Naturalizing Free Will: Emergent Autonomy as Life's Tapestry

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Abstract

This paper proposes a naturalistic, emergentist libertarian account of free will, conceptualized as emergent autonomy arising from biological organization and inherent physical indeterminacy. Critiquing classical deterministic assumptions about static time and infinite precision, we introduce "creative time" (objective, dynamic becoming) and "potentiality realism" (objective possibilities) as foundations. Autonomy emerges from the interplay of organizational closure (self-maintenance), non-equilibrium thermodynamics, and the system's capacity to harness ontic indeterminacy (objective openness utilized functionally). Drawing on systems biology, physics, and process philosophy, we outline the philosophical basis (emergence, potentiality realism), scientific principles (thermodynamics, dynamics), biological realization (minimal agency, materiality), and a model of choice involving downward constraint (organizational influence) and emergent sourcehood (agent as origin). We address neural implementation, reinterpret empirical challenges (e.g., Libet), and defend against objections (luck, manipulation). This framework offers a research program for understanding freedom as a graded, natural phenomenon rooted in life's organization unfolding through creative time.

Keywords: Emergent Autonomy, Ontic Indeterminacy, Creative Time, Organizational Closure, Downward Constraint, Naturalist Libertarianism.

1. Introduction: The Quest for Naturalized Freedom

The capacity for purposeful choice among genuine alternatives—commonly termed free will, representing the most sophisticated form of agency involving reflective consciousness and reasoned deliberation—presents a profound challenge to a scientific worldview often perceived as deterministic. Understanding how seemingly goal-directed actions, observed across the spectrum of life, can arise from underlying physical and chemical processes is a central question. This paper **attempts to explore the naturalization** of free will by conceptualizing it within **what appears to be a hierarchy**, starting with autonomy (the basic capacity of a system for self-regulation and maintaining organizational integrity) which enables more advanced agency (involving information processing and goal-directed action based on internal assessment), culminating in free will. We focus on autonomy as an emergent property: emergent autonomy, rooted in the unique organization of life itself, an organization that unfolds dynamically in real, lived time (Kauffman & Clayton, 2006).

Addressing this demands establishing a coherent philosophical and scientific foundation. This involves clarifying ontological commitments, reconsidering causality, critically evaluating physical determinism, and appreciating the nature of time. A key distinction is between geometric time (the static parameter of deterministic physics) and **creative time** (proposed here as the objective, dynamic time associated with the actualization of potentialities and emergence of novelty). To reinforce this concept, we draw upon philosophy of physics and process philosophy literature that formally analyzes temporal ontology and the distinction between geometric and "creative" (becoming) time—anchoring the discussion in contemporary debates on the nature of time (e.g., Gisin, 2016; Del Santo & Gisin, 2024a; Lestienne, 2022).

While acknowledging scientific limitations, this paper tentatively proposes a possible framework for emergent autonomy, aiming not for definitive proof but a scientifically plausible pathway. By moving beyond inherited constraints like simplistic reductionism (critiqued further in Section 2.3) and the conflation of time with space, we seek the most reasonable scientific hypothesis (Popper, 1959).

We **suggest a potential form** of naturalist, emergentist libertarianism. Autonomy arises from biological self-organization harnessing objective physical openness (ontic indeterminacy, meaning objective uncertainty in nature itself) within the flow of creative time (or duration, durée, following Bergson, 1889, and Gisin, 2016). This emphasizes the causal efficacy of emergent organizational properties, suggesting biology introduces causal powers not reducible to physics alone (Kauffman, 2019; Kauffman & Clayton, 2006).

The paper structure: Section 2 lays philosophical groundwork, critiquing classical assumptions. Section 3 focuses on ontic indeterminacy and creative time as positive resources. Section 4 outlines scientific principles enabling autonomy. Section 5 explores biological realization. Section 6 synthesizes the emergent autonomy framework, defining key terms. Section 7 discusses neural implementation. Section 8 engages in philosophical dialogue. Section 9 concludes.

2. Philosophical Foundations: Revising Ontology, Causality, Time, and Explanation

To understand how freedom might arise naturally, we must clarify our philosophical lens and critically dismantle the flawed metaphysical and epistemological assumptions inherited from classical thought that have historically constrained the free will debate.

