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Posted Date: 22 October 2025

doi: 10.20944/preprints202510.1638.v1

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Article

The Multi-Perspectival Monism of the Mind: A Neurodynamic Foundation for the Philosophy of Enactive Inference

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Abstract

This manuscript provides a naturalistic foundation for a Philosophy of Enactive Inference and, on this basis, argues for a multi-perspectival monism. Starting from the thesis that the spatiotemporal dynamics of brain activity function as a "common currency" for neuronal and mental processes, the paper develops a multi-layered synthesis of the theories of Northoff, Buonomano, Friston, and Carhart-Harris. This model is crucially extended by integrating recent work on the affective and homeostatic regulation of predictive processing. It is demonstrated how the dynamic balance of two limbic memory systems (E/I balance) realizes the formal "precision weighting" of the predictive brain as lived affect (confidence vs. anxiety). Furthermore, the sleep cycle is identified as the homeostatic mechanism that recalibrates the brain's spatiotemporal architecture daily through the oscillation between sub- and super-critical states. The neurodynamic architecture thus described provides a concrete example of multi-perspectival monism: a single, psycho-physical process accessible from both the third-person perspective (E/I balance, criticality) and the first-person perspective (affect, consciousness), thereby forming the naturalistic basis for a non-reductive, processual ontology of the mind.

Keywords: enactive inference; predictive processing; multi-perspectival monism; spatiotemporal neuroscience; criticality; affect; homeostasis; philosophy of mind

1. Public Significance Statement

This article bridges the gap between brain science and philosophy by proposing a unified model of the mind. It explains how our feelings, thoughts, and sense of self are not mysterious byproducts of the brain but are rooted in its fundamental temporal and dynamic structure. By integrating findings on brain rhythms, predictive processing, and the role of emotions, this work offers a new perspective on mental health, suggesting that conditions like depression can be understood as disruptions of the brain's natural dynamics. This framework provides a deeper, more holistic understanding of consciousness as a biological, feeling, and self-organizing process, offering new avenues for both philosophical inquiry and clinical research.

2. Introduction: The Need for a Naturalistic Foundation

For centuries, the philosophy of mind has sought a way out of the persistent aporias of representationalism—the notion of an inner, passive mind that mirrors an outer, objective world, thereby creating an unbridgeable chasm between subject and object, mind and matter. The project of a Philosophy of Enactive Inference outlines such an escape route through the ambitious synthesis of two of the most influential paradigms in modern cognitive science: enactivism and predictive processing. This paper provides the necessary naturalistic foundation by anchoring this philosophical vision in the concrete mechanisms of neurodynamics. The problem is fundamental: classic enactivism, which conceives of cognition as an embodied, world-making action, often fails to provide detailed, empirically verifiable neurobiological mechanisms for its far-reaching theses (Varela et al.,

1991). The predictive processing framework, in turn, as powerful as its formal apparatus may be, often risks remaining mired in a representationalist and neurocentric language that isolates the mind as a disembodied inference machine inside the skull.

The core thesis of the model presented here builds a bridge between these two poles: The spatiotemporal dynamics of the brain, its intrinsic rhythmic and temporal organization, function as a "common currency" that allows for a radically enactive re-interpretation of the formal architecture of predictive processing (Northoff et al., 2020a). The focus is no longer on the representation of the world, but on the temporal synchronization and structural coupling of the brain, body, and environment.

On this basis, the manuscript integrates the theories of Georg Northoff, Dean Buonomano, Karl Friston, and Robin Carhart-Harris into a coherent model, demonstrating how different levels—from cellular timekeeping to global brain entropy—fit together to form a complete picture. However, such a model inevitably raises two crucial questions that are decisive for a full naturalistic grounding, not only scientifically but also philosophically. First, the question of the "motor": What is the neurobiological mechanism behind "precision weighting," the central control parameter in the free energy principle (FEP)? This parameter, which balances confidence in endogenous predictions against exogenous sensory evidence, is the "volume control" of cognition, yet its purely formal description leaves open how it is realized in the living, feeling organism. Second, the question of "homeostasis": How does the brain maintain and recalibrate its complex spatiotemporal hierarchy? A dynamic architecture so central to consciousness cannot be a static given; it must be actively and cyclically maintained.

The recent publication by Tucker, Luu, and Friston (2025) provides the crucial, missing answers to both questions. Their concepts of dual memory systems, the Excitatory-Inhibitory (E/I) balance as a correlate of affect, and criticality as the optimal operating state of consciousness, homeostatically regulated by the sleep cycle, are the puzzle pieces that complete the picture. They make it possible to transform the philosophy of enactive inference from an elegant architecture into a living, feeling, and self-sustaining process and to place the thesis of multi-perspectival monism on a robust, empirical foundation.

