally intractable for large systems, or ambiguous in interpretation. The following are starting points and practical proxies rather than definitive quantifications.

- **Integration:** multi-information, Φ-family measures; proxy: perturbational complexity index (PCI) [5].
- **Differentiation:** repertoire entropy, effective state-space dimensionality, Lempel–Ziv complexity [22].
- **Recursion / Self-Reference:** directed (Granger-like) feedback metrics, measures of top-down prediction influence, perturbation-response asymmetries.
- **Boundary maintenance:** Markov blanket estimation, information-flow asymmetries, relative metabolic/energetic isolation indices.
- **Adaptive coherence:** cross-timescale mutual information, attractor stability measures, control-theoretic robustness indices (e.g., resilience to perturbation).

Practical research will often rely on proxies (PCI, targeted perturbation outcomes, behavioral readouts) that trade theoretical purity for feasibility.

3.10 Empirical predictions and falsifiability

The framework gives concrete, falsifiable predictions.

1. **Disorders of consciousness:** Loss of integration, recursion, or adaptive coherence should correlate with loss of phenomenal presence (e.g., anesthetic induction, vegetative states). PCI and related indices should track graded changes.
2. **Dissociations:** Systems with high differentiation but low integration or lacking recursion should fail to sustain a stable, attributive perspective. Such dissociations (integration>differentiation or vice versa) falsify simple single-factor theories and support the composite threshold view.
3. **Developmental trajectories:** Measures of integrated differentiation, recursion, and boundary maintenance should increase with ontogeny in ways that correlate with behavioral markers of individuation (sustained attention, self-other distinction).
4. **Artificial systems:** Artificial systems engineered to satisfy the organizational threshold should display behavior and functional signatures of integrated agency. Whether they instantiate presence depends on substrate questions and the nomological postulate; such systems provide crucial empirical tests.

5. **Perturbation tests:** Targeted disruption of recursive self-reference (e.g., via TMS in re-entrant loops) should degrade metacognitive and perspectival markers more than comparable disruption to peripheral processing.

Falsification would arise from reliable demonstrations that systems meeting the operationalized threshold lack behavioral/neural signatures associated with presence, or that systems clearly lacking key constraints nonetheless exhibit robust, reportable phenomenal presence (or accepted behavioral proxies thereof).

3.11 Illustration: the pain example (tie to §2)

Recall the nociceptive example from Section 2. Pain systems exhibit the five constraints to a significant degree: integration across pain networks (ACC, insula, somatosensory cortices), differentiation of pain qualities, self-referential modulation (pain as "mine"), bodily boundary maintenance (localization within the body schema), and adaptive coherence (persistence and modulation). This operationalizes why these neural organizations are proper candidates for meeting the Phenomenal Instantiation Threshold and thus instantiating painful experience.

3.12 Limitations and open questions

This framework leaves several important questions open:

- **Why?** It does not reduce the metaphysical 'why' (why organization and presence are connected)—that foundational claim is supplied by the two-sector ontology (Section 2) and framed here as a nomological postulate.
- **Substrate dependence:** Are the constraints substrate-neutral or do specific biophysical properties matter? This remains empirical.
- **Quantitative thresholds:** Precise numerical cutoff values for metrics are not provided here; the framework yields ordinal and multivariate predictions to be refined experimentally.
- **Combination rules:** How the constraints trade off or combine (strict conjunction vs. graded interactions) is an open empirical issue.

3.13 Summary and transition

The organizing claim of this section is modest but precise: given the dual-sector ontology, *phenomenal individuation* in the measurable sector requires a conjunction of organizational properties—integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence. These five constraints are proposed as a minimal, jointly necessary architecture for transforming undifferentiated presence into a bounded, perspectival, temporally extended stream of experience. Framed as a *composite threshold postulate*, this yields testable predictions, clear routes to empirical falsification, and concrete targets for operationalization.

Section 4 addresses major metaphysical, conceptual, and empirical objections to this picture and situates it with respect to competing theories of consciousness. Section 5 then sketches an action-first research program, outlining how these organizational constraints might be formalized in terms of action-structured dynamics and used to derive quantitative measures for future empirical work.

4 Philosophical Objections and Theoretical Positioning

Having articulated the two-sector ontology (Section 2) and the organizational constraints for phenomenal individuation (Section 3), we now address a series of philosophical objections and situate the framework among existing theories of consciousness. The objections fall into three broad families:

- **Metaphysical objections** (e.g., category error, hard problem, epiphenomenalism, zombies, explanatory gap) question the basic coherence of positing a fundamental condition of presence and a nomological bridge to organization.
- **Conceptual/epistemic objections** (e.g., Mary's room, why these five constraints, the meta-problem) challenge the intelligibility or motivation of the framework and our self-understanding of consciousness.
- **Empirical/structural objections** (e.g., realizer problem, over-generation) target the substrate neutrality and predictive bite of the proposal.

If the metaphysical objections succeed, the framework collapses; if the empirical and conceptual objections succeed, the framework remains coherent but loses scientific utility. The section proceeds accordingly: first objections and replies, then theoretical positioning.

4.1 Objections and Replies

4.1.1 Objection 1: The Category Error

Objection. No description of organizational structure in the measurable sector can *logically entail* consciousness. To say that "integration, recursion, and boundaries *produce* or *are* phenomenal presence" is to commit a category mistake: structure and experience belong to different kinds.

Response. The framework explicitly agrees that organizational properties do not *logically entail* consciousness. We reject any attempt to identify consciousness with structure or to derive presence from purely structural concepts. Instead, we posit a *nomological* link: in our universe, there is a *lawlike pattern* connecting certain organizational configurations in the measurable sector to the *individuation* of phenomenal presence grounded in the unmeasurable sector.

This is analogous to other laws of nature. We do not deduce from pure logic that mass curves spacetime or that like charges repel. These are not conceptual truths; they are discovered regularities we codify as laws. Likewise, the relationship between organizational topology and

phenomenal individuation is not a conceptual identity but a lawlike pattern: given that the unmeasurable sector provides the universal condition of presence, certain physical organizations determine *where and how* that presence manifests as individuated, perspectival, contentful consciousness.

Thus the relevant correlation is not between structure and the *existence* of presence (which is metaphysically fundamental), but between structure and the *individuation and form* of presence. That avoids the category error: we do not claim that structure *is* presence; we claim that structure *organizes* the manifestation of presence.

To be explicit: the category error would arise if we claimed that fully describing organizational structure in the measurable sector *logically entails* the existence of phenomenal presence. We do not claim this. We claim instead that organizational structure determines the *form and location* of presence whose *existence* is grounded independently in the unmeasurable sector. The nomological postulate links organizational topology to patterns of individuation, not to the ontological ground of presence itself.

4.1.2 Objection 2: The Hard Problem

Objection. The hard problem asks why physical processes should give rise to experience at all [6], rather than remaining purely functional or behavioral. Your organizational story seems to presuppose that experience already exists: it explains *where* experience appears, not *why* it appears.

Response. This is correct—and it is a feature, not a bug. The framework does not attempt to solve the hard problem by reducing presence to structure. Instead, it *relocates* the hard problem: the existence of phenomenal presence is taken as a metaphysical primitive grounded in the unmeasurable sector. The organizational constraints of Section 3 then address a *distinct* question: given that presence exists, *under what conditions* does it become locally individuated as a bounded, perspectival, contentful experience?