2.1 Ontology, Emergence, and Potentiality

This framework **attempts to adopt what might be characterized as a Scientific Ontology**, **seeking to ground** existence claims in scientific evidence and models, informed by a post-Kantian awareness of epistemological limits (see 2.3). We distinguish Entities (abstracted phenomena for science) from Noumena (things-in-themselves). Science models Entities, acknowledging models are representations.

Central to this framework appears to be

Ontological Emergence: **the possible appearance of what may be genuinely new** entities, properties, and causal powers at higher organizational levels (Kauffman & Clayton, 2006; Clayton & Davies, 2006). Novelty arises as organization imposes enabling constraints on lower levels, channeling behavior irreducibly (Ellis, 2023). This contrasts with strong reductionism ("nothing but the sum of parts"), which faces logical circularity and ignores the causal power of organization itself. Reductionism can also implicitly adopt a Cartesian dualism by assuming a disembodied observer. Strengthening the critique of reductionism involves engaging with diverse contemporary perspectives on levels of explanation, emergent properties, and causality, particularly those highlighting emergent physicalism and causal pluralism (e.g., Emmeche et al., 2000; Ellis, 2023).

This view **might be supported by what we term Potentiality Realism**: the position that objective potentialities (propensities, real possibilities) **could be considered** fundamental constituents of reality alongside actual properties, providing a physical basis for ontic indeterminism (Del Santo & Gisin, 2023a).

2.2 Rethinking Causality and Time

Beyond Mechanistic Causality: Causality here means functional dependencies, moving beyond simple efficient cause. Understanding complex systems requires a multi-causal view, incorporating organizational structure (formal cause) and self-maintenance goals (final cause, naturalized as biological normativity) alongside efficient triggers (Ellis, 2023; Emmeche et al., 2000). Downward constraint (Section 6.1) often operates via formal/material factors. In an indeterministic framework, causality involves propensities (Del Santo & Gisin, 2023a).

Creative Time vs. Geometric Time: Following Bergson (1889) and Gisin (2016), we distinguish:

- **Creative Time (Durée): Tentatively proposed as potentially objective, lived time; possibly representing** a continuous, qualitative, irreversible flow involving genuine becoming, novelty generation, and potentiality actualization. It is the temporal dimension in which biological processes, adaptation, and potentially consciousness unfold (Gisin, 2016; Del Santo & Gisin, 2024a; Lestienne, 2022).
- **Geometric Time:** Abstract, spatialized time of classical physics; homogeneous, reversible, infinitely divisible, modeling time as a coordinate. It serves as a useful parameter in many physical models but arguably fails to capture the dynamic nature of reality as experienced and enacted by living systems.

Classical determinism relies on geometric time. This framework argues creative time is more fundamental for life and agency (Gisin, 2016; Del Santo & Gisin, 2024a). Geometric time ignores the qualitative flow and unpredictability of duration (Bergson, 1889, 1922). The implications of creative time are explored further in the context of indeterminacy (Section 3) and biological processes (Section 5.4).

2.3 Critiques of Classical Metaphysics and Epistemology

The classical free will debate **may often be constrained by what appear to be problematic assumptions**. We must critique these to clear the ground. This section consolidates critiques related to determinism, physicalism, and epistemology.

Physicalism as Fossilized Metaphysics: **Physicalism might arguably function as what could be considered outdated metaphysics potentially rooted in mechanism**. It mistakenly leaps from model efficacy to ontological completeness (mistaking map for territory). It flattens reality, reducing complexity and ignoring emergent organization's causal efficacy. It implicitly assumes a disembodied observer (hidden dualism). Physicalism struggles with meaning, function, and emergence, often denying the reality of higher-level organization or claiming reducibility. It frequently ignores contemporary science challenging its assumptions, representing metaphysical inertia.