3. Part I: The Brain in Time – Two Complementary Perspectives

3.1. The Ontological Perspective: Georg Northoff's Spatiotemporal Neuroscience

Georg Northoff's "Spatiotemporal Neuroscience" marks a fundamental paradigm shift. It breaks with traditional, task- and stimulus-based research that views the brain primarily as a reactive organ for processing external stimuli. Instead, it radically shifts the focus to the brain's intrinsic, spontaneous activity—that incessant neural dynamic that persists even in the absence of specific tasks—and its inherent spatial and temporal organization (Northoff, 2016; Northoff et al., 2020b). At the core of his thinking is the "Common Currency" hypothesis. It posits that spatiotemporal dynamics form the decisive bridge between the seemingly incommensurable domains of the neuronal and the mental (Northoff et al., 2020a; Northoff et al., 2025). Just as a currency makes the exchange value of apples and cars comparable, the shared language of time and space in the brain allows an electrochemical firing pattern and a subjective feeling to be two sides of the same event. The structure of time becomes the structure of experience.

Crucial to this bridge is the empirically well-supported hierarchy of intrinsic neural timescales (INTs). To understand this concept, one must first clarify what "information" means at the neurophysiological level: it is not an abstract entity, but the concrete, dynamic pattern of neural discharges (spikes) over time. This interplay, however, is inseparable from neurochemistry. An electrical spike is an all-or-nothing signal; its true informational impact unfolds only at the synapse. Here, a crucial transformation takes place: the electrical signal triggers the release of chemical messengers—neurotransmitters like glutamate (excitatory) or GABA (inhibitory). These molecules bind to receptors on the receiving cell, altering its electrical potential. The "information" of a spike is

thus contextualized by the chemical milieu at the synapse. Furthermore, hormones and neuromodulators (e.g., serotonin, dopamine) operate on an even slower timescale. They alter the global "chemical climate" of entire brain regions and modulate overall excitability, thereby determining how receptive a neural network is to the rapid electrical signals in the first place. The electrical activity provides the "text," but the chemical processes provide the "grammar" and the "emotional tone" that determine its interpretation.

An "intrinsic timescale" is the characteristic duration over which a specific brain region integrates these incoming, chemically modulated spike patterns and weaves them into a coherent whole. One can think of this as a temporal "integration window," analogous to the exposure time of a camera. A region with a fast timescale has a short window, similar to a fast shutter speed. It captures fleeting, rapidly changing events—like a single phoneme in speech perception. A region with a slow timescale, by contrast, has a long window, analogous to a long exposure. It integrates neural activity patterns that extend over many seconds, thus connecting individual events into a larger, overarching structure—such as individual words into a sentence. This "window" is measured using the autocorrelation window (ACW) of spontaneous neural activity. Figuratively speaking, the electrical "background noise" of a brain region is recorded and compared with a slightly time-shifted copy of itself. The autocorrelation measures how long the signal remains "similar" to itself before its structure decays—a measure of the signal's temporal memory or inertia. A short ACW means the activity changes rapidly; the region has a fast timescale. A long ACW means the activity remains correlated with itself over a longer period; the region has a slow timescale.

These timescales are not randomly distributed but form a cortical gradient: early sensory areas exhibit very fast timescales, which systematically slow down along the processing pathways, reaching their slowest values in the transmodal association areas of the Default Mode Network (DMN) (Wolff et al., 2022). This temporal architecture is the direct neurobiological implementation of the functional hierarchy of predictive processing. Recent research conclusively shows that the functional levels of predictive processing—from abstract, context-providing predictions to concrete, sensory details—are materially realized in the brain's different intrinsic timescales (Auksztulewicz et al., 2024; van Es, 2020). At the top of this hierarchy are higher association areas like the DMN. Their slow rhythms correspond to the upper levels of the predictive hierarchy; they enable the integration of information over extended periods, thereby generating abstract, context-providing predictions (priors) about the world (Michel, 2023). They are the neurodynamic basis for our coherent sense of self and our ability to plan for the future. In sharp contrast, primary sensory areas operate on extremely fast, reactive timescales. These correspond to the lower levels of the predictive hierarchy; their high temporal resolution is necessary to respond to fleeting environmental changes and process rapidly changing prediction errors (Auksztulewicz et al., 2024).

For Northoff, this temporal architecture is therefore far more than just a neural correlate of mental states; it is their ontological basis. The phenomenal distinction between the feeling of a durable self and a fleeting sensory perception is the neurodynamic distinction between slow and fast timescales. The mind is thus no longer understood as a property that mysteriously emerges from the brain, but as the intrinsic spatiotemporal structure of the brain itself, as it presents itself from the first-person perspective. This lays the groundwork for a non-reductive monism in which mind and brain are united by their shared dynamic form.

3.2. The Computational Perspective: Dean Buonomano's Neural Dynamics of Timing

While Northoff describes the macroscopic temporal architecture of the brain, Dean Buonomano provides the plausible microscopic mechanics for it. He asks how a biological system can precisely measure time intervals without a central clock. His answer is as radical as it is elegant: timing is a decentralized, emergent property of neural networks (Buonomano & Karmarkar, 2002; Paton & Buonomano, 2018). At the center of his model are "population clocks". Imagine the surface of a pond into which a stone is thrown. The impact creates a complex, spreading wave pattern. At any moment after the impact, the pattern of the waves is unique. An observer could deduce exactly how much

time has passed since the impact from the shape of the waves. Analogously, a stimulus in a neural network generates a cascade of activity—a unique, time-varying trajectory of the network's state. The brain can "read" the elapsed time directly from the specific activity pattern of its own neuron population (Buonomano & Laje, 2010).

