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On the Neurodynamics of Consciousness: A Field Theory for *Qualia* and Intentional Objects

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Abstract: The problem of consciousness remains one of science's most enduring challenges, particularly the *Hard Problem* — the difficulty of explaining subjective experience and phenomenal content. While modern models correlate brain activity with conscious states, they often lack causal mechanisms to resolve this issue. This work proposes a theoretical framework based on neural mass dynamics and thermodynamics, aiming to resolve the *Hard Problem* by conceptualizing consciousness as a nonlocal phenomenal field modulated by neural energy dynamics. I introduce neurentelechy — a measure of energy dissipation linked to conscious content — and formalize how brain energy organizes *qualia* and intentional objects within a temporally structured virtual framework. Using indexed *qualia* vectors, I develop a mathematical formalism to represent intentional objects and their transformations. The model yields testable predictions grounded in energy-based neural coding, entropy dissipation, and neurodynamic fluctuations, providing a falsifiable framework aligned with computational neuroscience. This approach integrates neuroscience, thermodynamics, and phenomenology, suggesting consciousness as a structural field property of reality, potentially resolving the *Hard Problem*.

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1. Introduction

For centuries, discussions about consciousness were the exclusive domain of philosophy and took forms differing significantly from contemporary conceptions (De Sousa, 2015; Revonsuo, 2010). Historically, these discussions revolved around the terms soul and mind, which, in their most eminent definitions, encompass the characteristics of what modern philosophy calls consciousness (Freeman, 2008; Reale and Antiseri, 2003). Plato and Aristotle already debated what the human soul was and how it related to the material world. For Plato, the human soul was something separate from the body, immaterial and immortal, while for Aristotle, the soul was part of the human form, something that belongs to the body and can only exist through matter (Reale and Antiseri, 2003). Although these philosophers disagreed on the nature of the soul and how it relates to the material body, both attributed to the soul rationality and other aspects associated with the human conscious mind (Reale and Antiseri, 2003). This discussion extended over the centuries, passing through Descartes and, more recently, philosophers such as Place, Nagel, Chalmers, Searle, and Dennett, without reaching a resolution or consensus (Revonsuo, 2010).

The theory of Cartesian dualism, which in some ways represents a return to Plato, gained significant prominence after being defended by René Descartes in the 17th century. Descartes, through his method of hyperbolic doubt, conceived his famous phrase: *Cogito, ergo sum* (I think, therefore I am), and from it constructed an argument to demonstrate that the mind, with its thoughts, is of a nature entirely distinct from the physical body. His view on the mind-body relationship became highly, perhaps the most, relevant in academic debates (Revonsuo, 2010). However, with recent advances in neuroscience, some scientists and philosophers have come to understand that consciousness is, in fact, a fundamentally biological phenomenon, a product of the human brain, something quite close to what Aristotle defended (Revonsuo, 2010; De Sousa, 2015). The doctrine that opposes Cartesian dualism is called physicalism. It is based on this doctrine that, around the 1990s, a science dedicated to solving the "last great philosophical problem", the problem of consciousness, began to take shape (Revonsuo, 2010; De Sousa, 2015).

With the aim of contributing to the development of a science of consciousness based on current knowledge of neurobiology, De Sousa (2015) argues that scholars committed to investigating the problem of consciousness must have answers to the following questions: (1) What is consciousness? (2) How to formulate a theory about consciousness? (3) What methodologies to adopt? (4) What practical consequences might the clarification of consciousness bring? Among these four fundamental questions, the scientist interested in the study of consciousness must first and foremost have an answer to question (1). This is because every serious scientific research has the initial task of defining its object of study.

Consciousness can be defined in various ways, such as the state of being awake, which implies that any organism not asleep or in a coma is considered conscious (Genaro, n.d.). Tononi describes consciousness as the presence of subjective experiences, including perceiving scenes, feeling pain, thinking, or self-reflection (Tononi et al., 2016). Similarly, Revonsuo emphasizes that being alive as a conscious subject goes beyond mere biological existence. Unlike inanimate objects or simple organisms, a conscious being is mentally and internally alive, experiencing its own existence. Revonsuo explains that a conscious being possesses an internal psychological reality, characterized by a continuous flow of subjective experiences that constitute the essence of consciousness (Revonsuo, 2010).

The views of Tononi and Revonsuo on what consciousness is align with those of Thomas Nagel. According to the latter, when someone is, for example, smelling a rose or having a conscious visual experience, there is something that is "perceived" or "felt" subjectively (Genaro, n.d). At times, philosophers refer to conscious states as phenomenal or qualitative states. More technically, philosophers understand these states as having qualitative properties called *qualia* (plural of *quale*). *qualia* are often defined as the felt properties or qualities experienced during conscious states (Genaro, n.d).

In this work, the concept of consciousness reflects the ideas of Tononi, Revonsuo, and Nagel regarding the nature of consciousness, as well as the notion that conscious states possess *qualia*. Based on these ideas about what consciousness is, three fundamental premises can be extracted: (1) The contents of an individual's consciousness are accessible only to the individual themselves; (2) These contents constitute a subjective reality, which presents itself directly and factually to each person; (3) The contents of consciousness are of a nature distinct from brain states.

Thus, for scientists engaged with the problem of consciousness, the central challenge is to answer the question: How does the brain produce, or cause, subjective conscious states endowed with characteristics entirely distinct from brain physiology? This is the problem of brain-consciousness causation, the core of the modern consciousness problem. Chalmers and Levine have identified critical dimensions of this problem that render it particularly intractable. Chalmers frames it as the *Hard Problem* (Chalmers, 1996), while Levine conceptualizes it as the *Explanatory Gap*, as discussed by Revonsuo (2010).

The *Hard Problem* of Consciousness (Chalmers, 1996) questions how physical systems, such as the brain, generate subjective experiences (e.g., pain, self-awareness), given the absence of mechanistic models explaining how neuronal activity produces such phenomena. This challenge is further complicated by the *Explanatory Gap* (Revonsuo, 2010), which highlights the limitations of correlational frameworks. Even rigorous associations between neural patterns (e.g., visual cortex activation) and subjective states (e.g., color perception) lack causal grounding, reducing them to mere descriptive mappings. Revonsuo (2010) posits that identifying invariant neural correlates (Z) for specific conscious states (Q) merely confirms covariation, not causation, leaving the brain-consciousness relationship unresolved, a "logical leap" irreducible to conventional neurobiological principles. While the *Hard Problem* (ontological) and the *Explanatory Gap* (epistemological) emphasize distinct dimensions, both converge on the core challenge of brain-consciousness causation.

Addressing this necessitates identifying the neurodynamic mechanisms by which physiological processes modulate conscious states. In the absence of such a framework, causal claims remain speculative; empirical evidence can only substantiate covariation, not causation (Revonsuo, 2010).