In other words:

- The hard problem concerns the *existence* of presence.

- Our theory concerns the *conditions* for the *individuation* and *structure* of presence.

The former is metaphysical; the latter is empirical. The framework is honest about this division of explanatory labor, rather than pretending that structural analysis alone can explain why there is anything it is like.

4.1.3 Objection 3: The Combination Problem

Objection. How do many parts give rise to a single, unified conscious subject? Panpsychist versions of the combination problem ask how micro-experiences compose macro-experience [11]; more generally, critics ask why an integrated system yields *one* experience rather than many.

Response. The dual-sector ontology dissolves the panpsychist version of the combination problem: we do not posit micro-experiences in fundamental particles or fields. Presence is not distributed in small units awaiting combination; it is a universal condition provided by the unmeasurable sector. What is composed in the measurable sector is not presence itself but the *organizational structure* through which presence becomes individuated.

The more general question remains: why does integrated organization support a *single* locus of phenomenal individuation rather than multiple distinct perspectives? Here the answer is structural. Constraint 1 (integration) demands that the informational dependencies among components cannot be factorized into independent subsets without loss of functionally relevant information. In such a system there is no non-arbitrary decomposition into informationally autonomous subsystems. Consequently, there is no principled way to assign multiple independent loci of individuation. The system's causal/informational topology constitutes a *single, irreducible locus* at which presence can be individuated.

A useful analogy is holography: a single interference pattern supports one coherent image because the information is globally integrated; one cannot separate it into independent images without destroying the structure. Likewise, an appropriately integrated, recursively self-referential, boundary-maintaining, coherent system constitutes one unified subject rather than a collection of subjects.

Moreover, the constraints are interdependent (Section 3): integration alone does not suffice. It must be coupled with recursive self-reference and boundary maintenance. A system that is informationally integrated but lacks self-modeling would not constitute a unified *perspective*; a system that is integrated but lacks boundaries would not constitute a distinct *individual*. The five constraints jointly ensure that individuation yields singular, perspectival subjects rather than mere unified informational fields.

4.1.4 Objection 4: The Realizer / Substrate Problem

Objection. If only organization matters, then any system realizing the same organizational pattern should instantiate consciousness: classical digital computers, large computational simulations, or even bizarre constructs like a room of people simulating neurons with pen and paper. This seems implausible and invites reductios.

Response. The framework is *in principle* substrate-neutral: the five constraints in Section 3 are defined in organizational terms. However, several important qualifications follow:

1. **Implementation conditions.** The constraints may depend on implementation-specific properties that go beyond abstract computation: continuity or bandwidth of causal interaction, noise profiles, timescale relations, or biophysical constraints. Whether a given substrate can realize the requisite *causal* and *informational* topology is an empirical question.

2. **Causal realization vs. mere simulation.** A computational simulation of a conscious system—even if functionally isomorphic at the input–output level—need not instantiate

the *real-time, causal-power architecture* required for genuine integration, recursive self-reference, and boundary maintenance. The constraints demand a specific causal topology realized in the world, not merely a correct mapping from inputs to outputs. A simulation is a *description* or emulation of a dynamics; phenomenal instantiation, on this framework, requires the dynamics themselves to be physically instantiated.

3. **Substrate dependence as open question.** The framework predicts that whatever substrate can *in fact* realize the Phenomenal Instantiation Threshold should instantiate consciousness, but it does not claim in advance that every abstractly possible implementation is physically realizable, or that all realizable implementations are equally stable or robust.

Thus the view is neither trivially pan-computational nor biologically chauvinist. It provides organizational criteria and leaves the substrate question open to future theoretical and empirical work.

4.1.5 Objection 5: Epiphenomenalism

Objection. If the unmeasurable sector lies "outside spacetime" and plays no role in the causal dynamics described by physics, then isn't phenomenal presence causally inert—merely an epiphenomenal shadow of physical processes?

Response. This objection presupposes that presence is a separate item that could, in principle, enter into causal relations. On our view, this is a category mistake. The framework is best described as a *dual-sector view with a manifestational link*. There is one causal order described by physics in the measurable sector, and it is causally closed in the usual sense. The unmeasurable sector provides the fundamental condition of phenomenal presence and determines *how* certain physical processes are manifest—namely, as experientially present from a first-person perspective when they satisfy the relevant organizational constraints.

When a painful stimulus leads to withdrawal, we can describe the event purely in structural terms: nociceptive pathways, integrative hubs, motor commands. We can also describe it as an experienced pain that motivates avoidance. There are not two parallel events (one neural, one experiential) vying for causal relevance. Rather, there is one event with two complementary aspects:

- a *structural aspect* in the measurable sector, fully captured by physical description, and
- an *experiential aspect* in the unmeasurable sector, instantiated as phenomenal presence when the organizational constraints are met.

The experiential aspect is not an extra causal ingredient added on top of the physical dynamics; it is the *mode in which* those dynamics exist for the subject when the Phenomenal Instantiation Threshold is met. Epiphenomenalism would arise only if we posited experiences as additional, causally idle entities over and above physical processes. The dual-sector–manifestational picture denies this: there is a single causal story, and presence is how part of that story is *manifest*.

4.1.6 Objection 6: Over-Generation

Objection. Many systems exhibit some degree of integration, complexity, or boundary maintenance (galaxies, cells, corporations). Why do we not attribute consciousness to all of them?

Response. The framework addresses this in two ways. First, the Phenomenal Instantiation Threshold is explicitly *composite*: it requires *all* five constraints—integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence—to be jointly satisfied to a sufficient degree. Galaxies may be dynamically coherent but lack recursive self-modeling; individual cells maintain boundaries but lack global integration and higher-order self-reference; corporations have information flow but not unified causal integration in the relevant sense.

Second, the constraints are not independent checkboxes. As argued in Section 3, they form a mutually supporting architecture: high integration without differentiation yields trivial dynamics; self-modeling without boundaries yields unanchored representation; boundary maintenance without adaptive coherence fails to support a temporally persistent subject. The interdependence and required robustness sharply restrict which systems qualify.

4.1.7 Objection 7: Why These Five Constraints?

Objection. The condition set in Section 3 might seem ad hoc: why exactly these five organizational features, rather than fewer (e.g., IIT's integration and differentiation) or more?

Response. The five constraints are not arbitrarily chosen correlates; they are derived from two sources:

1. **Phenomenology.** Conscious experience exhibits at least five structural features:
   - *Unity*: experiences appear as single fields, not disjoint fragments ⇒ integration.
   - *Contentfulness*: experiences are rich and discriminable ⇒ differentiation.
   - *Perspectival character*: experiences are always "for someone" ⇒ recursive self-reference.
   - *Boundedness*: experiences belong to particular subjects, not to arbitrary aggregates ⇒ boundary maintenance.
   - *Temporal continuity*: subjects persist across time ⇒ adaptive coherence.
2. **Metaphysics (two-sector ontology).** The unmeasurable sector provides undifferentiated presence without intrinsic structure. For presence to manifest as recognizable consciousness, the measurable sector must supply the missing *form*: structured content, bounded loci, perspectival orientation, and persistence. The five constraints jointly provide exactly these formal features. They are the minimal organizational conditions under which undifferentiated presence can appear as individuated, perspectival, contentful, temporally extended experience.