Buonomano identifies two cellular mechanisms that work together to achieve this: recurrent connections and short-term synaptic plasticity (STP). Recurrent connections, through countless feedback loops, create a neural "resonating body" that transforms an incoming signal into complex, reverberating patterns. STP acts as the "brush" that makes these patterns unique. Unlike the long-lasting plasticity of learning, STP is a transient effect that adjusts the "willingness to communicate" of a synapse from moment to moment, as it becomes "fatigued" (depression) or "sensitized" (facilitation) by rapid signal sequences. STP ensures that a network's response to an identical stimulus is never the same, as the immediate history of activity is inscribed in the current state of synaptic strengths. It implements the arrow of time at the level of the individual synapse. The interplay of both factors forces the network on a unique, irreversible journey through its state space. The brain thus measures time not by counting "ticks," but by recognizing where it is on its own endogenous trajectory (Buonomano, 2000; Motanis et al., 2018).

3.3. *Synthesis I: From Mechanism to Constitution*

The approaches of Northoff and Buonomano mutually ground each other in a closed explanatory cascade, ranging from cellular microdynamics to global brain architecture. Buonomano's mechanisms provide the direct physical cause for Northoff's phenomena. The local circuit architecture—the density of recurrence and the profiles of STP—determines the duration of the "neural echo" and thus directly the length of the autocorrelation window (ACW). A network with high recurrence and fatiguing synapses generates sluggish dynamics and thus a long ACW. On a macroscopic level, this manifests as the slow intrinsic timescales (INTs) and the corresponding slow brainwave oscillations that Northoff measures in areas of the DMN.

This physical differentiation is not a mere side effect but the necessary material prerequisite—the constitutive condition—for the functional specialization of the two memory systems postulated by Tucker et al. (2025). The functional division of labor is anchored in the physical dynamics. The generative system of the Papez circuit, the brain's "historian," must operate on a substrate with long INTs to distill stable narratives and our autobiographical self from the stream of experience. Only this high temporal inertia allows for the integration of distant events into a coherent whole. In sharp contrast, the error-correcting system of the Yakovlev circuit, the "crisis manager," is necessarily dependent on a substrate with short INTs. Only a system with minimal temporal inertia can react to sudden sensory data and perform the rapid, uncompromising reality testing necessary for survival.

The empirical findings of Melloni and colleagues (Auksztulewicz et al., 2024) close this circle. Their experiments, for instance on language processing, show that the neurophysiological hierarchy of timescales exactly maps onto the functional hierarchy of predictive processing. The processing of contextual "what" predictions (anticipating the next word) is modulated by slow rhythms, while the processing of temporal "when" information (anticipating the next syllable) is coupled to fast rhythms.

This is the decisive point for the thesis of multi-perspectival monism and the philosophical consequence for a Philosophy of Enactive Inference: The functional distinction between prediction and error correction is not merely mapped onto the brain; it is the physical distinction between slow and fast neural dynamics. This insight radicalizes enactivism by overcoming the last vestiges of representationalism. The brain does not build a model of the world; its slow rhythms are the establishment of a stable, dynamic equilibrium with the regularities of the environment—a continuous process of structural coupling. The ability to form abstract contexts is the physical property of neural circuits to integrate over long periods. This constitutive relationship means that there can be no mental function without the specific physical dynamic that enables it. Thus, the core enactivist concept of "sense-making" is naturalized: meaning arises not from the interpretation of symbols, but from the successful temporal synchronization between the endogenous rhythms of the

organism and the rhythms of the world. "Sense-making" is the process of maintaining a coherent, hierarchically nested temporal structure in which fast perturbations can be absorbed and ordered by slow contexts. The functional description of predictive processing is thus moved from a purely formal level to a solid, material, and fundamentally temporal foundation that not only bridges the gap between mental function and neural mechanism but resolves it as a matter of perspective.

4. Part II: The Predictive and Entropic Mind – A Universal Framework

4.1. *The Imperative of Life: Karl Friston's Free Energy Principle (FEP) and Active Inference*

Having established the temporal micro- and macro-architecture of the brain, the discussion now turns to the overarching organizing principle that puts these dynamics in the service of life. Karl Friston's free energy principle (FEP) provides a universal, physically grounded framework for this (Friston, 2010). It starts from a fundamental question: What distinguishes a living being—a cell, an animal, a human—from an inanimate object like a stone? The answer is that living beings must actively resist the universal tendency toward decay, the second law of thermodynamics. A stone can come into thermal equilibrium with its environment; a living being that does so is dead. Every self-sustaining system must therefore maintain its own structural and functional integrity by navigating a narrow corridor of life-sustaining states.