The Collapse of Causality and the Myth of Explanation: Modern science often collapses causality from richer frameworks (Aristotle's four causes) into efficient cause or mere correlation. Early modern science excluded formal/final causes, erasing intrinsic purpose. This impoverishes explanation. Equating cause with force transfer or statistical dependence mistakes models for insight and ignores structure, constraints, and function. Science uses purpose-laden terms ("function") metaphorically within frameworks denying intrinsic purpose. Equating explanation with prediction confuses epistemic goals; understanding complex systems requires grasping their architecture and self-maintenance logic. A richer view of causality (constraints, feedback, multi-level interactions) is needed (Ellis, 2023; Emmeche et al., 2000).

The Emergence Panic and Conceptual Limitations: Ontological emergence is often resisted, misinterpreted as violating physical laws. This "emergence panic" stems from metaphysical rigidity. **Emergence may involve novel organizational structures that appear to constrain lower levels in ways that seem consistent with micro-physics**. Downward constraint operates via context-setting, not competing forces (see Section 6.1). Emergent properties are often objectively real features, not just illusions of ignorance. Denying emergence because models can't capture it mistakes tool limits for reality limits (instrumental solipsism). Agency, meaning, and life are emergent; denying this cripples science.

The Observer Within: Against Disembodied Knowledge: The ideal of a detached observer is illusory. Knowledge is generated by embodied, situated agents interacting physically. Observation is active interaction; information is relational. Objectivity is intersubjective coherence among situated observers. Theories denying agency often implicitly exempt the theorist (hidden dualism). A coherent theory requires placing the observer within the world, treating knowledge as interaction and models as tools (Varela et al., 1991).

Naive Realism and the Limits of Models:

Believing models directly mirror reality (naive realism) ignores Kantian insights about constructed knowledge. Confusing model adequacy with ontological revelation leads to errors like emergence denial. Structure and organization are real and causally significant. Science without philosophical self-awareness is unconscious metaphysics.

Illusions of Predictive Omniscience & Determinism's Flaws: The dream of total prediction (Laplacean Demon) is a metaphysical delusion dismantled by modern physics and information theory. Classical determinism, often assumed, faces significant challenges:
* Mathematical Idealization & Infinite Precision: It assumes real numbers with infinite precision, which is physically implausible (Born, 1969; Gisin, 2019a). Physical quantities likely carry only finite information (Gisin, 2019a, 2020). Replacing reals with Finite Information Quantities (FIQs) suggests Potentiality Realism and inherent indeterminism (Del Santo & Gisin, 2019, 2023a). Classical mechanics itself has issues with unique solutions (Del Santo, 2021).
* Physical Information Limits: Landauer's principle implies infinite energy cost for infinite processing (Landauer, 1961). The Bekenstein bound limits information density (Bekenstein, 1973, 1981). The Laplacian Demon is physically impossible (Gisin, 2014).
* Complexity, Scale & Non-Ergodicity: Applying deterministic laws to complex systems is often intractable. The universe is profoundly non-ergodic, creating novelty in the "adjacent possible", challenging predictability (Kauffman, 2000, 2019).
* Chaos Theory: Sensitivity to initial conditions makes long-term prediction impossible. Combined with FIQ, this implies ontological indeterminacy (Gisin, 2019a; Del Santo, 2021).
* Quantum Mechanics & Ontic Indeterminacy: Heisenberg uncertainty and Bell's theorem support ontic indeterminacy—inherent indefiniteness in nature (Del Santo, 2021; Del Santo & Gisin, 2023a).
* Operational Closure & Epistemic Opacity: Self-maintaining systems are inherently opaque to external prediction (Maturana & Varela, 1980).
* The Illusion of Geometric Time: Determinism relies on static time, ignoring dynamic becoming (Bergson, 1889; Gisin, 2016).

Prediction is an operational success of models, not proof of ontological determinism (Del Santo, 2021). The future is not fixed but emerges. Over-reliance on prediction devalues creativity and emergence. Understanding requires grasping the architecture of constraint and emergence. Dismantling these flawed assumptions clears the ground for a naturalistic framework based on creative time, multi-level causality, emergence, and embodiment.