This can be summarized schematically:

Phenomenal feature	Corresponding constraint
Unity of experience	Integration
Rich, discriminable content	Differentiation
First-person perspective	Recursive self-reference
Subject-bound ownership	Boundary maintenance
Persistence through time	Adaptive coherence

Thus, these five constraints are not a mere list of correlates but a *minimal set of formal conditions* required to solve the problem of phenomenal individuation: they specify how the measurable sector must be organized to "carve out" a bounded, perspectival, contentful individual from the universal background of presence. Alternative sets of constraints (e.g., integration + differentiation alone) are predicted to yield at most *proto-phenomenal* organization: structured informational fields lacking full perspectival and bounded subjecthood. This prediction is empirically testable via the dissociations discussed in Section 3.

4.1.8 Objection 8: Philosophical Zombies

Objection. If the link between organization and phenomenal presence is nomological rather than logical, then one can conceive of *zombies*: systems that satisfy all five constraints yet lack experience. Does this not show that organization cannot truly explain consciousness?

Response. On our view, zombie scenarios are *conceptually coherent* but *nomologically impossible* given the actual laws of our universe. This mirrors other cases of nomological necessity: it is conceptually coherent to imagine a fluid that behaves like water but is not H_2O, yet in our world "water is H_2O" is a lawlike identity. The conceivability of "XYZ-water" does not undermine the actuality of the law.

Similarly, the organization–presence connection is posited as a law of nature: given the actual two-sector ontology, any system that satisfies the Phenomenal Instantiation Threshold instantiates phenomenal presence. A "zombie" that satisfies the threshold yet lacks presence would violate this law; it is ruled out by the nomological structure of our universe (though it remains epistemically possible that we could be wrong about what the actual laws are).

The zombie argument thus supports our framework on two fronts:

- It shows that consciousness cannot be *logically derived* from structure alone, undermining reductive physicalism.

- It motivates a dual-sector, lawlike connection between organization and presence, exactly what our nomological postulate articulates.

4.1.9 Objection 9: The Knowledge Argument (Mary's Room)

Objection. Mary knows all physical and functional facts about color vision but learns something new when she first experiences red [14]. Does this not show that no amount of structural information suffices for phenomenal knowledge?

Response. The Mary case illustrates the very distinction the two-sector ontology encodes. Before leaving the room, Mary has complete *structural* knowledge: she knows all the organizational facts about color processing in the measurable sector. What she lacks is *experiential instantiation*: the manifestation of those structures as phenomenal presence in her own perspective.

When she first sees red, Mary acquires no new structural facts; rather, she gains a new *mode of access* to those facts—they become instantiated in her first-person field. This is precisely the difference between:

- Knowing the organizational conditions for phenomenal individuation (Section 3), and
- Actually undergoing an instance of individuated presence.

The knowledge argument thus supports the claim that structural and phenomenal aspects are categorically distinct yet systematically connected. It undermines reductive physicalism; it does not undermine a dual-sector, manifestational framework.

4.1.10 Objection 10: The Explanatory Gap

Objection. Even granting a nomological link, you have not explained *why* these organizational properties enable phenomenal individuation. You have simply asserted the connection as a fundamental law. Does the explanatory gap not remain?

Response. At some point, any explanatory framework must bottom out in primitive principles. In physics, we cannot explain why mass curves spacetime or why quantum probabilities have the Born rule; we can only describe these regularities with increasing precision and explore their consequences. Analogously, the present framework bottoms out in two primitive claims:

1. The unmeasurable sector provides the *universal condition of phenomenal presence.*
2. The Phenomenal Instantiation Threshold (Section 3) specifies the organizational conditions under which this presence manifests as individuated, perspectival, contentful experience.

The first is a metaphysical postulate; the second is a nomological postulate. Together they leave a residual "why"-question—why our universe has these laws rather than others—that the framework does not pretend to answer. The value of the theory lies in:

- Making explicit what is taken as primitive (presence, lawlike link),
- Precisely specifying the organizational side of the law,

- Generating empirical predictions and testable dissociations.

In that sense, the explanatory gap is not *closed*, but it is clearly *localized*: we know which part of the story is lawlike postulate and which part is derivable structure.

4.1.11 Objection 11: The Meta-Problem of Consciousness

Objection. Even if your framework is correct, it must also explain the *meta-problem*: why we are so compelled by the Hard Problem and the idea of an explanatory gap. If consciousness is just a lawfully organized manifestation of presence, why does it seem so deeply mysterious and resistant to physicalistic explanation?

Response. The meta-problem arises naturally from the two-sector structure of the framework. Our third-person scientific descriptions operate entirely within the measurable sector: they traffic in structural, relational, and functional properties. Phenomenal presence, by contrast, is grounded in the unmeasurable sector and accessed only via first-person instantiation.

We should therefore expect a persistent sense that something is "left out" by structural description: the mode of presence itself is never among the terms of the description. This systematic omission generates the intuition that there is a further fact beyond all physical and functional facts. The framework explains this intuition not as an illusion but as a direct consequence of the two-sector nature of reality: any purely structural theory, no matter how complete in its own domain, will omit the unmeasurable condition of presence and thus appear phenomenologically incomplete from within.

Furthermore, the framework predicts that consciousness researchers working entirely within the measurable sector (using only structural/functional descriptions) will inevitably *feel* that something is missing from their theories, even as those theories become empirically complete. This phenomenological sense of explanatory inadequacy is not a bug in human cognition but a natural consequence of operating within one sector while the condition of presence resides in another. The persistent intuition that "there is more to consciousness than physics can capture" is thus *veridical* on our framework, not illusory.

4.2 Position Among Existing Theories

We now situate the framework relative to major theories of consciousness. The goal is not to dismiss existing accounts but to show how their core insights are retained, reinterpreted, or extended within the dual-sector, manifestational picture.

4.2.1 Integrated Information Theory (IIT)

Agreement. IIT correctly emphasizes that consciousness is associated with systems that are both highly integrated and highly differentiated [24]. Our Constraints 1 and 2 explicitly incorporate these ideas.

Divergence. IIT tends to treat Φ (or related measures) as both a measure of complexity and a measure of consciousness itself. On our view, such measures quantify *organizational properties* in the measurable sector. They are not identical to consciousness; they are candidate indicators of whether the Phenomenal Instantiation Threshold is approached or met.

Moreover, IIT faces over-ascription and exclusion issues (e.g., attributing consciousness to simple logic gates, and difficulties around overlapping systems). Our composite threshold, which additionally requires recursive self-reference, boundary maintenance, and adaptive coherence, predicts that many IIT-style "conscious" systems lack full phenomenal individuation and thus are not conscious in the sense at stake here.

4.2.2 Global Workspace Theory (GWT)

Agreement. GWT captures an important feature of conscious processing: globally broadcast information that is widely available for report, reasoning, and action [3, 8]. This is naturally interpreted as contributing to integration and differentiation.

Divergence. GWT primarily explains *access consciousness*: information being globally available to cognitive systems. Our framework argues that access, though important, is insufficient for *phenomenal* consciousness. A system could have a global workspace yet lack recursive self-reference or robust boundary maintenance; such a system, on our view, would exhibit rich access without fully instantiated phenomenal presence—for example, a massively parallel architecture that broadcasts information without maintaining a hierarchical self-model, or a distributed network with extensive information sharing but weak individuation boundaries between putative "subjects".