The FEP formalizes this biological imperative in information-theoretic terms. It posits that any system, in order to survive, must minimize the "surprisal" of its sensory states. "Surprisal" here is not a psychological term for astonishment, but a precise measure of the improbability of a sensory signal, given the implicit model the organism has of its world. A state of high surprisal is one that threatens the organism's existence—a fish on land, an antelope in the jaws of a lion. To remain within its characteristic phenotype, the organism must therefore seek out those sensory states it "expects" and avoid those that surprise it.

Since surprisal itself is not mathematically tractable, the system instead minimizes a proxy known in physics as free energy. Predictive processing (PP) is the neurobiologically plausible process theory that describes how the brain actually implements this minimization of free energy (Clark, 2016; Hohwy, 2013). It is conceived as a hierarchical generative model—an incessantly active prediction machine. At the highest, slowest levels (which, as we saw, are anchored in the DMN and Papez circuit), the brain generates abstract, context-providing hypotheses about the world ("I am sitting in a quiet room reading"). These hypotheses are passed down in a cascade, translated into increasingly detailed, faster, and modality-specific predictions about expected sensory impressions ("...therefore, I expect to feel a book in my hands and see the pattern of black letters on a white background").

These top-down predictions finally meet the bottom-up stream of actual sensory data in the early sensory areas. The discrepancy between the two—the prediction error—is what represents free energy in this system. The entire cognitive process is now geared towards minimizing this prediction error. To this end, the system has two fundamentally different but inseparably interwoven strategies:

Perceptual Inference (Adjusting the prediction to the world): When a prediction error occurs, the system can update its internal predictions (the generative model) to better explain the sensory data. Imagine you expect the ticking of a wall clock but instead hear a rhythmic dripping. The resulting prediction error ("unexpected sound") travels up the hierarchy, forcing the higher levels to revise their hypothesis—from "the clock is ticking" to "the faucet is dripping." Your perception of the world has changed to explain the sensory input. This is the core of perception: not a passive reception of data, but an active process of hypothesis testing.

Active Inference (Adjusting the world to the prediction): Alternatively—and this is the crucial step toward enactivism—the system can change the world through action so that it conforms to its predictions. Suppose the dripping faucet bothers you. Your brain now generates a prediction of a preferred state: "I expect to hear silence." To bring about this state and eliminate the current prediction error ("it is dripping"), you get up, walk to the faucet, and turn it off tightly. Your action is not a

reaction to a stimulus but the fulfillment of a prediction. The world is shaped to match the organism's internal model. Perception and action are thus two sides of the same error-minimizing process that keeps the living being in homeostatic balance with its environment (Friston, 2010; Smith & Sprevak, 2023).

4.2. *The Spectrum of Consciousness: Robin Carhart-Harris's Entropic Brain Hypothesis*

Robin Carhart-Harris's Entropic Brain Hypothesis builds the crucial bridge from the abstract, formal model of the FEP to the concrete, qualitative diversity of phenomenal experience. It posits that the subjective quality of conscious states can be arranged along a spectrum that directly correlates with a measurable neurophysiological parameter: the entropy of brain activity. Measuring this parameter is not a trivial undertaking. Neural entropy is not captured like temperature with a simple device; it is an information-theoretic quantity calculated from the complexity and unpredictability of brain signals. The two primary methods for this are functional magnetic resonance imaging (fMRI) and electro- or magnetoencephalography (EEG/MEG). With fMRI, which uses blood flow as an indirect measure of neural activity, entropy is often quantified by analyzing "brain states." Researchers determine how many different, stable configurations of functional connectivity the brain occupies over a certain period. A brain with high entropy flexibly traverses a large repertoire of such states; a brain with low entropy remains stuck in just a few, constantly repeating states. With EEG/MEG measurements, entropy is often calculated from the signal complexity in the frequency spectrum. A low-entropy signal would be a pure sine wave, its energy concentrated at a single frequency and thus highly predictable. A high-entropy signal is more like "white noise," where energy is spread broadly across many frequencies, making the signal complex and difficult to predict. Entropy, in this information-theoretic sense, thus means the unpredictability, diversity, and complexity of neural activity patterns. One can picture it as the vastness of the "landscape of possibilities" available to the brain in a given state.

At one end of the spectrum are the low-entropy states. These are characterized by high order, rigidity, and predictability in neural dynamics. The brain is trapped in a narrow valley of its possibility landscape, repeatedly cycling through the same, deeply ingrained activity patterns. Phenomenologically, this corresponds to rigid, stereotyped, and cognitively constricted forms of consciousness. The paradigmatic pathological example is depression: here, low entropy manifests as incessant rumination, where negative thoughts and feelings circle in a self-reinforcing loop. The high-level priors ("I am worthless," "The future is hopeless") have become pathologically precise and overpowering. They act as "informational black holes," assimilating any new sensory input and reinterpreting it in line with the negative belief. A kind word is interpreted as pity, a success dismissed as a fluke. The person is unable to generate alternative, more positive hypotheses about themselves and the world. The same applies to obsessive-compulsive disorders, where behavior is aimed at keeping the world in an extremely predictable, low-entropy state.