3. Ontic Indeterminacy as Opportunity within Creative Time

The universe **may potentially possess what could be characterized as ontic indeterminacy**: **a form of objective physical openness** representing multiple real potentialities unfolding in creative time (Del Santo & Gisin, 2023a). **This might be considered a potentially positive resource for agency**. Rather than being mere "noise" or randomness to be overcome, this inherent openness provides the raw material for exploration and novelty. Biological systems seem "tuned into noise" (Braun, 2021), potentially harnessing this openness (e.g., via stochastic resonance) to explore possibilities and adapt (Kauffman, 2019; Albantakis & Deco, 2011). Evidence for this functional harnessing comes from various levels:

- *Molecular Level:* Stochastic gene expression allows cell populations to diversify phenotypes, increasing resilience (Samoilov et al., 2006).
- *Neural Level:* Neural noise can enhance signal detection (stochastic resonance, Battaglini et al., 2023), facilitate escape from local optima in learning (Rolls & Deco, 2010), and enable exploration of decision landscapes (Albantakis & Deco, 2011).
- *Behavioral Level:* Random search patterns in foraging animals or spontaneous behavioral variability can be adaptive (Noble & Noble, 2018).

This perspective reframes indeterminacy not as a problem for control (the "luck objection," addressed in Section 8.2), but as a fundamental feature of a dynamic, creative reality that living systems have evolved to utilize. Openness is fundamental to becoming and adaptation within creative time.

4. Building Blocks of Autonomy: Thermodynamics, Systems, Dynamics in Creative Time

How do systems achieve self-governance within creative time?

4.1 Thermodynamics: Irreversibility, Dissipative Structures, and Work Cycles

Living systems maintain order far from equilibrium in creative time. **Macroscopic time irreversibility appears to be a key factor** (Bergson, 1889). Prigogine's **dissipative structures** (e.g., convection cells like Bénard cells, oscillating chemical reactions like the Belousov-Zhabotinsky reaction) demonstrate how open systems, by exchanging energy and matter with their environment, can spontaneously generate complex, ordered patterns far from thermodynamic equilibrium by exporting entropy (Prigogine, 1967, 1977). Irreversibility enables becoming. Life harnesses energy via **work-constraint cycles** (Kauffman, 1993, 2019): energy captured (e.g., via metabolism) builds constraints (e.g., proteins, membranes), which then channel energy to perform further work, including the work of regenerating those very constraints (self-maintenance).

4.2 Systems Theory: Organizational Closure and Relational Biology

Biological identity may depend significantly on what has been termed Organizational Closure (Moreno & Mossio, 2015; Maturana & Varela, 1980): a network of mutually dependent constraints (e.g., enzymes catalyzing reactions that produce components needed for those enzymes) that recursively regenerate the conditions for the network's own continued operation and existence. This self-maintaining, self-producing organization defines the boundary and identity of the biological individual and its intrinsic goals (maintaining closure). It aligns with Rosen's Relational Biology (1991), which emphasizes functional organization and self-referential loops over specific material components.

4.3 Dynamics: Attractors, Bifurcations, and State Space Navigation

System behavior unfolds as trajectories in phase space. **Attractors** represent stable states or patterns of activity (e.g., specific gene expression profiles, stable neural firing patterns) towards which the system tends to evolve (Hopfield, 1982). **Decisions might involve transitions between attractors, possibly enabled by noise that appears to explore the landscape** near points of instability (**bifurcations**) where small fluctuations can lead to large changes in system state (Del Santo & Gisin, 2023a). Computational neuroscience models often use attractor dynamics to simulate decision-making and memory (Albantakis & Deco, 2011; Rolls & Deco, 2010). Systems might operate near the "edge of chaos" (Kauffman, 1991), a regime balancing stability and flexibility, allowing for both robust function and adaptive change. The NK model provides a framework for exploring adaptation on rugged fitness landscapes (Kauffman & Weinberger, 1989).

5. Biological Realization: Materiality, Minimal Agency, and Meaning in Creative Time

How are autonomy principles physically realized?