This yields a concrete prediction: there can be dissociations between global broadcasting and phenomenal individuation. The framework thus refines rather than replaces GWT: global workspace is one possible mechanism contributing to some constraints but is not a complete theory of consciousness.

4.2.3 Predictive Processing and Active Inference

Agreement. Predictive processing and active inference theories emphasize generative models, prediction error minimization, and Markov blankets [7, 10]. These directly relate to recursive self-reference (Constraint 3) and boundary maintenance (Constraint 4).

Divergence. Predictive processing is primarily a theory of inference and control; it does not by itself explain why optimal prediction or free-energy minimization should be accompanied by experience. Our framework says: when such predictive architectures also satisfy the remaining constraints (integration, differentiation, adaptive coherence), they provide the organizational substrate through which the unmeasurable sector's condition of presence can be individuated as a conscious perspective.

In short, active inference describes *how* certain systems regulate and maintain themselves; the dual-sector ontology explains *when and where* those systems are also phenomenally instantiated.

4.2.4 Higher-Order and Meta-Cognitive Theories

Agreement. Higher-order and meta-cognitive theories rightly highlight the role of self-representation and meta-representation in conscious awareness [20]. This corresponds to recursive self-reference and meta-cognitive components of Constraint 3.

Divergence. Such theories often implicitly treat higher-order representation as nearly sufficient for consciousness, focusing on representational relations among states. Our framework insists that higher-order structure must be embedded in a broader organizational context: without strong integration, sharp boundaries, and temporal coherence, higher-order representation alone does not secure phenomenal individuation.

Thus, higher-order features are necessary but not sufficient conditions. The dual-sector ontology also adds a metaphysical layer: self-representations help determine the *form* of individuated presence, but do not explain the *existence* of presence.

4.2.5 Panpsychism and Emergentism

Panpsychism. Panpsychist views posit ubiquitous fundamental phenomenal properties, which then somehow combine to yield macro-experience [11]. They gain an explanation of why consciousness exists (it is fundamental) but struggle with:

- The combination problem (how micro-experiences compose a unified subject),
- Over-ascription (electrons, rocks, and mugs become proto-subjects),
- Lack of principled individuation criteria.

Emergentism. Emergentist views posit that consciousness emerges from complex organization without specifying any fundamental phenomenal ground. They gain a story about why complexity matters but face:

- An explanatory gap (why complexity should yield experience at all),
- Ambiguity in what counts as sufficiently complex.

Dual-sector synthesis. Our framework retains the core insight of each while avoiding their weaknesses:

- Like panpsychism, it treats presence as *fundamental*, but as a universal condition in the unmeasurable sector rather than as micro-entities attached to matter.
- Like emergentism, it treats consciousness as dependent on *organization*, but only at the level of *individuation and form*, not at the level of *existence*.

There are no micro-experiences to combine; what combines are structural relations in the measurable sector. Presence is not emergent; only its individuated expression is. This blocks both panpsychist over-ascription and emergentist fundamentalism about structure.

4.2.6 Russellian Monism

Russellian monism distinguishes between the structural/relational properties captured by physics and the intrinsic properties that purportedly underlie them, sometimes identified with proto-phenomenal or phenomenal qualities [2].

Agreement. This structural/intrinsic distinction resonates with our measurable/unmeasurable sector distinction: physics describes relational organization; experience reveals something about the intrinsic mode of existence.

Divergence. Many Russellian monist models posit proto-phenomenal properties instantiated by physical entities (particles, fields) and then face combination problems similar to panpsychism. Our framework instead posits a universal condition of presence (unmeasurable sector) and treats individuation as a function of organizational constraints. There are no proto-phenomenal quanta localized at the micro-level; the locus of individuation is at the level of organized systems. This difference is crucial: Russellian monism must explain how micro-level proto-phenomenal properties compose into macro-level experience, whereas we avoid this entirely because presence is not distributed at the micro-level awaiting combination—it is a universal ground that becomes individuated only at the organizational level.

4.2.7 Quantum Consciousness Theories

Theories such as Orch-OR (Penrose–Hameroff) tie consciousness to specific quantum processes or objective collapse events [12].

Neutral stance. Our framework is agnostic about whether quantum processes are necessary or helpful for realizing the five constraints. If quantum coherence turns out to be required for achieving certain forms of integration or recursion, this will inform the empirical side of the theory but does not modify the basic metaphysical and organizational commitments.

What the framework contributes is a clear criterion: any quantum proposal must show how its favored processes contribute to integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence. Absent that, quantum structure alone is not a theory of consciousness but at best a hypothesis about implementation.

4.3 Summary and Outlook

The dual-sector framework offers a principled middle path between reductive physicalism, panpsychism, and emergentism. It treats phenomenal presence as metaphysically fundamental (unmeasurable sector) while insisting that individuated conscious subjects arise only when the measurable sector realizes specific organizational constraints. The objections addressed in this section show that:

- The view avoids category errors by positing a nomological, not conceptual, link between organization and individuation.
- The hard problem is neither denied nor trivially solved, but localized in the postulate of presence as a primitive.

- The combination, epiphenomenalism, zombie, knowledge-argument, and meta-problem worries are accommodated rather than suppressed.

- Major existing theories contribute partial insights that are reinterpreted within a more explicit metaphysical framework.

The next section turns from philosophical positioning to future work in formalization and empirical research: specifying quantitative realizations of the constraints, refining candidate measures, and designing experiments that can support or falsify the nomological postulate linking organizational structure and phenomenal individuation.

5 Toward an Action-First Formalization

The preceding sections have been deliberately framework-first rather than mathematics-first. Section 2 articulated a dual-sector ontology in which phenomenal presence is grounded in an unmeasurable sector, while the measurable sector furnishes the structural and dynamical conditions for phenomenal *individuation*. Section 3 then proposed five organizational constraints—integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence—as the minimal conditions under which the measurable sector can support bounded, perspectival, contentful experience. Section 4 addressed metaphysical, conceptual, and empirical objections and positioned the framework among existing theories of consciousness.

In this section we outline a more speculative component of the program: *an action-first route to formalization*. The aim is not to present a completed formal theory, but to sketch a coherent research direction that respects the metaphysical commitments of the framework while connecting more directly to the language of fundamental physics. We therefore stress at the outset:

> This section is programmatic. It proposes a way of *developing* the organizational constraints in an action-first idiom; it does not claim to deliver a finished "phenomenal action functional" with ready-to-use empirical formulas.

5.1 Why Prioritize Action over Information?

The organizational constraints in Section 3 were introduced using familiar information-theoretic and dynamical language: mutual information, entropy, perturbational complexity, predictive models, Markov blankets, and so on. Conceptually, however, the framework is compatible with different mathematical parametrizations of "organization". Why, then, explore an *action-first* route rather than remaining in a purely information-theoretic idiom?

We see three motivations—ontological, structural, and pragmatic.

Ontological motivation (within the measurable sector). In fundamental physics, *action functionals*—Lagrangians and their path-integral generalizations—play a distinctive role. They determine which trajectories in configuration space are physically admissible by selecting those

that render the action stationary. In this sense, action specifies the space of *possible histories* before any coarse-graining into discrete states or probabilities.

Information-theoretic quantities, by contrast, typically arise as *summaries* of statistical structure over such histories: entropies, mutual informations, and predictive coding errors presuppose a space of events and probability distributions over them. Within the measurable sector, it is therefore natural—though not mandatory—to treat action as ontically prior and information as a derived, coarse-grained ledger of how action is distributed.