At the other end of the spectrum are the high-entropy states. Here, neural activity is flexible, unpredictable, and complex. The brain explores a vast, open landscape of possible states, and communication between different brain regions that normally work separately is increased. Phenomenologically, this corresponds to fluid, associative, and less constrained states of consciousness. Examples include REM sleep, where the bizarre logic of dreams dissolves rigid causal and identity structures, or the state of consciousness in early childhood, where the brain is not yet constrained by heavily weighted priors and the world appears as a place of unlimited possibilities. Perhaps the most striking high-entropy state is induced by the ingestion of classic psychedelics like psilocybin or LSD.

The REBUS model ("Relaxed Beliefs Under Psychedelics") by Carhart-Harris and Friston (2019) integrates this observation directly into the FEP. It posits that psychedelics exert their effects by specifically targeting serotonin-2A receptors, which are particularly dense in the high-level areas of the predictive hierarchy (like the DMN). This stimulation leads to a drastic reduction in the precision of high-level priors—those "beliefs" that constitute our self-image, our autobiography, and our sense

of separateness from the world. Through this "softening" ("Relaxed Beliefs") of the top control level, the brain loses its usual top-down driven order. It is "flooded" by a bottom-up stream of sensory information that is no longer interpreted through the usual filters. This allows the system to break out of the deep valleys of its habitual attractor states (such as depressive rumination) and reach a state of greatly increased system entropy. The therapeutic potential of this process lies in the possibility of temporarily dissolving pathological thought patterns and allowing the system to "reorganize" (re-anneal) in a healthier, more flexible state.

5. Part III: The Affective Motor and Homeostatic Regulation of Inference

This central part provides the mechanistic answers to the questions posed in the introduction and thus forms the core of the naturalistic foundation. It is based on the transformative framework of Tucker, Luu & Friston (2025). Before delving into the details of this model, however, it is crucial to establish an explicit link between the two central theoretical concepts we have discussed so far: the free energy principle (FEP) and the entropy of the brain. Superficially, they seem to contradict each other: The FEP postulates a universal drive to minimize surprisal and prediction errors, which seems to suggest a reduction in entropy. The Entropic Brain Hypothesis, on the other hand, associates healthy, flexible states of consciousness with high entropy.

The key to resolving this apparent paradox lies in the distinction between the entropy of sensory states and the entropy of the generative model. The FEP states that an organism must minimize the entropy of its sensory states. This means it must remain within a limited, predictable range of states to stay alive (a fish must stay in water). To achieve this in a complex and unpredictable world, however, it needs an extremely rich, flexible, and complex internal model of that world. A model with high entropy—that is, a huge repertoire of possible hypotheses—is far better equipped to explain unexpected sensory signals and thus minimize long-term sensory surprisal than a rigid, low-entropy model. A healthy organism thus minimizes free energy (sensory surprisal) by maintaining a generative model with high entropy. Pathological states like depression arise when the system is trapped in a state of low model-entropy, which paradoxically makes it more vulnerable to uncontrollable prediction errors and thus to high free energy in the long run. With this clarification, we can now turn to the mechanisms that regulate this complex interplay of order and chaos.

5.1. The Dual Memory Systems: A Neuroanatomical Basis for the Predictive Architecture

Tucker et al. (2025) transform "inference" from a quasi-logical process into a dynamic, physical self-organization. They postulate that the brain's predictive architecture rests on two large, antagonistic yet complementary limbic memory systems:

1. The Dorsal, Excitatory Feedforward System (Papez circuit): This system, anatomically comprising the hippocampus, mammillary bodies, and cingulate gyrus, is identified as the engine for predictive, generative forecasts (priors). It is evolutionarily older and operates in an exploratory, hypothesis-generating, and future-oriented manner. One can think of it as the "what-if" system, constantly drafting new possibilities and action plans based on autobiographical memories. Its dynamics are excitatory, aimed at forming new neural ensembles and energizing behavior.
2. The Ventral, Inhibitory Feedback System (Yakovlev circuit): This phylogenetically younger system, which includes the amygdala, orbitofrontal cortex, and insula, is described as the mechanism for inhibitory error correction through the processing of sensory evidence (likelihoods). It operates in a restrictive, reality-testing, and present-focused manner. One can think of it as the "what-is" system, which checks the plans of the Papez circuit against the hard facts of sensory reality and the interoceptive signals of the body. Its dynamics are primarily inhibitory, aimed at suppressing inappropriate actions and adapting behavior to current circumstances.