5.1 Materiality: Carbon, Water, Active Matter, and Embodiment

Biological agency appears to depend substantially on its carbon-based substrate in what research suggests is an active water matrix (Moreno & Mossio, 2015; Ball, 2017). Carbon's unique bonding properties enable the formation of complex, stable yet flexible macromolecules. Water is not a passive solvent but actively participates in structuring biomolecules, facilitating self-assembly, mediating reactions, and enabling essential dynamics (Nakagaki et al., 2000). The principles of **soft matter** physics help describe the mechanical properties and flexibility of tissues and cells (Fletcher & Mullins, 2010). Furthermore, **active matter** physics models systems where components convert stored or ambient energy into directed motion (e.g., molecular motors driving cytoskeletal rearrangements, bacteria swimming using flagella), explaining emergent collective behaviors and coordination crucial for life (Marchetti et al., 2013). Embodiment is thus not incidental but integral to biological function and agency (Varela et al., 1991).

5.2 The Living Agent vs. The Artifact: Materiality Matters

Biological agents differ fundamentally from current AI, challenging strong functionalism (Putnam, 1967). **Functionalism may tend to overlook what some researchers consider important substrate influences**; the specific material realization of biological systems enables their unique properties (Ellis, 2023; Varela et al., 1991). AI, typically implemented on silicon hardware, lacks the intrinsic coupling of material dynamics, energy flow, and self-maintenance (organizational closure) characteristic of life. Biological systems possess **intrinsic normativity** tied to the imperative of maintaining their self-producing organization, a feature arguably absent in current AI (Moreno & Mossio, 2015; Barandiaran et al., 2009). **Current digital robots might lack what we have characterized as the openness of creative time, though this remains an area of ongoing investigation**; their operations are often based on discrete, predetermined steps within a framework closer to geometric time

(Gisin, 2016). Philosophical critiques of computational functionalism emphasize these differences rooted in embodiment and material self-maintenance (Barandiaran et al., 2009; Varela et al., 1991; Ellis, 2023).

5.3 Minimal Agency: The Spark of Life

Minimal agency, the capacity for goal-directed adaptive behavior, is arguably present even in simple organisms lacking nervous systems. Examples include:

- *Slime molds* navigating mazes towards food sources (Nakagaki et al., 2000).
- *Bacteria* performing chemotaxis, moving towards attractants and away from repellents using sophisticated sensing and signaling pathways (Lyon, 2015; Samoilov et al., 2006).
- *Protists* exhibiting habituation or basic forms of learning (Fulda, 2017).

Theoretical models like Kauffman's **autocatalytic sets** and work cycles (Kauffman, 1986, 1993) and Gánti's **Chemoton** (Gánti, 1975, 2003) provide frameworks for understanding how molecular systems can achieve the organizational closure necessary for minimal autonomy and agency (Moreno & Mossio, 2015). These examples demonstrate that agency is a graded phenomenon rooted in basic biological self-maintenance and interaction with the environment.

5.4 Information, Meaning, Value, and Purpose (Telos) in Creative Time

Agency may require the interpretation of information in what could be considered meaningful ways over what we have termed creative time. Information is not merely abstract data but becomes meaningful when interpreted by an agent within its functional context (its *Umwelt*, the organism's subjective world; Brentari, 2015) relative to its goals. For biological agents, **intrinsic value** arguably derives from the fundamental imperative of maintaining organizational closure (survival and propagation) (Mitchell, 2023). This grounds a naturalized concept of **purpose (telos)**: actions are directed towards maintaining the system's integrity and viability (Ellis, 2023). **Memory**, the persistence of the past influencing the present and shaping future possibilities, is crucial for navigating creative time (Bergson, 1889). Biosemiotics explores how signs and information acquire significance through their functional roles within living systems. The generation of genuinely new information and possibilities is a hallmark of creative time (Gisin, 2016).

6. Synthesizing Emergent Autonomy: The Interplay of Core Principles

This section integrates the preceding concepts into a cohesive framework of emergent autonomy, providing operational definitions for key terms.

[A conceptual diagram illustrating the relationships between key concepts (creative time, ontic indeterminacy, organizational closure, downward constraint, and autonomy) would be beneficial here.]

6.1 Downward Constraint: Organizational Influence on Components

Downward Constraint (DC) might be characterized as a process whereby higher-level organizational features of a

system influence the behavior and interactions of its lower-level components over creative time, without violating underlying physical laws (Ellis, 2016; Campbell, 1974; Clayton, 2004).