Resolving this age-old problem based on neurobiology would provide science with the theoretical framework necessary to unify the natural sciences with the human sciences. This is because the fundamental object of study in psychology and other human sciences is the human being with their unique characteristics, the most notable of which is consciousness. Some scientists, captivated by the possibility of solving the modern problem of consciousness, have proposed theoretical models that aim to explain how the brain produces conscious states (De Sousa, 2015). The present work extends these approaches by incorporating thermodynamic and relativistic principles, complementing models such as the Global Neuronal Workspace (Dehaene) and Integrated Information Theory (Tononi et al., 2016).

According to De Sousa (2015), the most well-known neural models of consciousness in the literature include: (1) Multiple Drafts (Dennett), (2) Somatic Markers (Damasio), (3) Neurodynamic (Freeman), (4) Global Workspace (Baars), Global Neuronal Workspace (Dehaene), and (5) Dynamic Core (Edelman). While some of these models acknowledge the importance of brain physiology in the emergence of conscious phenomena, their theoretical frameworks are primarily cognitive in nature, as seen in the models proposed by Dennett and Baars. In contrast, other models emphasize neurobiology in their theoretical constructs. Regarding the common features shared by these models, De Sousa highlights five key aspects: (1) the adoption of the concept of information as central; (2) the ontological thesis that the neuron is the basic unit of information processing; (3) the principle of neural interconnectivity; (4) the ontological thesis of brain modularity; and (5) the principle of information distribution across the brain. Additionally, De Sousa notes that all these models implicitly share the physicalist thesis, which posits the brain as a physical entity and the cause of consciousness (De Sousa, 2015).

Walter Freeman's neurodynamic model appears to be one of the most promising regarding the unification of the natural sciences and the human sciences. Freeman provides an original perspective on consciousness that requires the action of physical mechanisms driving brain physiology to enable the emergence of conscious experiences, forming a kind of causal continuum from physics to biology, and then from biology to psychology (Freeman, 2009, 2008, 2001, Freeman et al., 2015, 2003). In his approach, attractors constantly drive the brain toward lower energy states, producing patterns of brain activation that correlate with conscious experiences, detectable through techniques such as EEG (electroencephalography), fMRI (functional magnetic resonance imaging), and PET (positron emission tomography) (De Sousa, 2015; Freeman, 2001). Freeman also asserts that brain neurodynamics are governed by both linear and non-linear equations (Freeman et al., 2015). The concept of neurentelechy builds upon these neurodynamic principles, particularly in relation to dissipative structures (Prigogine, 2002), offering a mathematical representation of energy dissipation in the brain and its potential relationship with conscious experience.

Furthermore, for Freeman, the brain is an open system far from equilibrium and thus describable by Prigogine's theory of dissipative structures (Prigogine, 2002). Applying this theory, it can be said that the brain constantly self-organizes as it receives energy from its external environment, which drives it even further from equilibrium. This energy can come from food, light, mechanical waves, etc. When the brain receives an energy influx that destabilizes it, its activation pattern undergoes a bifurcation. At this moment, the brain's own history and energy fluctuations will cause it to reorganize, adopting one of many possible new structures or collapsing.

It is important to mention that Freeman himself admits he has not been able to postulate a causal mechanism to explain how brain physiology gives rise to conscious states (De Sousa, 2015; Freeman et al., 2015). This stance is commendable; however, unlike him, most other authors do not even bother to propose any causal mechanism. For them, the idea that that the brain causes conscious states is taken as self-evident (De Sousa, 2015). As a consequence, their models are of the type: Z, at which point a miracle happens, then Q. Unfortunately, they focus only on establishing correlations and

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neglect to address the core of the modern problem of consciousness, the *Hard Problem* and the *Explanatory Gap*.

The lack of resolution for this core issue demonstrates that there is still much work to be done in order to solve the problem of consciousness. New scientific research focused on discovering the causal mechanisms of conscious states needs to be conducted. Only with these mechanisms well-described and tested through experimentation will it be possible to establish a general neuroscientific theory of consciousness.

The following subsections will present the foundational themes of this work. Subsection 1.1 will address intentionality and *qualia*, and in subsection 1.2, Albert Einstein's theory of special relativity will be introduced in a summarized and simplified manner, as it is central to the theoretical model proposed in this work.

1.1. Intentionality and Qualia

The concept of intentionality in the philosophy of mind dates back to medieval scholastic philosophers and is a technical notion with little to no relation to the colloquial concept of intention (Gunttenplan, 1994; Lyons, 1995; Mandik, 2010; Rakova, 2006). In the medieval approach, a distinction was drawn between (1) *esse naturale*, referring to natural existence, such as that of a mountain or a flower, and (2) *esse intentionale*, denoting intentional or mental existence, such as a thought or mental image. Regarding the latter, the term *intentionale* derives from the Latin root *intentio*, which can be roughly translated as "to have an idea" or "directing attention in thought" (Lyons, 1995).

In the 19th century, the German philosopher Franz Brentano reintroduced the term into the philosophical mainstream. According to his conception, intentionality is the hallmark of the mental, characterized by the mind's directedness toward intentional objects, the real or imagined contents to which the mind can be directed (Gunttenplan, 1994; Mandik, 2010; Rakova, 2006). This means that mental acts, such as thinking and believing, always possess content: thinking is always about something, just as belief is always about something. The mind's directedness toward an object is semantically marked by this "aboutness". Intentional mental acts always involve content.

Linked to intentionality is the concept of intentional states, which are mental states or functions that contain intentional objects. These states include thoughts, beliefs, desires, emotions, etc. (Gunttenplan, 1994; Rakova, 2006). In the sentence, "John thinks about Mary", the intentional state is the thought, and the intentional object is Mary. The same pattern applies to "Ivan wants to eat pizza", where the intentional state is the desire to eat, and the intentional object is pizza. In both examples, the minds of John and Ivan are directed toward an object, they exhibit intentionality and intentional objects, yet the type of mental experience differs. Thinking is not the same as desiring. One can feel a desire without thinking about the desire itself, just as one can think of countless objects or beings, from personal desires to fantastical entities like unicorns or werewolves.

Intentionality, as defined above, relates directly to the concept of consciousness. Conscious mental states exhibit directedness toward intentional objects (though not always). However, intentional states are not necessarily conscious (Gunttenplan, 1994). This aligns with the Freudian concept of the unconscious, which consists of mental states that exist but are not conscious (Revonsuo, 2010). The existence of unconscious intentionality is evident when considering that a person need not actively think about a belief to hold it. A sleeping person, or someone awake imagining the Tooth Fairy playing a harp for Santa Claus, may simultaneously believe in Jesus, Muhammad, or Buddha.

Over time, some authors have advocated reductionist approaches to intentionality (Gunttenplan, 1994). With the rise of behaviorism in the last century, attempts were made to equate intentional states to mere dispositions for behavior caused by environmental or internal stimuli (Gunttenplan, 1994; Revonsuo, 2010). Its founder, John B. Watson, argued ideologically that science should rely solely on directly and publicly observable data. Consequently, he concluded that consciousness could not be a scientific object of study, as conscious phenomena are not publicly observable. For Watson, such phenomena could not be understood in purely physical terms, relegating them to metaphysical entities outside the scope of science. In his view, psychology should study only public behavior and discard "metaphysical" concepts, as he deemed them, such as desire, volition, feeling, and thought (Revonsuo, 2010). Thus, addressing intentionality as traditionally defined by medieval scholars and Brentano would be unscientific.