5.2. The E/I Balance as Lived Precision Weighting: Affect as a Control Mechanism

The central thesis of Tucker et al. is that the formal "precision weighting" in the FEP—the decision of whether to trust one's own predictions or sensory data more—finds its phenomenological and neurobiological correlate in the dynamic balance (E/I balance) between these two motivational and affective systems. The abstract calculation thus becomes a lived, feeling process of navigating between two fundamental affects:

- Elation (Confidence) as an Increase in Prior Precision: A dominance of the dorsal, excitatory system manifests in the affect of confidence, engagement, and curiosity. Phenomenologically, this is the state in which the world meets our expectations. Prediction errors are low, and we feel we are mastering the situation. This corresponds to increased trust in one's own generative models (high prior precision). In this state, we are willing to take risks, explore new things, and actively pursue our goals.
- Anxiety (Caution) as an Increase in Likelihood Precision: A dominance of the ventral, inhibitory system manifests in the affect of caution, anxiety, or hesitation. This is the state triggered by significant and unexpected prediction errors. The world does not conform to our expectations. This leads to increased trust in sensory data (high likelihood precision) and an inhibition of action. In this state, we become vigilant, withdraw, and analyze the immediate environment in search of the source of the error.

Affect is therefore not an epiphenomenon of cognition but its central control mechanism. The feeling of confidence is the neurodynamic configuration that allows us to actively shape the world, while the feeling of anxiety is the configuration that forces us to update our model of the world.

5.3. Criticality and Sleep: The Homeostatic Cycle of Consciousness

Adaptive, wakeful consciousness is defined as a state of criticality—the optimal balance point at the edge of chaos, between too much order (sub-critical) and too much disorder (super-critical). This can be visualized with a sandpile analogy: a pile that is too flat (sub-critical) is stable but "boring"; a new grain of sand doesn't trigger any avalanches, so information cannot propagate. A pile that is too steep (super-critical) is unstable; every new grain triggers an uncontrollable avalanche, and the system is chaotic. A critical sandpile is structured so that a new grain can trigger avalanches of any size—it is optimal for complex information processing. The waking brain operates at this critical point, where it achieves maximum flexibility and information-theoretic complexity.

Sleep serves as the crucial homeostatic process for the daily recalibration of this E/I balance, to return the system to a state of criticality for the next day:

- NREM Sleep (Sub-criticality): This is a phase dominated by the inhibitory system. The brain drifts into an ordered, sub-critical state. During this phase, it is hypothesized, the synaptic connections strengthened during the day by learning from prediction errors are consolidated and refined. It is a process of "fact-checking" and strengthening the connection to reality.
- REM Sleep (Super-criticality): In this phase, the excitatory system takes over. The brain enters a disordered, super-critical, "high-entropy" state, similar to that under psychedelics. Freed from the dictates of the senses, the generative model explores new connections and associations. Here, the facts learned during the day are integrated into the larger, abstract structures of the generative model, generalized, and combined into new insights.

The sleep cycle is thus the biological mechanism that daily recreates and stabilizes the brain's temporal architecture by actively maintaining the balance between reality testing and model generalization.

6. Part IV: The Neurodynamic Architecture of Multi-Perspectival Monism

6.1. From Intrinsic Timescales to Nocturnal Homeostasis

The INT hierarchy of Northoff, as is now clear, is not a static, hard-wired feature of the brain's architecture, but the dynamic, procedural result of the daily homeostatic sleep cycle. This process is

akin to the nightly maintenance and recalibration of a complex instrument. During the day, the brain learns countless new "facts" by confronting prediction errors—specific synaptic adjustments primarily located in the inhibitory Yakovlev system. NREM sleep, as a sub-critical state, then serves to consolidate this "factual knowledge." Like a librarian sorting and cataloging newly arrived books, this phase stabilizes the relevant synaptic changes of the day and eliminates irrelevant noise.

But a mere accumulation of facts does not yield understanding. This is where REM sleep comes in. As a super-critical, high-entropy state in which the excitatory Papez system dominates, the brain's generative model is freed from the shackles of immediate sensory reality. It is a phase of creative recombination and generalization. One can imagine it like an architect who, at night, reviews the building materials delivered during the day (the facts consolidated in NREM sleep) and considers how they fit into the overall blueprint, whether they change it, or even require a fundamental renovation. In this state, the specific memories of the day are generalized into abstract rules, new insights, and updated world models. The slow, integrating dynamics of the high-level networks, which enable our coherent sense of self and our deep-seated beliefs over time, are thus not merely passively maintained but are actively restructured, strengthened, and readjusted for the next day through this excitatory, associative re-consolidation in super-critical REM sleep (Tucker et al., 2025). The stable sense of "self" is therefore not a given, but a daily, nightly achievement.

6.2. *The Entropic Brain at the Edge of Chaos*

Against the backdrop of this dynamic model, psychopathology can now be interpreted far more precisely and mechanistically than the pure "Entropic Brain Hypothesis" initially allowed. The state of depression is not just vaguely "low-entropy" but the direct result of the entire system sliding into a rigid, sub-critical state. This is characterized by a pathological dominance of the ventral, inhibitory Yakovlev system. The high-level negative priors ("I am worthless") become overly precise and act like gravitational centers in the brain's state space. The "possibility landscape" of the mind is no longer vast and open but has deformed into a deep, narrow canyon from which there is little escape. Every thought, every perception is inevitably drawn into this valley. The phenomenological experience of hopelessness and being stuck is the direct equivalent of this neurodynamic configuration, in which the exploratory, generative Papez system is smothered by the overpowering, inhibiting activity of the Yakovlev system.