Structural motivation (connection to individuation). The measurable sector supplies the temporal and structural scaffolding through which timeless, undifferentiated presence (unmeasurable sector) becomes an individuated stream of experience. Action is, very literally, a measure of *change and becoming*: it accumulates along worldlines, weights alternative histories, and encodes which transitions are dynamically favoured or suppressed.

If phenomenal individuation requires not merely static structure but a *history*—a temporally extended, self-maintaining organization—then action provides a natural candidate quantity for formalizing how presence is "shaped" into a bounded, temporally coherent perspective. Put architecturally:

> If the unmeasurable sector provides the universal *medium* of presence, and the five constraints specify the *architectural blueprint* of an individual, then action supplies the temporal *scaffolding*: the dynamical process through which that blueprint is instantiated in the medium across time.

On this picture, action does not replace structure or information; it underwrites the *becoming* of structured histories in the measurable sector.

Pragmatic motivation (empirical and computational). Information-theoretic measures such as integrated information Φ are notoriously difficult to compute for large systems: they scale poorly with system size and depend sensitively on how one partitions the system. Action and related quantities (e.g., variational free energy, dissipated work, perturbational cost) can sometimes be estimated more directly from dynamics, perturbation responses, or thermodynamic bounds, without requiring full joint probability distributions.

An action-first formalization may therefore offer alternative, potentially more tractable proxies for the same organizational features: how tightly coupled a system's parts are (integration), how many distinct histories it can support (differentiation), how its present dynamics depend on its own past (recursive self-reference), how it maintains boundaries over time, and how it coordinates across timescales (adaptive coherence).

Complementarity rather than exclusivity. This is not to deny the value of information-first approaches. Information measures remain extremely useful for identifying correlates of consciousness and for characterizing functional architectures. The action-first program aims at a deeper explanatory tier: it seeks to clarify *why* the informational patterns that correlate with

consciousness arise from the underlying physics of the system and *why* those particular patterns have the phenomenal significance they do. In practice, a mature theory is likely to employ both vocabularies, with action-based quantities grounding and constraining information-theoretic ones.

Relation to information-first programs. This stance contrasts with information-first programs (such as Wheeler's "it from bit" or certain interpretations of quantum information theory) that take information as metaphysically fundamental. Our framework does not aim to settle the debate between action-first and information-first metaphysics in physics. For present purposes, we adopt a *working assumption* that action is the more appropriate primitive for capturing becoming in the measurable sector, while information-theoretic quantities are treated as derived summaries. The core commitments of the framework, however, concern the *structural constraints* required for phenomenal individuation; those could, in principle, be developed in either idiom.

5.2 Action, Temporal Structure, and Phenomenal Presence

In the dual-sector ontology of Section 2, the unmeasurable sector provides the universal condition of phenomenal presence. It is atemporal, non-spatial, and does not evolve. The measurable sector, by contrast, is the arena of change: fields, particles, and complex systems tracing out histories in spacetime.

From this perspective, phenomenal individuation requires at least three things from the measurable sector:

1. A **history space**: a repertoire of possible trajectories (ways the system could evolve).
2. A **selection principle**: some rule that makes certain trajectories dynamically preferred (actual) relative to others.
3. A **self-maintaining organization**: a pattern of constraints that preserves a bounded, coherent structure across time.

Action is precisely the quantity that encodes (i) and (ii): it assigns a weight or "cost" to trajectories and, via variational principles, selects the extremal ones as dynamically realized. The organizational constraints of Section 3 then specify (iii): how the allowed trajectories must be structured for a system to support a single, perspectival, contentful stream of experience.

On this view, the connection between action and presence is not that presence is "made of" action (that would violate the sector distinction), but that:

> *Action characterizes the space of becoming in the measurable sector. Phenomenal individuation occurs when that space is structured in such a way that undifferentiated presence can manifest as a temporally extended, bounded perspective following a constrained family of trajectories.*

Action, in other words, provides the *temporal scaffolding* of individuation; the five constraints specify how this scaffolding must be organized for a conscious subject to exist.

5.3 Recasting the Five Constraints in Action Language (Informal Sketch)

We now sketch—at a deliberately informal level—how the five organizational constraints might be recast in an action-first idiom. Let X denote a candidate conscious system, with configuration variables $q_X(t)$ and an associated action functional $S_X[q_X]$ describing its dynamics (possibly after coarse-graining over microscopic degrees of freedom).

The goal is not to introduce new mathematics, but to indicate how one might construct *action-based analogues* of the information-theoretic quantities used in Section 3. We emphasize that the quantities described here are programmatic placeholders, not rigorously defined functionals.

Integration as irreducible action coupling. Informational integration measures how much a system's components behave as a unified whole. In action language, one natural idea is to examine whether the system's action can be decomposed into approximately independent parts.

Very schematically, suppose X is partitioned into subsystems A and B with actions S_A and S_B. An action-first analogue of integration would ask: to what extent can S_X be approximated as $S_X \approx S_A + S_B$? Where such a decomposition fails—i.e., where there exist interaction terms that cannot be neglected without substantially altering which trajectories extremize S_X—we say the system exhibits high *action integration*. The technical challenge is to turn this intuition into a precise measure.

A key difficulty, familiar from Integrated Information Theory, is that any quantification of integration must choose a *partition*. The action-first perspective suggests a possible way of mitigating this circularity: rather than imposing partitions by hand, we can ask how the emergent action landscape itself clusters degrees of freedom into relatively weakly-coupled subsets. On this view, "natural" subsystem boundaries are those along which action coupling is dynamically minimal in the characteristic regimes of the system. Which clusters count as natural subsystems may itself be *timescale-dependent*: partitions that minimize action coupling over fast dynamics need not coincide with those that do so over slower adaptive processes, dovetailing with the role of adaptive coherence in coordinating across timescales.

Differentiation as richness of admissible trajectories. Informational differentiation concerns how many distinct states or patterns the system can realize. In action terms, we can instead look at the *repertoire of dynamically admissible trajectories* that have comparatively low action.

Intuitively, a system is more differentiated if there is a large set of distinct, dynamically plausible histories (e.g., multiple metastable attractors, diverse response patterns) that all satisfy the system's constraints. An action-based measure of differentiation would quantify the "volume" of trajectory space occupied by such low-action histories, relative to the total space of possible trajectories.

Recursive self-reference as history-dependent action. Recursive self-reference requires that a system's present dynamics depend not only on external inputs but on a model of its own state. In action language, this suggests looking at action functionals where the integrand depends on functionals of the system's *own recent history*.

For example, one might consider an effective action of the form

$$S_X[q_X] = \int L\Big(q_X(t), \dot{q}_X(t), H[q_X]_{[t-\tau,t]}\Big)\, dt,$$

where $H[q_X]_{[t-\tau,t]}$ encodes a coarse-grained summary of the recent trajectory (e.g., moving averages or prediction errors). Trajectories whose extremization crucially depends on such history functionals would exhibit an action-based signature of recursive self-reference [23].

Boundary maintenance as asymmetric admissibility of crossings. Boundary maintenance requires a robust separation between "inside" and "outside" over relevant timescales. In action terms, this suggests that trajectories in which the system's macroscopic boundary dissolves should incur a much higher action cost than those that preserve it.