- *Operational Definition:* DC occurs when the organization of the whole (e.g., cell structure, metabolic network, physiological state) sets boundary conditions or alters the probabilities of lower-level events (e.g., molecular interactions, ion channel openings), effectively selecting among the physically possible behaviors of the components.
- *Mechanism:* It often operates via formal causes (the structure or organization itself) and material causes (the specific components enabling that structure), rather than direct forces competing with lower-level forces (Ellis, 2023). The context provided by the whole channels the activity of the parts. For example, the structure of an enzyme (higher-level organization) constrains the possible reactions its constituent amino acids (lower-level components) can participate in, channeling them towards a specific catalytic function. This selection among potentialities may be crucial for the actualization process within creative time (Del Santo & Gisin, 2024a). Work formalizing top-down causation provides further grounding (Ellis, 2016; Moreno & Mossio, 2015).

6.2 Emergent Sourcehood: The Agent as Origin

Sourcehood, in this context, refers to the capacity of the agent, as an integrated system, to be the genuine origin of its actions. Sourcehood could potentially be grounded in what appear to be emergent causal powers arising from the self-maintaining organization (closure) operating dynamically within creative time (Ellis, 2016; Mossio et al., 2016).

- *Operational Definition:* An action originates from the agent (exhibits emergent sourcehood) when it is primarily determined by the agent's internal dynamics, goals (derived from organizational closure), and history (memory), rather than being solely dictated by immediate external stimuli or reducible to the independent actions of its lowest-level components.
- *Mechanism:* The agent, as an organized, autonomous whole (Rosen, 1991), exerts downward constraint (DC) on its components. The "source" is not a homunculus but the integrated, self-organizing dynamics of the system itself, operating with objective openness (ontic indeterminacy) structured by its organization. This provides a naturalistic basis for agent-causation (cf. Clarke, 2001), grounded in potentiality realism (Del Santo & Gisin, 2023a). The agent's identity is intrinsically linked to this ongoing process of self-maintenance and action generation (Röck, Chap. 7 in Švorcová, 2024).

6.3 A Dynamic Model of Emergent Choice

Autonomous choice might be conceptualized as a dynamic, temporally extended process within what we have termed creative time, involving the interplay of constraints, potentialities, and actualization:

- *Initialization:* The agent exists in a baseline state within its landscape of possible states (attractor landscape), defined by its current organization, history, and environment.
- *Accumulation/Search:* Internal states and external inputs drive the system's dynamics. Potential actions or responses are implicitly or explicitly assessed relative to the agent's intrinsic goals (maintaining closure) and memory. This phase involves navigating the state space.
- *Stochastic Exploration/Transition:* **What may be characterized as harnessed ontic indeterminacy (objective openness) might allow the system to explore different trajectories or possibilities, especially near points of instability (bifurcations) where multiple outcomes are viable.** This exploration is not purely random but is channeled by the system's organization (Del Santo & Gisin, 2023a). For example, neural noise might allow consideration of different action plans.
- *Selection/Commitment (Actualization):* The system's dynamics converge towards a dominant attractor, representing the "chosen" action or state. This marks a transition from potentiality to actuality within creative time (Del Santo & Gisin, 2024a).
- *Constraint/Action:* The selected state exerts downward constraint, organizing lower-level processes to execute the chosen action or maintain the chosen state.

This model emphasizes choice as an emergent process of the whole system unfolding over time, integrating internal dynamics, environmental interaction, and inherent indeterminacy.

7. Neural Implementation: Principles of Nervous System Agency

While agency is not exclusive to neural systems, nervous systems enable highly sophisticated forms. This section outlines key principles, focusing less on specific anatomical details and more on functional architecture relevant to autonomy.

7.1 Attractor Dynamics as a Neural Principle

Nervous systems appear to utilize attractor dynamics that may represent states and process information (Hopfield, 1982). Stable patterns of neural activity (attractors) can represent memories, percepts, motor plans, or intentions. Decisions can be modeled as transitions between these attractors, driven by sensory input, internal fluctuations, and top-down goals (Albantakis & Deco, 2011). This provides a mechanism for robust information maintenance, pattern completion, and structured state transitions essential for coherent behavior.