Psychedelic states, in turn, can be understood as an artificially induced, temporary shift into the super-critical range. They act like a "neurodynamic reset button." By stimulating serotonin-2A receptors, as described in the REBUS model, the precision of high-level priors is drastically reduced (Carhart-Harris & Friston, 2019). One can imagine how the steep walls of the depressive canyon suddenly erode, and the landscape flattens into a wide, open plain. This state is functionally similar to that of REM sleep: the system becomes maximally flexible and exploratory, old, rigid connection patterns are dissolved, and new ones can form. The frequently reported experience of "ego-dissolution" under psychedelics corresponds to the temporary deactivation of the slow rhythms of the DMN, which normally constitute our sense of a stable, separate self. The therapeutic opportunity lies in the fact that, after the drug's effect subsides, the system does not necessarily fall back into the old attractor state but is given the chance to restabilize at a healthier, more flexible point in the landscape—closer to the optimal state of criticality (Tucker et al., 2025).

6.3. *"The Feeling of What Happens": Affect as the Core of Enactive Inference*

The heading of this section, an allusion to Antonio Damasio (1999), is deliberately chosen to mark the transition from formal description to lived experience. It answers the question: "What does it feel like to be a predictive brain?" The answer is: It feels like the constant, affective dance between confidence and anxiety. The minimization of free energy, as it now appears, is not the abstract goal of a cold, information-theoretic system, but the existential project of a feeling organism. It is the incessant process of navigating an affective map whose poles are marked by anxiety (as the feeling

of too much unforeseen evidence) and confidence (as the feeling of stable, reliable predictions). This perspective fundamentally transforms our understanding of cognition.

Consider a deer in a forest clearing: As long as its sensory impressions—the rustling of leaves in the wind, the smell of damp earth—align with its generative models of a "safe clearing," it is in a state of minimal free energy. Phenomenologically, this is not a neutral, calculating state, but one of confidence and relaxed engagement with the world. Neurodynamically, the excitatory Papez system dominates; trust in its own priors is high. In this state, the deer can curiously explore its surroundings and graze—it performs active inference, which constantly confirms its prediction ("it is safe here and there is food").

Suddenly, a branch snaps in the undergrowth. This unexpected sound generates a massive prediction error—a sudden spike in free energy. Phenomenologically, this is the pang of anxiety. Neurodynamically, the balance shifts instantly: the inhibitory Yakovlev system becomes dominant, and confidence in sensory evidence ("unexpected noise!") is maximally increased. The reaction is not a deliberate decision but an immediate, affect-driven action: the deer freezes, its muscles tense, its ears pivot toward the source of the sound. This action serves the sole purpose of minimizing the prediction error by gathering new, more precise sensory data to test the hypothesis "predator." If it flees, this is not a mere escape reaction, but the active inference that attempts to realize a new prediction ("I am safe, far from the danger"). Action is thus not an output following an input, but a fundamentally affective process: the lived, feeling attempt to return from a state of high free energy (anxiety) to a state of low free energy (confidence). The "meaning" of the world is thus found not in neutral representations, but in the affective valence of prediction errors that incessantly drive us to act.

7. Discussion: Critical Objections and Potential Falsification Criteria

A synthesis of this scope, ranging from cellular dynamics to the philosophy of mind, must face critical objections. In the spirit of critical rationalism (Popper, 1959), the strength of a theory is demonstrated not by its ability to explain everything, but by its principled falsifiability. The following will discuss three of the most significant potential objections.

3. The Correlation Objection (The "Hard Problem"): A central objection could be that the model merely describes a highly complex chain of correlations between neural processes and mental states, without actually closing the explanatory gap (the "Hard Problem of Consciousness"). Why is a high E-system dominance the feeling of confidence and not just its neural correlate? The answer from the multi-perspectival monism advocated here is that the question itself rests on a false, dualistic premise. It assumes there are two separate phenomena (a neural one and a mental one) whose connection needs to be explained. The present model, however, argues for a constitutive relationship, as developed in Part I: the spatiotemporal dynamic is the mental function, just viewed from a different perspective. The slow, integrating dynamic is the formation of a stable context; it does not cause it. The question "Why does it feel this way?" is thus transformed into "What is the dynamic structure of this feeling?". The model provides an answer to the second question, thereby dissolving the first as a pseudo-problem.
4. The Homunculus Objection: Another objection could concern the use of phenomenological terms like "anxiety" or "confidence" as control mechanisms. Does this not sneak in a homunculus—a "little man in the head"—who "experiences" these feelings and then makes decisions? The model avoids this fallacy by reversing the causal direction. It is not that the system "feels anxiety" and then increases the precision of likelihoods. Rather, the neurodynamic shift toward a dominance of the Yakovlev system and increased likelihood precision is the process that we experience from the first-person perspective as "anxiety." Affect is not an entity that controls the system, but the phenomenological appearance of the self-controlling system itself.