Another reductionist approach to intentionality emerged from functionalism, regarded as one of the most significant frameworks for the mind-body problem, as it represented the first academic attempt to resolve it objectively. Functionalists criticized behaviorists for denying the mind's existence and replacing it with behaviors and behavioral dispositions (Gunttenplan, 1994).

According to U.T. Place, behaviorism produced an "intractable residue" of conscious phenomena by denying their reality, a nonsensical stance, given that every mentally sound human can perceive and describe their own thoughts, feelings, etc. (Gunttenplan, 1994; Place, 1956). The existence of these phenomena is evident in acts of thinking, feeling, and formulating arguments like this one; denying them is to deny reality itself.

For functionalists, the mind results from interactions between external stimuli and behavioral responses (Gunttenplan, 1994; Revonsuo, 2010). Mental states, in the functionalist model, are seen as functions of an information-processing system (Revonsuo, 2010). Within this framework, intentionality is understood in terms of causal relations: it is what causes mental states through external stimuli and, in turn, causes behavior (Gunttenplan, 1994). Functionalism introduced the computer analogy, likening the mind to software and the brain to hardware. Some functionalists claim that stimulus-response interactions are formally equivalent to algorithms the brain uses to determine responses to stimuli (Revonsuo, 2010). This idea is known as strong artificial intelligence or computational functionalism (Chalmers, 1996; Gunttenplan, 1994).

Like behaviorism, functionalism also has flaws. Its primary weakness, shared with behaviorism, is its reductionism, which strips away seemingly obvious characteristics described in classical definitions of mind and intentionality (Gunttenplan, 1994). Thus, neither model resolves the mind-body problem nor offers a valid naturalistic solution to the medieval and Brentanian concept of intentionality. Interactions between stimuli and responses cannot equate to thoughts, feelings, or other mental states, as mental states possess qualities (*qualia*), such as the sensation of red, pain, saltiness, sweetness, bitterness, pleasure, etc. (Mandik, 2010; Rakova, 2006; Revonsuo, 2010). One cannot open a brain and locate a quality. *Qualia* elude reductionist attempts the mind and intentionality. Intentional objects possess *qualia*, and for this reason, reductionist approaches to intentionality also fail.

Revonsuo (2010) emphasizes the indispensable role of *qualia* in consciousness, arguing that subjective experience would cease to exist without them. He describes *qualia* as the foundational elements of the "subjective stream" of psychological life, constituting the internal world of human consciousness. According to Revonsuo, *qualia* exhibit distinct characteristics: they vary in intensity (e.g., faint sounds versus vivid colors), are perceived within specific spatial and temporal contexts, and persist dynamically before fading from awareness. This temporal and perceptual dimensionality underscores their irreducibility to purely physical or functional terms (Revonsuo, 2010).

This work adopts physicalism as a premise, much like the behaviorists and functionalists did, but in a distinct approach from these two. In the following subchapter, a brief explanation of the theory of special relativity will be presented, which will be used in subsequent sections to propose a resolution to the *Hard Problem*.

1.3. Relativistic Inspiration

In 1905, Albert Einstein published his seminal paper "On the Electrodynamics of Moving Bodies" (Einstein, 1905). In this work, he introduced to the academic world the theory now known as special relativity (or restricted relativity). This theory should not be confused with the theory of general relativity, also authored by Einstein but published approximately a decade later (Einstein, 1952).

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Special relativity is limited to describing the behavior of objects moving relative to inertial frames of reference, and is based on two postulates: (1) The laws of physics are the same in all inertial frames of reference, e (2) The speed of light is the same in all inertial frames of reference (Einstein, 1952; Rindler, 2011). In Newtonian theory, time is absolute (or universal), meaning the passage of time is the same in all possible frames of reference. This idea contradicts the second postulate of special relativity. If the speed of light is the same in all inertial frames of reference, it is impossible for the passage of time to always be the same in all such frames (Rindler, 2011).

This becomes clear when imagining two observers: one inside a train moving uniformly at 40 km/h and another standing still outside the train. In Newtonian physics, if the observer inside the train measured the speed of a light beam emitted by themselves in the direction of the train's motion as C km/h, the observer outside the train would measure the speed of the same light beam as C + 40 km/h. However, in Einsteinian physics, the speed of light cannot vary under the same circumstances, meaning both observers would measure the speed of light as the same. Since the speed of light cannot vary in special relativity, something else must vary in the described situation, and Einstein proposed that this "something" is time and space. For Einstein, time dilates and space contracts as bodies move relative to one another (Einstein, 1905). While this conclusion by Einstein served as an initial conceptual guide, the model has since evolved into a more robust ontological formulation. The non-spatial nature of *qualia* no longer depends on relativistic space-time distortions, but is now accounted for by treating consciousness as a nonlocal phenomenal field modulated by neural activity. Thus, while relativistic principles inspired the initial framework, the model now operates within a self-consistent field-theoretical ontology independent of spacetime geometry.

2. Neurentelechy

Neurons, like any other cell type, need to produce large amounts of energy to maintain their functions. To achieve this, cellular metabolic processes convert energy substrates into usable units, ensuring the sustenance of neuronal activities. During this process, a gradient is generated that drives ion transport, enabling the production of energy in large quantities. Through these processes, brain cells generate an energy reserve, which, via specific ion transport mechanisms, makes it possible to maintain the resting potential across neuronal membranes. Upon receiving appropriate signaling, neurons fire action potentials, which can alter the activity patterns of the entire brain. It is through the firing and propagation of these action potentials that brain activity patterns correlated with conscious experiences are formed.

As the available energy is expended to restore the membrane potential of neuronal axons, additional energy must be generated to sustain the brain's functions. This process causes the brain to oscillate over time between different energy states. At times, the brain increases its energy reserves; at other times, it depletes them. Since energy expenditure is required for the firing and propagation of action potentials, it is expected that conscious experiences occur when the brain is expending energy, or at the point immediately following an energy expenditure phase and immediately preceding an energy production phase. The following equation provides a theoretical description of the energy expenditure required for brain activity to be associated with the emergence of a conscious experience:

$$N_\alpha = Q_{t+1} - Q_t + Q_\lambda (1)$$

This equation measures the absolute neurentelechy[1] (N_α) between two adjacent time points. The variable N_α refers to the energy associated with the emergence of a conscious experience, whether *quale* or intentional object. Q_t is the amount of the Q (energy) in a time (t), Q_{t+1} corresponds to Q in an

1 Combination of the terms neuron and entelechy; conveys the metaphorical idea of the entelechy of neurons. In Aristotelian philosophy, entelechy was the act, or the perfection of a body achieved through the transformation of potentiality into actuality (Reale and Antiseri, 2003). Thus, the metaphor of neurentelechy represents the idea of neurons reaching their perfect potential, which is to produce consciousness.