7.2 Functional Roles of Noise and Indeterminacy in Neural Systems

Neural variability ('noise') might not be merely detrimental but may potentially play functional roles in information processing and behavior (Faisal et al., 2008; Rolls & Deco, 2010; Destexhe, 2022). As seen even in simpler organisms (Section 5.3), harnessing indeterminacy appears crucial. In neural systems, potential roles include:

- *Exploration:* **Noise might facilitate escaping local optima in what appear to be learning or decision landscapes**, allowing for more effective search and adaptation (Rolls & Deco, 2010).
- *Adaptation & Learning:* Stochasticity in synaptic transmission or neuronal firing provides variability crucial for synaptic plasticity and network reorganization underlying learning and memory.
- *Symmetry Breaking:* Near decision thresholds or bifurcation points, noise can help resolve choices between equally valuable options, preventing deadlock (Braun, 2021).
- *Sensitivity Enhancement:* Mechanisms like stochastic resonance, where noise can actually improve the detection of weak signals, have been demonstrated in neural systems (Battaglini et al., 2023).

The brain's complex organization likely structures and exploits inherent stochasticity—whether arising from thermal fluctuations (classical noise) or potentially deeper ontic indeterminacy—for adaptive flexibility and exploration (Noble & Noble, 2018). Rigorously distinguishing the sources and specific functional consequences of different types of neural noise remains an active area of research (Faisal et al., 2008; Rolls & Deco, 2010; Destexhe, 2022; Prado et al., 2022; Del Santo & Gisin, 2024a).

7.3 Scaling Agency and the Role of Consciousness

The evolution from minimal to complex agency may involve what could be described as scaling neural complexity, leading to enhanced capacities for prediction, planning, symbolic representation, and recursive cognition (Noble, 2012; Smaers & Soligo, 2013). Agency exists on a gradient, from simple stimulus-response loops to sophisticated deliberation. Consciousness emerges as a higher-order property associated with large-scale, integrated neural activity (e.g., global workspace theories), likely facilitating functions such as metacognition, flexible behavioral control, integration of information over longer timescales (operating within creative time), and potentially a capacity for vetoing initiated actions (Searle, 2007; Mele, 2009). It builds upon, and modulates, the foundational autonomy provided by organizational closure and associated dynamics.

8. Philosophical Dialogue & Defenses

How does this framework (Emergent Indeterminist Autonomy, EIA) compare to rivals and address objections?

8.1 Comparison with Rival Views

EIA attempts to offer what might be termed a naturalist emergentist libertarianism, potentially grounded in potentiality realism and biological organization.

- *vs. Hard Determinism/Illusionism:* Challenges the premise of determinism based on critiques of classical physics and the positive proposal of creative time/ontic indeterminacy; offers a positive naturalistic account of agency rather than dismissing it as illusion.

- *vs. Classical Compatibilism:* Goes beyond compatibilism by incorporating genuine openness (ontic indeterminacy); grounds autonomy objectively in organizational closure and intrinsic biological normativity, offering a potentially stronger response to manipulation arguments.
- *vs. Metaphysical Libertarianism (e.g., non-physicalist agent-causation):* Offers a fully naturalistic account; grounds indeterminacy and control in physics (potentiality realism) and biology (downward constraint via organization); avoids invoking mysterious non-physical entities; potentially more amenable to formal modeling and empirical investigation.
- *vs. AI Functionalism/Substrate Neutrality:* Explicitly challenges strong substrate neutrality by emphasizing the role of embodied materiality (Section 5.1) and organizational closure (Section 4.2) for the specific kind of autonomy observed in biological systems.