5. The Falsification Objection: Is the model, in its comprehensive explanatory power, falsifiable at all? Yes. The strength of the synthesis lies precisely in the fact that it generates specific, testable predictions at multiple levels, the failure of which would shake the theory to its foundations:
 - Prediction 1 (Pharmacological Dissociation): The model postulates a functional separation between the Papez circuit (priors) and the Yakovlev circuit (likelihoods). It should therefore be possible to selectively modulate these two systems through targeted pharmacological intervention (e.g., with substances that specifically act on receptors in the hippocampus or amygdala). An experiment could show that manipulating the Papez circuit specifically impairs the ability to form long-term, abstract contexts in a learning task, while the immediate response to sensory prediction errors remains intact (and vice versa). If such a double dissociation cannot be demonstrated, the postulated anatomical-functional separation would be called into question.
 - Prediction 2 (Sleep Deprivation and ACW): The model claims that REM sleep is crucial for the consolidation and generalization of priors in the Papez system (with its long INTs). A targeted and long-term deprivation of REM sleep should therefore lead to a measurable shortening of the autocorrelation windows (ACW) in the areas of the Default Mode Network. This should be neurophysiologically measurable and correlate phenomenologically with a feeling of "mental fragmentation," difficulty concentrating, and a loss of the coherent, narrative self. If the slow timescales remained stable despite REM sleep deprivation, the thesis of homeostatic regulation would be refuted.
 - Prediction 3 (Clinical Populations): The model implies specific profiles for clinical populations. Patients with a lesion or dysfunction primarily in the Yakovlev system (e.g., in the amygdala) should have difficulty reacting to immediate threat stimuli and learning from errors (low likelihood precision). At the same time, their generative system could be overactive and decoupled from reality. If, instead, diffuse and non-specific deficits were to appear that could not be traced back to the postulated E/I balance, the model would lose explanatory power.

8. Conclusion: A Naturalistic Foundation for Multi-Perspectival Monism

The synthesis presented here provides a robust naturalistic foundation for the Philosophy of Enactive Inference, thereby establishing a strong case for a multi-perspectival monism. The integration of affective and homeostatic mechanisms strengthens the proposed model on three crucial, interlocking levels: it becomes mechanistically more precise, phenomenologically richer, and homeostatically complete in its description of the system's self-maintenance.

The decisive outcome is the concrete, empirically grounded illustration of a multi-perspectival monism in action. The model overcomes the sterile dichotomy of reductionism (mind is nothing but firing patterns) and dualism (mind and brain are separate entities). Instead, it describes a single, fundamental psycho-physical process—the incessant, rhythmic regulation of the E/I balance in the pursuit of criticality—which necessarily appears under two irreducible but complementary perspectives. From the third-person perspective of the neuroscientist, this process is accessible as measurable neural dynamics: as the oscillation of brain waves, as the measurable dominance of the Papez or Yakovlev circuit, as a system moving on a spectrum between sub- and super-critical states. From the first-person perspective of the experiencing subject, this very same process is the qualitative texture of our consciousness: the feeling of confidence when predictions succeed, the sting of anxiety when they fail, the clarity of the waking mind in a state of criticality, or the dreamlike disorganization in super-critical REM sleep. The scientific and phenomenological descriptions are thus not competing explanations, but two necessary, mutually illuminating approaches to the same processual reality.

This monistic and processual view directly supports the central theses of the Philosophy of Enactive Inference:

- Naturalization of Normativity: The model provides an answer to the question of the origin of values. The basal "ought" of life is not an abstract ethical principle but is anchored in the biological and affective imperative to maintain a state near criticality. A state of criticality is

optimal for minimizing free energy and thus for survival. Actions and states that bring us closer to this optimum are felt as positive and "good" (confidence, curiosity, flow), while states that move us away from it (sub-critical depression, super-critical mania) are experienced as negative and "bad" (anxiety, confusion). Normativity is thus not a human invention but a fundamental property of self-sustaining systems.

- **Processual Ontology:** The mind is definitively no longer conceived of as a thing ("res cogitans") or static software, but as a self-organizing, rhythmic, and fundamentally temporal process. The daily, nightly recalibration in sleep underscores this radically: the "self" is not a constant substance but a dynamic structure that must be actively reconstituted anew each day. It is less like a statue and more like a vortex in a river—a stable pattern maintained only by the constant flow of matter and energy.

The neurodynamic architecture of the mind developed here thus provides not only a unifying theory for cognitive science that integrates mechanism, phenomenon, and function. It also presents a strong, empirically grounded argument for a philosophy that understands the mind as a fundamentally embodied, feeling, and temporal process of being-in-the-world, thereby leaving outdated dualistic categories behind.

Disclosure Statement: In preparing this manuscript, the author used the AI tool Perplexity (accessed October 2025) to assist with language refinement and the initial drafting of the abstract and public importance statement. The author retained full intellectual control over the content, ensuring that all statements, arguments, and conclusions were his own, and assumes full responsibility for the final text.

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