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even time after t, e Q_λ represents the Q of the background activity[2]. In this work, time zero (the origin) is arbitrarily defined as having lower energy than time one, leading to the implication that odd-numbered time points possess greater energy than even-numbered ones. This reflects the brain's energetic oscillation. As a result of this equation, the value of N_α will be a negative number, corresponding to the loss of brain energy associated with the initiation and propagation of action potentials, that is, the performance of work capable of triggering the emergence of some content of consciousness. To demonstrate how the presented equation works, consider the fictitious values in Table 1.

Table 1. Values to demonstrate how equation (1) works.

	Q_{t+1}	Q_t	Q_λ
Exemplo 1	30	100	30
Exemplo 2	70	100	30
Exemplo 3	70	100	35

With the values from Example 1, the result of the equation is as follows:

$$N_\alpha = 30 - 100 + 30 (1.1)$$

$$N_\alpha = -40$$

Using the values from Example 2, the result of the equation is:

$$N_\alpha = 70 - 100 + 30 (1.2)$$

$$N_\alpha = 0$$

And for the values of Example 3, this is the result:

$$N_\alpha = 70 - 100 + 35 (1.3)$$

$$N_\alpha = 5$$

As neurentelechy corresponds from a type of energy expenditure, of the 3 results presented for equation (1), the only one in which neurentelechy occurs is in (1.1). In the other results, the values found are 0 or 5 (positive number), indicating the non-occurrence of neurentelechy. Thus, for neurentelechy to occur, the following requirement must be met:

$$Q_t > Q_{t+1} + Q_\lambda (1.4)$$

In this model, all energetic terms — including Q_α, Q_ω, N_α, and S — are treated as dimensionless or expressed in arbitrary units. This convention aligns with standard practices in theoretical neuroscience and neural mass modeling, where the focus lies on relative variations in system dynamics rather than on absolute physical magnitudes. Although the formalism draws inspiration from thermodynamic and physical principles, it is embedded within a phenomenological framework aimed at capturing the informational and structural properties of brain–consciousness coupling. As such, explicit physical units (e.g., joules or watts) are not assigned, and their absence reflects a deliberate abstraction to preserve conceptual generality, mathematical tractability, and cross-domain applicability.

3. Bipartite Reality and the Neurodynamic Code

Neurentelechy can describe how the brain's dynamics make it possible to perform work within consciousness. To ensure clarity for readers from different disciplines, the mathematical formalism will be introduced step by step, with explanatory examples. However, the mechanism by which the energy dissipated in the form of action potentials is converted into a form usable by consciousness

2 All brain energy expenditure is not directly related to conscious experience, that is, related to other functions such as involuntary movements, homeostasis regulation, etc.

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remains an open question. To contribute to solving this issue, consider the following thought experiments:

(1) Think of someone you love! Now, locate where in space your thought is situated! Where is it? At what point in space can the feeling of love be located?

(2) Reflect on what you were thinking before reading this sentence. Can you recall what you were thinking about 10 minutes ago?

The results of these experiments reveal something profound about the nature of conscious content. While it is possible to assert that a particular brain area is responsible for a certain thought, it is not possible to claim that thoughts are actually located at the spatial point where these regions exist. The possibility of spatially locating a cause does not imply the possibility of spatially locating its effect. This suggests that consciousness is not situated at any point in spatial dimensions. However, the fact that it is possible to temporally locate thoughts, even if imprecisely, conclusively shows that the phenomena of consciousness occur in time. These results support the inference that consciousness can be modeled as a nonlocal phenomenal field whose dynamic configurations correlate with patterns of neural activity. While subjective experience lacks spatial coordinates in the physical sense, the field itself appears to interact globally with the brain's energetic landscape.

This work proposes the principle of bipartite reality as an explanation for the temporal occurrence of consciousness. According to this principle, reality is divided into two partitions: (1) *Real Space*, and (2) *Virtual Space*[3]. What characterizes real space is the presence of both time and space. Therefore, the objects located within this partition are objects that can be located in both the spatial dimensions and the temporal dimension. In contrast, in virtual space lie objects that occur solely in time. According to the bipartite reality principle, consciousness is not contained within the real space of the brain, but in its virtual space. This interpretation aligns with philosophical discussions on intentionality while providing a physicalist framework that connects neurodynamic processes with phenomenal consciousness. Although this bipartite principle was initially inspired by relativistic considerations, it is now interpreted as a representational tool. The notion of virtual space is reframed as a descriptive abstraction of a nonlocal consciousness field, rather than as a literal physical domain devoid of spatial dimensions.

The development of this model began with insights drawn from Einstein's theory of special relativity, particularly his demonstration of how relative motion fundamentally links space and time, showing that as an object's speed increases, time dilates while space contracts in the direction of motion (Einstein, 1905). This profound interdependence suggested that similar relationships might operate at different physical scales, including in biological systems. The original hypothesis proposed that the brain's energy dissipation patterns could generate analogous space-time modulations at quantum or thermodynamic scales, creating subtle but significant distortions that might influence conscious experience. These theoretical space-time perturbations were envisioned as operating through temporal rather than spatial dimensions, potentially explaining how consciousness could emerge as a physically-grounded yet non-spatial phenomenon. This relativistic inspiration crucially established several foundational principles: that conscious experience need not be spatially localized to be physically realized, that energy dynamics play an essential mediating role between neural activity and phenomenology, and that temporal structure represents a fundamental characteristic of subjective experience. While these core insights remain valid and have been preserved in the model's current formulation, the specific mechanism of space-time distortions has been superseded by a more comprehensive field-theoretical framework. The updated version replaces the original virtual space concept with a physically-grounded phenomenal field interacting with neural processes, transforms the space-time modulation hypothesis into a direct field-neural coupling paradigm, and generalizes the energy-based approach into a unified theory of consciousness as a fundamental property of

3 Virtual space is space in potential. Virtual space is not space as defined by physical science. One cannot speak of width, length, or depth of objects present in this space. Virtual space is space in the sense of partition or compartment.

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reality. This theoretical evolution mirrors the progression seen in physics itself, where earlier heuristic models give way to more complete formulations, while preserving their foundational conceptual insights into the nature of phenomena.

Building upon the Einsteinian ideas that originally inspired this work and the bipartite reality principle, the initial formulation proposed that energy dissipation in neural processes could generate subtle spacetime modulations capable of influencing consciousness. The original argument maintained that if conscious contents exist primarily in the temporal dimension (as their phenomenology suggests), and if neural activity produces spacetime metric effects (following Einstein's demonstration that energy warps spacetime), then action potentials might modulate consciousness through temporal distortions. This line of reasoning, though now reformulated in terms of field interactions, first revealed how consciousness might emerge from yet transcend neural spatial organization.

The model further proposed that if such space-time distortions could modulate consciousness, there must exist a neurodynamic code transmitted via neurentelechy. In the original framework, this code took the form of energetic signatures in virtual space that were interpreted by the mechanisms of consciousness to generate content. While the current field-theoretical formulation has replaced these specific mechanisms with more fundamental field interactions, the essential concept of information-bearing energy patterns (neurentelechy) mediating between brain and experience remains central to the model's architecture.