More concretely, one can imagine defining a family of coarse-grained boundary variables $B_X(t)$ (encoding, say, membrane integrity or Markov-blanket structure) and comparing the action of trajectories that maintain B_X within a stable range to those in which B_X is disrupted. Boundary maintenance would then correspond to regimes where boundary-breaking trajectories are dynamically suppressed (high action) relative to boundary-preserving ones.

Adaptive coherence as multi-timescale action coordination. Adaptive coherence concerns how a system coordinates information across multiple timescales to maintain stable, goal-directed behavior while allowing flexible change. In action language, this suggests a hierarchy of coupled action functionals operating at different temporal resolutions: fast sensorimotor loops, intermediate control policies, and slow structural adaptations.

An action-based signature of adaptive coherence would be the existence of hierarchically nested extremal principles: local variations that preserve global action-optimality, and slow adjustments that reshape the effective action landscape in a way that sustains individuation over long timescales.

These sketches are intentionally high level. Turning them into precise quantities would require, among other things, specifying how to partition systems into subsystems, how to define effective actions at different scales, and how to relate action-based measures back to familiar information-theoretic proxies.

5.4 A Schematic "Phenomenal Action Functional"

Given the five constraints and their informal action-based sketches, it is tempting to write a unified "phenomenal action functional" of the form

$$\mathcal{A}_{\text{phen}}[X] \;=\; F\Big(\mathcal{I}[S_X],\, \mathcal{D}[S_X],\, \mathcal{R}[S_X],\, \mathcal{B}[S_X],\, \mathcal{C}[S_X]\Big),$$

where $\mathcal{I}, \mathcal{D}, \mathcal{R}, \mathcal{B}, \mathcal{C}$ are action-based analogues of integration, differentiation, recursion, boundary maintenance, and coherence, respectively, and F is some aggregating functional.

We stress that this expression is *schematic*: it is a template for how a future, fully developed formalism might package the five constraints into a single quantity, not a definition we can yet compute. A natural class of candidates for F would enforce a *composite threshold* structure: for example, one might require

$$\mathcal{A}_{\text{phen}}[X] > \theta \quad \text{only if} \quad \mathcal{I}[S_X] > \theta_{\mathcal{I}},\ \mathcal{D}[S_X] > \theta_{\mathcal{D}},\ \mathcal{R}[S_X] > \theta_{\mathcal{R}},\ \mathcal{B}[S_X] > \theta_{\mathcal{B}},\ \mathcal{C}[S_X] > \theta_{\mathcal{C}},$$

with the individual thresholds $\theta_{\mathcal{I}}, \ldots, \theta_{\mathcal{C}}$ allowed to be interdependent to reflect the constraints' mutual support (e.g., high integration without sufficient recursion might fail the composite test even if $\mathcal{I}$ alone is large).

A realistic formalization program would need to:

- Provide explicit definitions of each functional $\mathcal{I}[S_X], \ldots, \mathcal{C}[S_X]$ for relevant model classes (e.g., stochastic differential equations, neural field models).
- Establish correspondence theorems relating these to existing information-theoretic measures (e.g., mutual information, entropy rates, perturbational complexity).
- Explore concrete forms of F that respect the interdependence of constraints and implement a principled composite threshold.
- Test whether such a functional tracks the empirical markers of consciousness at least as well as purely information-based measures.

Until such work is done, $\mathcal{A}_{\text{phen}}$ should be read as a research target, not as something we claim to have already constructed.

5.5 Routes for Development: Two Illustrative Programs

There are many possible routes toward a concrete action-first formalization. We briefly sketch two illustrative programs, without attempting to develop them in detail.

Route A: Reconstruction from constrained variance. One route begins from the observation that many physical reconstructions (starting from variance, symmetry, and invariance principles) lead naturally to action principles. The idea would be to start with very weak assumptions about how variance in dynamical quantities is constrained across scales, and to derive:

1. an effective action formalism for the class of systems under consideration;
2. structural conditions under which this action supports the five organizational constraints.

This route is ambitious and technically demanding; it would likely require tools from field theory, stochastic processes, and renormalization. For the purposes of this paper, we simply note it as a long-term possibility: a way to derive, rather than postulate, the relevant action structures.

Route B: Action-driven self-organization in concrete models. A more immediate route is to study concrete dynamical models where action and self-organization are tractable. For example, consider spatially extended systems (reaction-diffusion, neural fields, active matter) with activity-dependent couplings that accumulate a form of "action memory". Very schematically, one might write:

$$\frac{\partial u}{\partial t} = D\nabla^2 u + f(u, v) + g\Big(u, A\Big),$$
$$\frac{\partial A}{\partial t} = \alpha\, h(u) - \beta A + \eta\nabla^2 A,$$

where u is local activity, v recovery variables, and A an "action-channel" integrating recent activity $h(u)$ with decay rate β and diffusion η. The term $g(u, A)$ introduces feedback: future dynamics depend on accumulated "action".

Systems of this sort can exhibit:

- **Boundary formation**: stable interfaces where A gradients are steep, suggestive of emergent Markov blankets.
- **Self-reference**: local dynamics depending on their own history via A.
- **Integration**: long-range coupling mediated by the diffusive A-field.
- **Differentiation**: rich pattern repertoires in multistable regimes.

In such models one can attempt to compute candidate action-based measures, study how they covary with information-theoretic proxies, and explore how parameter changes move the system toward or away from the putative phenomenal instantiation threshold. For instance, one can test whether perturbations that selectively disrupt the A-channel (while leaving u-dynamics mostly intact) degrade integration and boundary maintenance more severely than perturbations of comparable magnitude applied directly to u, as the action-first perspective would predict. While far simpler than brains, these models provide concrete testbeds for the action-first program.

5.6 Relation to Existing Action-Based Frameworks

The action-first perspective touches several existing lines of work:

- **Active inference and the Free Energy Principle.** Active inference formulations treat biological systems as minimizing variational free energy, a quantity closely related to an action functional over trajectories. Our framework is compatible with this picture but adds the dual-sector ontology and the composite threshold for phenomenal individuation.

- **Stochastic thermodynamics and Landauer bounds.** Links between information, entropy production, and dissipated work suggest routes for estimating action-related costs of maintaining boundaries and internal models [4]. An action-first formalization could connect phenomenally relevant organization to thermodynamic efficiency and metabolic constraints on real systems.

- **Integrated action proposals.** Some variants of Integrated Information Theory have explored replacing integrated information with integrated action. Our framework differs in two ways: it treats action as primitive within the measurable sector rather than derived, and it insists on the full composite threshold (all five constraints) rather than integration alone.

These existing frameworks provide technical machinery that a mature action-first theory of phenomenal individuation would almost certainly borrow and extend.

5.7 Empirical Prospects, Challenges, and Limitations

If successful, an action-first formalization could offer several empirical benefits:

- **Alternative proxies.** Action-related quantities (e.g., perturbational cost, dissipated work, resistance to intervention) may provide more tractable proxies for the organizational constraints than exponentially costly measures like Φ.

- **Physical grounding.** By tying organizational constraints to action and thermodynamic costs, the framework could unify phenomenally relevant organization with energetic and metabolic constraints on real systems.

- **Multi-scale compatibility.** Action principles naturally accommodate multi-scale dynamics, which is essential for modeling adaptive coherence across time.

At the same time, substantial challenges remain:

- **Technical development.** Defining and computing action-based analogues of integration, differentiation, and so on for realistic models is non-trivial.