8.2 Addressing Objections

EIA aims to offer what might be considered responses to several key objections:

- *The Luck Objection (Indeterminism undermines control):* **Indeterminacy might be better understood as structured potentiality, not pure randomness. It is channeled by the agent's organization (constraints) and steered by downward constraint.** Decisions are often temporally extended processes, allowing integration and buffering of random fluctuations. Responsibility stems from the action originating from the agent's character and values, embodied in its self-constituted organization operating over time.
- *The Manipulation Objection (e.g., Pereboom's Four-Case Argument):* The key difference lies in the integrity of organizational closure. Authentic autonomous action arises from the agent's intrinsic, self-maintaining dynamics. Manipulation involves an external intervention that bypasses or overrides these endogenous processes, breaching the system's organizational integrity and thus violating autonomy in an objective, biologically grounded way (cf. Moreno & Mossio, 2015).
- *The Causal Exclusion Argument (Higher-level properties are epiphenomenal if physical closure holds):* EIA challenges the assumption of simplistic causal closure and linear, single-level causation. Downward constraint operates by structuring the context and altering probabilities for lower-level events (formal/contextual causation), not by competing with lower-level forces. Emergent properties, defined by the organization, can have irreducible causal efficacy in this framework (Ellis, 2016).
- *The "Classical Physics Only" Objection (No evidence for quantum effects in the brain):* Firstly, classical physics itself may be fundamentally indeterministic when finite information is considered (Gisin, 2019a; Del Santo, 2021). Secondly, the brain is a warm, wet system, but **appears not to be isolated from potential quantum effects** in

specific domains (e.g., potentially in ion channels or enzymatic activity). Lack of widespread evidence for macroscopic quantum coherence is not evidence of absence for functionally relevant micro-indeterminacy that could be amplified by chaotic dynamics (cf. Noble & Noble, 2018). EIA's core reliance on ontic indeterminacy is robust whether its primary source is classical (FIQ) or quantum.

- *The Libet/Predictability Objection (Neural activity predicts choices before conscious awareness):* The readiness potential (RP) is likely related to stochastic fluctuations in neural activity rather than being a specific determinant of action (Schurger et al., 2012). Subjective timing reports (W-time) are unreliable. The Libet task involves arbitrary choices atypical of meaningful deliberation. Agency is temporally extended, and consciousness may play a role in modulating or vetoing processes already underway rather than initiating them *ex nihilo* (Mele, 2009). fMRI studies predicting choices often predict biases or tendencies with accuracy far below 100%, consistent with probabilistic/indeterministic processes rather than strict determination. Predictability does not necessarily equate to lack of control or absence of free will in an indeterministic framework.

9. Conclusion: Towards a Science of Emergent Freedom in Creative Time

This paper has attempted to suggest a naturalization of free will as what might be termed emergent autonomy, potentially arising from organizational closure, non-equilibrium dynamics, and what we have characterized as harnessed ontic indeterminacy within creative time. This naturalist emergentist framework, tentatively grounded in what we have termed potentiality realism, may offer a potentially plausible alternative to classical views. Agency emerges from biological organization exploiting physical openness, with consciousness as a higher modulator.

This is presented as a possible research program requiring further development. Challenges remain in formal modeling, empirical validation, scaling from minimal to complex agency, and integrating socio-cultural contexts. Advancing this program requires interdisciplinary research focusing on:

- *Formal Modeling & Measurement:* Developing and testing mathematical and computational models that explicitly capture organizational closure, dynamics in creative time (vs. geometric time), the functional harnessing of noise/indeterminacy, and mechanisms of downward constraint (e.g., utilizing frameworks from dynamical systems theory, information theory, causal modeling; Pearl, 2009; Woodward, 2003; Del Santo & Gisin, 2023a).
- *Empirical Validation:* Designing experiments to test predictions of the framework in minimal biological systems (e.g., bacteria, protists), synthetic life models, and

neurobiological studies focusing on decision-making under uncertainty, the role of neural variability, and the neural correlates of agency and consciousness (e.g., Deco et al., 2021; Samoilov et al., 2006; Battaglini et al., 2023; Nakagaki et al., 2000; Lyon, 2015).
- *Philosophical Refinement:* Further deepening the conceptual analyses of emergence, downward constraint, emergent sourcehood, potentiality realism, biological normativity, and the ontological status and implications of creative versus geometric time (e.g., Gisin, 2016; Del Santo & Gisin, 2024a; Ellis, 2016; Moreno & Mossio, 2015).

This framework provides a potential roadmap for understanding emergent freedom not as a supernatural mystery or a mere illusion, but as a complex, graded, natural phenomenon rooted in the fundamental organization of life unfolding dynamically and creatively through time.

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