The general equations of neurentelechy are based on equation (1). In this equation, absolute neurentelechy can be classified as either primary matrix type or secondary matrix type. Now, consider the general equations:

$$M_\alpha = \sum_i^n N_{\beta_i} \quad (2)$$

$$M_\beta = \sum_i^n M_{\alpha_i} \quad (3)$$

M_α refers to the value of the primary matrix neurentelechy, and M_β to the value of the secondary matrix neurentelechy. N_β is the basal neurentelechy associated with a single matrix position. In both equations, the results will be negative. This occurs due to the following equation:

$$N_\beta = Q_{\beta_{t+1}} - Q_{\beta_t} + Q_{\beta_\lambda} \quad (4)$$

The variable Q_{β_t} represents the amount of energy of the matrix position in t, $Q_{\beta_{t+1}}$ is the amount of energy of the matrix position in t +1, e Q_{β_λ} is the Q of background activity. From equation (4), consider the development of the general equations (2) and (3), respectively:

$$M\alpha = \sum_i^n \left(Q_{\beta_{t+1}} - Q_{\beta_t} + Q_{\beta_\lambda}\right)_i \quad (5)$$

$$M_\beta = \sum_k^{n'} \left(\sum_i^n \left(Q_{\beta_{t+1}} - Q_{\beta_t} + Q_{\beta_\lambda}\right)_i\right)_k \quad (6)$$

From equations (5) and (6), it is possible to determine the neurentelechy associated with the code of a content of consciousness. Therefore, the values of M_α and M_β are important for understanding the thermodynamic relationship between the brain and consciousness, as they represent the energy associated with the causation and the propagation of space-time distortions resulting from brain neurodynamics.

To understand the neurodynamic code, it is useful to imagine a system composed of two perfectly superposed and inseparable flexible sheets (Figure 1). The lower sheet represents real space, and the upper sheet represents virtual space. Thus, whenever an elevation appears on one of the sheets, it must also appear on the other at the exact equivalent points. By imagining several of these elevations arising over time from events occurring in the real space sheet, one could observe a landscape in the system full of elevations and flat spaces. This topology is analogous to a neurodynamic code matrix, and each elevation is analogous to a N_β. Therefore, the neurodynamic code for a content of consciousness is like a photograph, updated at each moment, of this transient landscape.

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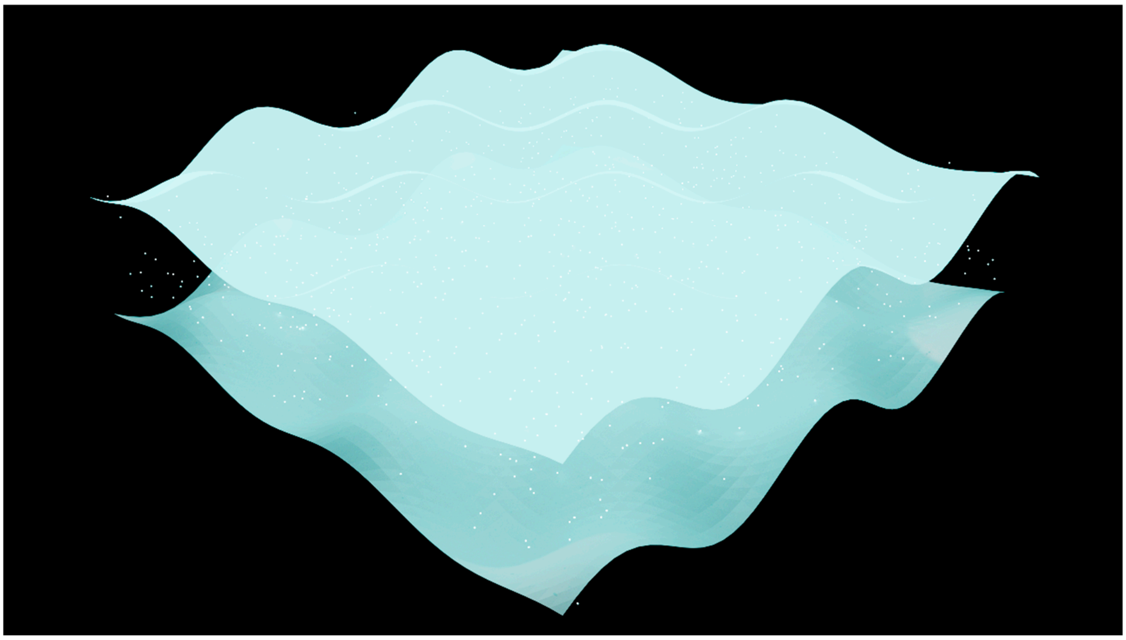

Figure 1. Schematic representation of the original bipartite reality framework, showing the proposed coupling between neural processes and conscious experience. The lower surface depicts real space (neural activity in physical spacetime), while the upper surface represents virtual space (the domain of conscious phenomena). In this initial formulation, particle movements in real space were theorized to produce spacetime distortions that induced corresponding modulations in virtual space, thereby organizing *qualia* into intentional objects. This conceptual model provided the foundation for the current field-theoretical framework, where these interactions are now understood as direct couplings between neural energetics and a nonlocal phenomenal field.

4. Qualia Vectors: The Driving Force of Consciousness

Intentionality, or the capacity of the mind to direct itself toward real or imaginary intentional objects, can be understood as a resultant force. In this perspective, intentionality is the result of the integration of several *qualia* within virtual space. *Qualia* vectors are the forces that direct consciousness toward *qualia*.

In this model, *qualia* are both the qualities described by philosophers of mind and the basic units of intentional objects that cannot be described as *qualia* in their strict philosophical sense. Once we consider all the parts that make up an intentional object as *qualia*, the possibility of decomposing intentional objects is evidenced by imagining a small red ball with the smell of strawberry (an intentional object). In this case, the intentional object is composed of at least two *qualia*: (1) the sensation of red and (2) the sensation of the smell of strawberry. These *qualia* triggered by sensory stimulation caused by the ball make up the intentional object. Therefore, if intentional objects are made of *qualia*, and intentionality is the direction of consciousness toward intentional objects, then intentionality is the resultant of the synergistic action of various *qualia* vectors.