- **Correspondence.** It must be shown that action-based measures either align with or improve upon information-based proxies in tracking consciousness across conditions (sleep, anesthesia, disorders of consciousness, etc.).

- **Partition choice.** Any measure of integration or boundary structure depends on how the system is partitioned into subsystems. The action-first viewpoint suggests that "good" partitions should be discovered rather than imposed, by identifying clusters of variables between which action coupling is relatively weak in the system's characteristic regimes. These clusters may themselves be *timescale-sensitive*: partitions that are natural for fast sensorimotor dynamics may differ from those that minimize coupling at slower adaptive or structural timescales, mirroring the role of adaptive coherence in coordinating across temporal layers.

- **Model dependence.** Action functionals are model-dependent; different coarse-grainings may lead to different measures. Understanding which levels of description are phenomenally relevant is itself a research question.

- **Metaphysical neutrality.** While we motivate an action-first stance, we remain open to the possibility that information-first or alternative formalisms may capture the same structural constraints equally well. The metaphysical core of the framework lies in the dual-sector ontology and the composite threshold, not in the choice of mathematical representation.

5.8 Summary and open problems

The aim of this section has not been to provide a finished quantitative theory, but to sketch how the organizational constraints developed in Section 3 might be recast within an action-first formalism that is faithful to the dual-sector ontology of Section 2. The guiding methodological idea is simple: within the measurable sector, what is fundamental for dynamics is not information but *action over histories*. Information-theoretic quantities then function as ledgers that summarize, in coarse-grained form, how action is distributed, constrained, and coupled across degrees of freedom. On this view, an action-first formulation is not a competitor to information-based approaches, but a deeper layer that seeks to explain why the informational patterns associated with consciousness arise from the underlying physics in the way they do.

We have outlined, in broad strokes, how each of the five constraints might admit an action-based analogue: integration as irreducible coupling in the action, differentiation as richness of low-cost trajectories, recursive self-reference as history-dependent contributions to the action, boundary maintenance as asymmetries in the admissibility of boundary-crossing paths, and adaptive coherence as multi-timescale coordination of action-structured dynamics. A schematic "phenomenal action functional" was introduced to indicate how these ingredients could, in principle, be combined into a composite threshold mirroring the nomological postulate of Section 3. We also sketched two complementary routes for making these ideas concrete: reconstruction from variance-like principles, and explicit models of action-driven self-organization.

Turning these sketches into a mature formalism raises a number of open problems:

- **Definition.** To define explicit action-based counterparts of integration, differentiation, recursion, boundaries, and coherence, and to show under what conditions they recover or refine familiar information-theoretic measures.

- **Partition and scale.** To address the partition problem endogenously: rather than imposing subsystem boundaries by hand, to extract them from the emergent action landscape itself, potentially in a scale-dependent way that reflects the nested timescales relevant for adaptive coherence.

- **Correspondence.** To establish correspondence principles linking action-based quantities to thermodynamic, energetic, and information-theoretic bounds, clarifying when these different formalisms converge or come apart.

- **Empirical tractability.** To identify practically measurable proxies for action-based constraints in neural and artificial systems, and to test whether they improve on or complement existing markers of consciousness.

These challenges make clear that the action-first perspective constitutes a long-term research program rather than an off-the-shelf tool. Its value, at this stage, is to sharpen the question of *how* a dual-sector ontology and a composite organizational threshold might be anchored more directly in the dynamical language of physics. The concluding section now steps back from these technical prospects to re-situate the overall framework, clarify its commitments, and outline the broader empirical and conceptual agenda it suggests.

6 Conclusion

This paper has developed a unified framework for thinking about consciousness that is simultaneously metaphysical, structural, and empirical. The central move has been to separate three questions that are often conflated: *what* consciousness is at the most fundamental level (its ontological ground), *when and where* it is instantiated (its conditions of individuation), and *how* those conditions can be formalized and tested (its scientific operationalization).

6.1 What has been proposed

At the ontological level (Section 2), we introduced a dual-sector picture. The *unmeasurable sector* provides the universal condition of phenomenal presence: a non-spatial, atemporal ground in virtue of which there is anything it is like for experience to exist at all. The *measurable sector* comprises the domain of physics and empirical science: spatiotemporal systems whose dynamics are describable in structural and dynamical terms. The key claim is that consciousness is not reducible to the measurable sector alone, but neither is it an extra substance: it is a manifestation of presence through particular organizations in the measurable sector.

At the structural level (Section 3), we proposed five organizational constraints that a physical system must satisfy in order to support *phenomenal individuation*: integration, differentiation, recursive self-reference, boundary maintenance, and adaptive coherence. Together, these constraints capture the defining features of conscious experience as it is lived: unity-in-variety, rich content, perspectival structure, bounded subjectivity, and temporally extended stability. We argued that these constraints are not a grab-bag of correlates, but a *minimal set of structural requirements* for transforming undifferentiated presence into a bounded, contentful, perspectival stream.

At the nomological level, we articulated a *composite threshold postulate*. Rather than claiming a logical or conceptual entailment from structure to experience, we posit a lawlike pattern in our universe: systems in the measurable sector that satisfy the five constraints above certain joint thresholds *nomologically* instantiate individuated phenomenal presence. The postulate is explicitly dual-aspect: it links organizational topology on the measurable side to patterns of

manifestation on the unmeasurable side, without identifying one with the other or positing a further mediating substance.

Section 4 then situated this framework within the philosophy of mind and consciousness science. We argued that the dual-sector picture and composite threshold jointly:

- avoid the category error of attempting to derive the existence of presence from purely structural facts, while still making substantive, lawlike claims about *where and when* presence is individuated;

- dissolve the panpsychist combination problem by denying that micro-experiences are distributed across physical parts in the first place—what combines are structural relations, not miniature subjects;

- treat epiphenomenalism as a misframing: the experiential and structural aspects are two inseparable modes of one process, not two causally competing entities;

- position the framework as a principled synthesis of insights from Integrated Information Theory, Global Workspace Theory, predictive processing, higher-order theories, panpsychism, and emergentism, while avoiding their characteristic difficulties.

Finally, Section 5 sketched an *action-first research program.* Within the measurable sector, action functionals provide a natural language for characterizing possible histories and their dynamical selection. We suggested that the five organizational constraints can be recast in terms of action-based quantities (irreducible coupling of action, richness of low-cost trajectories, history-dependent actions, asymmetries in the admissibility of boundary-breaking paths, and multi-timescale coordination of action), and outlined how a future "phenomenal action functional" might synthesize these into a unified, composite threshold. This is not a finished formalism, but a concrete agenda for tying the metaphysical picture more tightly to physics and dynamical systems theory.

6.2 What this framework does and does not claim

It is important to be explicit about the ambitions and limits of the proposal.

First, the framework *does not* claim to solve the "hard problem" in the reductive sense. The existence of phenomenal presence is taken as metaphysically primitive: a fundamental fact about reality, captured by the unmeasurable sector. The organizational constraints and the nomological postulate do not derive presence from structure; they specify which structures, in our universe, are such that presence manifests in individuated, bounded form. In this respect, the framework is closer to a law-based view than to a reductive identity theory.