If these conclusions are correct, then primary matrix neurentelechy acts as the fuel for *qualia* vectors, and secondary matrix neurentelechy as the fuel for intentionality. Thus, the energy present in real space in the form of neurentelechy is directly coupled to the phenomenal field, generating *quale* energy (Q_q) or intentional energy (Q_o), in the virtual space. The equations that describe these conversions are:

$$Q_q = (-1)(M_\alpha + S)(7)$$
$$Q_o = (-1)\left(M_\beta + S\right)(8)$$

The variable S represents entropy. During the space-time distortion process triggered by brain activity, it is expected that part of the energy will be converted into entropy. Therefore, it can be inferred that the remaining energy is used in the virtual space a Q_q and/or Q_o. Based on these equations and equation (1), consider then:

$$Q_\omega = (-1)(N_\alpha + S)(9)$$
$$Q_\alpha = Q_{t+1} - Q_t(10)$$

Q_ω represents the energy present in the virtual space associated with the emergence of any content of consciousness, whether a *quale* or an intentional object. Q_α is the total energy – neurentelechy and background activity – expended by the brain associated with the emergence of a conscious experience. Considering equations (1), (9), and (10), the following equation can be obtained:

$$Q_\omega = (-1)(Q_\alpha + Q_\lambda + S)(11)$$

This is referred to in the present work as the general thermodynamic equation of the bipartite reality. Through equation (11), it is possible to describe the conversion of energy associated with the real space to energy associated with the virtual space.

The hypothetical neurodynamic code can be understood as a matrix code, where each position in the matrix is a value of neurentelechy correlated with a local space-time distortion caused by the neurodynamics of an arbitrary brain region. A set of matrix positions forms a matrix, which contains the neurodynamic code of a content of consciousness[4]. These contents can be encoded by a primary matrix, or by a secondary matrix, which is a matrix formed from the combination of two or more primary matrices. The primary matrices encode *qualia*, and the secondary matrices encode intentional objects. Each of the possible matrices has an associated amount of neurentelechy. For primary matrices, the neurentelechy is primary matrix neurentelechy, and for secondary matrices, the neurentelechy is secondary matrix neurentelechy. Both types of neurentelechy result from the association of several basal neurentelechies associated with matrix positions.

5. Formalism for Simple Intentional Objects

In order to apply the bipartite reality model and test it empirically, a mathematical formalism for intentional objects is required. This work will focus solely on simple intentional objects, while future studies will address complex intentional objects. A simple intentional object is defined as a mental entity that can contain only one state per *quale* category, whereas a complex intentional object may have multiple states in each category. This means that a simple intentional object cannot, for instance, be simultaneously blue and yellow; it can only be blue with a certain intensity. This simplification facilitates the theoretical modeling and analysis of conscious contents.

An intentional object O can be represented as a vector in a vector space R^n, where n denotes the total number of possible *qualia*. Each dimension of the vector correspond to a *quale* type, with the associated scalar value denoting its intensity. The intensity of different *quale* types is represented by the vector α, which determines the magnitude of q, according to the equation:

$$O = \sum_c \sum_i \alpha^c \, \delta_i^c q_i^c \quad (12)$$

where c represents the *quale* category (e.g., "color", "shape"), and i is the index of a specific *quale* within a category (e.g., "red" or "blue" in the "color" category). Additionally$\delta_i^c \in \{0,1\}$acting as a binary selector, it selects only one *quale* per category, with 1 representing an active *quale* and 0 an inactive *quale*. The intensity is a value that can range between 0 and 1.

Based on this definition, three basic operations can be proposed to describe how intentional objects change within the virtual space: (1) Intensification, where the intensity of a *quale* is modified; (2) Transformation, which allows the substitution of one *quale* for another within the same category; and (3) Recombination, which adds or removes a category of *qualia*, enabling the intentional object to have more or fewer *qualia*. The equations for these operations are presented below, respectively:

$$O' = \sum_c \sum_i (\alpha^c + \Delta\alpha^c)\, \delta_i^c q_i^c \quad (13)$$
$$O' = \sum_c \sum_j \alpha^c \, \delta_j^c q_j^c \text{with} \delta_i^c \delta_j^c = 0 \quad (14)$$
$$O' = O + \sum_{c'} \sum_k \alpha^{c'} \, \delta_k^{c'} q_k^{c'} \text{with} c' \notin \{c\} \quad (15)$$

4 In this work, the number of rows and columns in a matrix associated with a content of consciousness will not be specified. What truly matters here is the concept of several values composing a table, forming a type of code.

where, in Equation 13, there is no summation over *c*. The idea here is that, at each time interval, some of these operations may occur, modifying the contents of consciousness and allowing its flow. These equations therefore capture, in a simplified yet structured manner, the fundamental dynamics of the virtual space, that is, of the human conscious mind.

Once the mathematical operations of virtual space have been described, it becomes necessary to establish their connection with real space, grounding the abstract structures of *qualia* and intentional objects in physically measurable quantities. To this end, a dynamic formulation is introduced to describe how energy flows from real to virtual spaces through intentional structure, without assuming thermodynamic equilibrium or stationary conditions. The approach adopted here is formally grounded in the tradition of neural mass models, which describe the mean-field dynamics of neuronal populations through differential equations. The use of this framework is intended to ensure compatibility with existing computational paradigms and to facilitate the implementation of simulations and the design of experimental validation protocols.

The basis of this connection lies in the transformation principle previously expressed in Equation 11, which establishes the relationship between the energy dissipated in real space and the energy manifest in the virtual space. Differentiating that equation with respect to time yields:

$$\frac{dQ_\alpha}{dt} = (-1)\left(\frac{dQ_\omega}{dt} + \frac{dQ_\lambda}{dt} + \frac{dS}{dt}\right) \quad (16)$$

In this equation, Q_α denotes the energy dissipated by neural activity in real space. Q_λ corresponds to the energy involved in non-conscious, yet functionally relevant, neural processes, and S refers to entropy associated with functional disorganization or diffusion within the system. The term Q_ω, in turn, represents the energetic content of the virtual space, and its time evolution must be defined with reference to the intentional structure active at each moment.

The emergence of conscious content is modeled as a nonlinear function of the sensory input qualified by the intentional vector:

$$\frac{dQ_\omega}{dt} = (1 + exp[-(\sum_c \sum_i \alpha^c\, \delta_i^c Q_i^c + \eta_t)])^{-1} \quad (17)$$

Here, Q represents the energy associated with the *quale* indexed by i and c — that is, the energetic cost, in the real space, of instantiating a particular *quale* in the virtual space. The sigmoidal form reflects the probabilistic and saturating nature of conscious emergence, while the stochastic component η_t allows for fluctuations in the selection of *qualia* under similar energetic and structural conditions.

Substituting Equation 17 into Equation 16 yields the following expression for the rate of energy dissipation in real space:

$$\frac{dQ_\alpha}{dt} = (-1)\left((1 + exp[-(\sum_c \sum_i \alpha^c\, \delta_i^c Q_i^c + \eta_t)])^{-1} + \frac{dQ_\lambda}{dt} + \frac{dS}{dt}\right) \quad (18)$$

Equations 16 through 18 describe a minimal neural mass model based on energy dynamics, in which intentional structure governs the emergence of phenomenal content, and this emergence is energetically constrained by neural dissipation, non-conscious processing, and entropy production. The adoption of a neural mass model formalism allows this theoretical structure to be aligned with contemporary computational neuroscience, offering a mathematically tractable and numerically implementable set of equations suitable for simulations and predictive modeling.

The formalism introduced offers a mathematically consistent approach to modeling simple intentional objects, combining *qualia*-based structure with a neurodynamic framework derived from energy dissipation principles. By treating intentional configurations as modulators of energetic flows within a neural mass model, it becomes possible to express the emergence of conscious content in terms of physically grounded variables. This integration provides a quantitative pathway between phenomenological organization and measurable neural dynamics.

The structure of the model is amenable to empirical investigation and computational simulation. Functional neuroimaging techniques such as fMRI, EEG, and MEG may be employed to assess whether variations in neural energy dissipation correspond to shifts in intentional configuration as predicted by the dynamics of Q_α. Psychophysical studies may further examine whether changes in perceptual intensity correlate with modulation patterns encoded in the intentional vectors. Additionally, computational implementations based on Equations 16 through 18 can be used to simulate the emergence and evolution of activation patterns consistent with the properties of simple intentional objects.

While currently limited to simple configurations — each containing at most one *quale* per category — the framework supports future generalizations to complex intentional objects, including multiple simultaneous *qualia*, hierarchical structures, and recursive transformations. This initial model focuses on simple intentional objects and foundational thermodynamic relations. Future work will generalize the framework to incorporate memory processes, multisensory integration, and operational definitions of entropy (S), aiming for tighter physiological correspondence. Combined with advances in empirical methodologies and modeling strategies, this approach represents a foundational step toward the construction of a formal neuroscientific theory of consciousness. The broader conceptual and empirical implications of this proposal will be explored in the following section.

6. Discussion

The initial bipartite reality hypothesis represented a conceptual breakthrough in addressing the *Hard Problem* of consciousness and the *Explanatory Gap*, by overcoming the limitations of conventional neuroscientific models that restrict themselves to correlations between neural activity and conscious states. While models such as Freeman's neurodynamic model (2001) describe oscillatory patterns associated with consciousness, and the Global Workspace theory (De Sousa, 2015) focuses on information integration for conscious access, both fail to explain how physical processes produce subjectivity.

The trajectory of this model mirrors theoretical advances in physics: just as Einstein's relativity subsumed Newtonian mechanics while preserving its empirical successes, the field-theoretical framework subsumes the original bipartite hypothesis. The early reliance on space-time metaphors served a pivotal role in shaping the model's causal structure, but the nonlocal field ontology now provides a more robust and empirically addressable foundation

This transition from a relativistic-inspired mechanism to a field-theoretical ontology preserves the original model's core insights while generalizing its physical foundations. Originally, the present model proposed a causal mechanism grounded in three pillars: brain thermodynamics, special relativity, and dissipative neurodynamics. However, it has since evolved into a more robust and coherent structure, abandoning its dependence on relativistic interpretation in favor of a field-theoretical ontology. In this refined framework, consciousness is conceived as a nonlocal phenomenal field modulated by neural activity. The concept of neurentelechy remains central, now reinterpreted as the energy involved in the coupling between the brain and the conscious field. The earlier assumption that consciousness arises in a temporal virtual domain, independent of spatial dimensions and modulated by space-time distortions from brain energy dissipation, is now reframed. The "virtual space" becomes a functional abstraction that represents configurations of the conscious field, rather than a literal ontological partition. This reinterpretation dissolves the need to invoke a collapse of spatial dimensions and aligns the model with known principles of field interaction.

Freeman's (2001) neurodynamics serves as a basis, as both models share the premise that energy oscillations and brain self-organization are central to consciousness. The mathematical framework developed here (e.g., Equations 1, 7–11, 16–18) captures how energetic patterns relate to the evocation of *qualia* and intentional states. The framework assumes that the emergence of conscious content is driven by specific energy transformations associated with intentional structures and neuronal dynamics. This opens immediate empirical possibilities: neuroimaging techniques like fMRI and MEG may be able to test whether fluctuations in energy dissipation correspond to changes in the content or intensity of conscious experience, supporting the field modulation hypothesis. The model, despite its theoretical advances, presents some limitations. First, it does not yet account for the role of memory, despite indications from neuroepigenetic studies (Miller & Sweatt, 2007) and integrative models (De Sousa, 2009) that memory is crucial for autobiographical and long-duration conscious states. Second, the model is limited to simple intentional objects, not yet extending to multisensory integration (e.g., simultaneity of color, sound, and texture). Third, while the model is thermodynamically grounded, direct measurement of interaction between neural activity and a nonlocal field remains technologically challenging.

From the standpoint of philosophy of science, the model gains robustness through its falsifiability. In line with Popper (1959) and Lakatos (1980), it makes the following testable predictions:

1. *Neurentelechy*: Direct measurement of brain energy gradients during conscious experiences can confirm or refute the existence of this specific energy. If experiments fail to detect energy fluctuations correlated with the emergence of *qualia*, the neurentelechy hypothesis would be undermined.
2. *Neurodynamic code*: The identification of matrix patterns in neuroimaging associated with specific *qualia* would validate the existence of a neurodynamic code. The absence of such patterns in empirical studies would be a strong counter-argument.
3. *Validity of mathematical operations* (Equations 13-15): The equations for intensification, transformation, and recombination assume that changes in *qualia* follow specific mathematical rules. Computational simulations or psychophysical tests could verify whether changes in perceptual intensity (Equation 13) or substitution of *qualia* (Equation 14) correspond to subjective reports. Discrepancies between mathematical predictions and empirical data would invalidate the proposed formalism.
4. *Neurodynamic connection* (Equation 18): This equation predicts that excitatory neural activity is modulated by the intensity of *qualia*. Neuroimaging experiments (e.g., fMRI, EEG, or MEG) could correlate brain activation patterns with variations in *qualia*. The absence of correlation or neural dynamics incompatible with the equation would refute the proposed connection.
5. *Excess entropy dissipation during conscious states*: If the conscious field is ontologically real and interacts with neural processes, then this interaction must be accompanied by physical consequences. According to thermodynamic principles, all physical interactions result in changes in entropy. Thus, the model predicts that the total energy dissipated during conscious processing should exceed the expected baseline of energy consumption attributable solely to internal neuronal activity. Empirical verification of anomalous entropy production — for instance, via calorimetric or high-resolution neuroenergetic measurements — would provide indirect support for the field interaction hypothesis. Failure to detect such excess dissipation, within statistically significant margins, would falsify the prediction and challenge the proposed coupling mechanism between brain and conscious field.

These falsifiability points make the model scientifically valid, according to the criteria of Popper (1959) and Lakatos (1980). The earlier formulation of a bipartite reality — in which consciousness was assigned to a temporally structured but spatially collapsed domain — is now reinterpreted not as an ontological claim, but as an operational abstraction. This conceptual device was instrumental in bridging early theoretical gaps, but the current field-theoretical model replaces it with a more coherent ontological foundation. Even so, the bipartite formulation retains heuristic value and exemplifies the kind of bold theorizing required to challenge established assumptions about the spatial localization of consciousness and the causal architecture linking brain and experience. If validated, the model could not only contribute to solving the *Hard Problem*, but also redefine the relationship between matter and mind. If refuted, its legacy will lie in the courage to confront long-standing theoretical impasses, following the example of paradigm-breaking thinkers such as Einstein.