Second, the framework *does* make strong, testable commitments about the structure of conscious systems. It predicts, more specifically, that:

- systems that lack any of the five constraints at sufficient strength cannot support full, perspectival consciousness, and that *selective* disruption of a single constraint—for example,

preserved large-scale integration with impaired recursive self-reference—should yield characteristic degradations in subjective perspective and metacognition even when other capacities remain relatively intact;

- systems that realize some but not all constraints may occupy intermediate "proto-phenomenal" regimes, with partial or degraded forms of experience that should be reflected in dissociations between behavioral responsiveness, global availability, and self-report;

- empirical markers of consciousness (e.g., perturbational complexity, connectivity signatures, metacognitive profiles) should covary in ways that reflect the *joint* satisfaction of the five constraints, rather than tracking a single scalar quantity;

- different theoretical approaches (IIT, GWT, predictive processing, higher-order models) can be understood as emphasizing different constraints within a single larger architecture, and should therefore converge in their empirical predictions when all five constraints are jointly quantified.

Third, the action-first program is explicitly framed as a *research direction*, not as a completed theory. At this stage, it serves two roles: it clarifies how the metaphysical commitments of the framework suggest a specific kind of mathematical formalization (history- and action-based, rather than purely state- and information-based), and it identifies concrete technical challenges whose resolution would significantly advance the science of consciousness (partition selection, multi-scale action measures, correspondence with thermodynamics, and so on).

6.3 Outlook

If the picture developed here is broadly on the right track, it suggests a number of avenues for future work.

Empirical and clinical. On the empirical side, the most direct next step is to refine and test operationalizations of the five constraints with existing tools: connectivity and entropy measures for integration and differentiation, perturbation-based indices for recursion and coherence, and dynamical boundary analyses for Markov-blanket structure. The composite threshold postulate yields concrete dissociation predictions (e.g., high integration with impaired recursion, or preserved recursion with disrupted boundaries) that can be probed in anesthesia, sleep, disorders of consciousness, neurodevelopment, and comparative studies across species and artificial systems.

Formal and physical. On the formal side, the action-first program can be pursued in parallel at two levels: in simplified model systems (neural fields, active matter, reaction–diffusion media) where candidate action-based measures are tractable, and in more realistic biophysical models where thermodynamic and metabolic constraints can be brought into contact with organizational measures. A long-term goal is to show that phenomenally relevant organization is not an *add-on* to physics but a particular way in which action-structured dynamics in our universe are realized.

Conceptual and ethical. Conceptually, the dual-sector ontology invites further work on questions beyond the scope of this paper: how phenomenal individuation relates to personal identity and survival; how the framework bears on questions about artificial consciousness and moral status; and how it interacts with broader debates in metaphysics and philosophy of science about laws, fundamentality, and explanation. If presence is fundamental and individuation is law-governed, then questions about *which* systems cross the threshold are not only scientific but also ethical. On this view, moral consideration should track a system's organizational profile—its position relative to the composite constraint-threshold—rather than merely its biological species, surface behavior, or resemblance to human cognition.

6.4 Closing remark

The guiding slogan that has emerged can be stated succinctly:

Action first; information as ledger; organization as constraint;
presence as ground; individuation as law-governed manifestation.

The hope is that by keeping these layers conceptually distinct yet systematically related, we can make progress on consciousness without promising more than any theory can reasonably deliver. The existence of phenomenal presence remains a primitive fact about reality; but given that fact, we can ask—and begin to answer—a more tractable question: *what must the world be like, structurally and dynamically, for the silent ground of presence to crystallize into the bounded, perspectival world of a conscious life like ours?*

References

[1] Larissa Albantakis, Leonardo Barbosa, Graham Findlay, Matteo Grasso, Andrew M Haun, William Marshall, et al. Integrated information theory (iit) 4.0: Formulating the properties of phenomenal existence in physical terms. *PLoS Computational Biology*, 19(10):e1011465, 2023.

[2] Torin Alter and Yujin Nagasawa. *Consciousness in the Physical World: Perspectives on Russellian Monism*. Oxford University Press, 2015.

[3] Bernard J Baars. *A Cognitive Theory of Consciousness*. Cambridge University Press, 1988.

[4] T Berjaga-Buisan et al. Thermodynamics of consciousness: A non-invasive perturbational framework. *bioRxiv*, 2025.

[5] Adenauer G Casali, Olivia Gosseries, Mario Rosanova, Mélanie Boly, Simone Sarasso, Silvia Casarotto, et al. A theoretically based index of consciousness independent of sensory processing and behavior. *Science Translational Medicine*, 5(198):198ra105, 2013.

[6] David J Chalmers. Facing up to the problem of consciousness. *Journal of Consciousness Studies*, 2(3):200–219, 1995.

[7] Andy Clark. Whatever next? predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, 36(3):181–204, 2013.

[8] Stanislas Dehaene, Jean-Pierre Changeux, Lionel Naccache, Jérôme Sackur, and Claire Sergent. Conscious, preconscious, and subliminal processing: a testable taxonomy. *Trends in Cognitive Sciences*, 10(5):204–211, 2006.

[9] Gerald M Edelman and Giulio Tononi. *A Universe of Consciousness: How Matter Becomes Imagination*. Basic Books, 2000.

[10] Karl Friston. The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*, 11(2):127–138, 2010.

[11] Philip Goff. *Consciousness and Fundamental Reality*. Oxford University Press, 2017.

[12] Stuart Hameroff and Roger Penrose. Consciousness in the universe: A review of the 'orch or' theory. *Physics of Life Reviews*, 11(1):39–78, 2014.

[13] Douglas R Hofstadter. *I Am a Strange Loop*. Basic Books, 2007.

[14] Frank Jackson. Epiphenomenal qualia. *The Philosophical Quarterly*, 32(127):127–136, 1982.

[15] Michael Kirchhoff, Thomas Parr, Ensor Palacios, Karl Friston, and Julian Kiverstein. The markov blankets of life: autonomy, active inference and the free energy principle. *Journal of The Royal Society Interface*, 15(138):20170792, 2018.

[16] Hakwan Lau and David Rosenthal. Empirical support for higher-order theories of conscious awareness. *Trends in Cognitive Sciences*, 15(8):365–373, 2011.

[17] Joseph Levine. Materialism and qualia: The explanatory gap. *Pacific Philosophical Quarterly*, 64(4):354–361, 1983.

[18] Thomas Metzinger. *Being No One: The Self-Model Theory of Subjectivity*. MIT Press, 2003.

[19] Thomas Nagel. What is it like to be a bat? *The Philosophical Review*, 83(4):435–450, 1974.

[20] David M Rosenthal. *Consciousness and Mind*. Clarendon Press, 2005.

[21] Bertrand Russell. *The Analysis of Matter*. Kegan Paul, Trench, Trubner, 1927.

[22] Michael Schartner, Anil Seth, Quentin Noirhomme, Melanie Boly, Marie-Aurélie Bruno, et al. Global and local complexity of intracranial eeg decreases during propofol anesthesia. *Journal of Neuroscience*, 35(50):16790–16803, 2015.

[23] Walter Senn, Nicolas Eanguené, and Marcus Benna. A neuronal least-action principle for real-time learning in cortical circuits. *eLife*, 2023.

[24] Giulio Tononi. An information integration theory of consciousness. *BMC Neuroscience*, 5 (1):42, 2004.

[25] Francisco J Varela, Evan Thompson, and Eleanor Rosch. *The Embodied Mind: Cognitive Science and Human Experience*. MIT Press, 1991.