However, as proposed by Lakatos (1980), even if some hypotheses of the model are refuted, this does not necessarily imply the complete rejection of the theory. Instead, such refutations may lead to adjustments in auxiliary assumptions, allowing the theoretical core to be preserved and refined. This continuous refinement process is essential for scientific progress, especially in complex fields like consciousness. Regardless of its empirical outcome, the model opens new frontiers for the science of consciousness, inviting the academic community to explore, and perhaps rewrite, the boundaries between the physical and the phenomenal.

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This model also opens the possibility of interpreting consciousness not merely as an emergent phenomenon, but as a fundamental property of reality — a nonlocal phenomenal field akin to physical fields such as the Higgs field. This is advanced as an ontological postulate rather than a directly testable empirical hypothesis: consciousness is conceived as a structural feature of spacetime, modulated — but not generated — by brain dynamics. This postulate is central to the internal conceptual coherence of the theoretical framework, as it accounts for the non-spatial yet temporally localizable nature of *qualia*, and for the fact that the brain modulates rather than produces conscious contents *ex nihilo*. In this view, the conscious field functions as a minimal ontological substrate upon which neurodynamic codes — mathematically formalized in the model — act to shape subjective experience. Despite its ontological character, the formulation leads to testable predictions: according to the model, any interaction between neural activity and the conscious field must generate a measurable increase in entropy, exceeding the dissipation predicted by conventional neurophysiological models. This prediction, explicitly detailed in falsifiability point 5, constitutes a critical test of the theory. In Lakatosian terms, it targets the hard core of the research programme — the postulated existence of a phenomenal field — and thus plays a decisive role in evaluating the scientific progressivity of the model. If verified, it would not only support the theoretical architecture but also provide an objective criterion for detecting the presence of consciousness in systems where subjective report is inaccessible, such as non-human animals, minimally conscious patients, or artificial agents. In this way, the model redefines the epistemic conditions for ascribing consciousness, advancing the project of grounding subjective phenomena in physically measurable parameters.

This perspective aligns with a non-dualist ontological monism, wherein the subjective and objective domains are regarded as complementary manifestations of a unified underlying reality — a position anticipated in Spinoza's ontology of substance and echoed in modern formulations such as Russell's neutral monism (Russel, 1921; Spinoza, 1985, 1677). In this light, consciousness is not an anomaly to be explained away, but a structural invariant of the universe itself, calling for a paradigm shift at the intersection of neuroscience, physics, and philosophy.

The original formulation of the model — based on the ontological hypothesis of a bipartite reality — sought to resolve the *Hard Problem* by introducing a causal mechanism capable of linking brain activity and subjective experience via space-time distortions as a heuristic scaffold. This approach aimed to bridge the *Explanatory Gap* by proposing a structural intermediary between neural dynamics and *qualia*. In contrast, the current field-theoretical formulation does not merely seek a mechanistic link, but enacts an ontological shift, in which the very premises of the *Hard Problem* lose their applicability. Rather than resolving the problem, the model now dissolves it: by rejecting the assumption that consciousness must emerge from non-conscious substrates and instead positing it as ontologically fundamental, the *Explanatory Gap* ceases to pose a legitimate conceptual challenge. The demand for a bridge between the physical and the phenomenal arises only within dualist or emergentist ontologies — frameworks that the present theory explicitly transcends.

This formulation eliminates the need to postulate a collapse of spatial dimensions in a separate virtual domain. It reinterprets the bipartition of reality as an epistemic abstraction and recasts the conscious domain as a nonlocal phenomenal field that coexists with and is modulated by neurodynamic activity. This evolution strengthens both the internal coherence and the empirical viability of the model.

7. Conclusion

This work proposed an innovative theoretical model grounded in dissipative neurodynamics, brain thermodynamics, and, in its original formulation, special relativity, aiming to address the *Hard Problem* of consciousness and the *Explanatory Gap*. Although the model was initially developed under the assumption that relativistic space-time distortions could explain the non-spatial nature of *qualia*, it has since evolved into a more coherent ontological framework. The current formulation adopts a field-theoretical ontology, treating consciousness as a nonlocal phenomenal field modulated by

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neural dynamics. In this new context, neurentelechy remains central, now interpreted as the energetic coupling between brain processes and the conscious field.

The notion of bipartite reality — dividing the physical domain into real space (with spatial and temporal dimensions) and a virtual domain structured solely by temporality — was initially inspired by Einstein's theory of special relativity (1905) and served as a conceptual scaffold to explain the apparent absence of *qualia* from physical space. However, this bipartition is now reinterpreted as an operational abstraction: the "virtual space" becomes a representational construct that maps modulations within the conscious field, rather than a literal ontological domain.

The mathematical formalism developed herein (e.g., Equations 1, 7–11, 16–18) captures the relationship between energy dissipation, *qualia*, and intentionality, establishing a dynamic interplay between the physical brain and phenomenal experience. Intentionality, understood as a resultant of *quale* vectors, reinforces the proposal that subjectivity emerges from precise thermodynamic and neurodynamic interactions within a system that is energetically open and dynamically coupled to the conscious field.

While the model does not exhaust the full complexity of consciousness, it offers a rigorous mathematical and conceptual foundation for future investigation. Crucially, the reformulation into a field-theoretical ontology introduces empirical testability. According to the model, if the brain interacts with a conscious field, then such coupling must obey thermodynamic constraints — most notably, resulting in excess entropy production. This prediction constitutes a critical test of the model, as described in falsifiability point 5. In the Lakatosian framework of scientific research programmes, it directly evaluates the hard core of the theory — the postulated existence of a phenomenal field — and thus provides a principled criterion for empirical adjudication.

It is important to emphasize that the hypothesis of a conscious field is adopted here as a fundamental ontological postulate, not as a directly observable entity. This postulate provides the necessary structural coherence for a model in which *qualia* are not generated *ex nihilo* by the brain, but rather modulated from a pre-existing field. This view aligns with non-dualist ontologies and with contemporary reinterpretations of neutral monism, as found in the works of Bertrand Russell and later thinkers. By positing the phenomenal field as ontologically fundamental — a structural property of reality akin to quantum fields — the model dissolves the *Hard Problem*: consciousness is not produced by the brain but modulated by it, potentially obviating the need for emergentist explanations.

In summary, this work not only advances the understanding of the brain–consciousness relationship but also proposes a scientific framework capable of generating testable predictions, undergoing critical empirical evaluation, and reshaping the epistemological framework of consciousness studies. It challenges established paradigms by postulating that consciousness is not an emergent anomaly but rather a structural invariant of the universe — an ontological field whose properties can, in principle, be inferred through objective physical correlates. The model's testability supports both its internal consistency and provides an objective physical criterion for the detection of consciousness, independent of subjective report — thereby enabling empirical investigation of awareness states in animals, patients with disorders of consciousness, and artificial agents. This reconceptualization calls for a reevaluation of fundamental assumptions in philosophy and neuroscience, establishing a foundation for a scientifically rigorous theory of subjective experience.

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