

Review

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Posted Date: 9 March 2026

doi: 10.20944/preprints202601.1886.v2

Keywords: consciousness; review; locality; non-locality; framework; LOQ; ALOQ



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Review

# The Local-Quantitative vs. the Anti-Local-Quantitative: A Novel Framework for Organising Theories of Consciousness

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## Abstract

Theories of consciousness span a wide conceptual spectrum, yet most may be broadly categorised into one of two methodological perspectives: the Local-Quantitative (LOQ), positing consciousness arises exclusively from quantifiable, neurological processes, and the Anti-Local-Quantitative (ALQ), positing extra-physiological, unquantifiable origins. By delineating key criteria—such as neural localisation, empirical measurability, and metaphysical assumptions—this framework offers a structure with which one may more effectively organise and compare theories ranging from Global Workspace Theory (Baars, 1988) to Orchestrated Objective Reduction (Hameroff & Penrose, 1996). Rather than replacing existing philosophical taxonomies, this framework serves as a supplementary tool to identify the commitments and experimental conditions of contemporary models. Establishing this dichotomy may streamline discourse, clarify philosophical commitments, and promote more coherent debate in consciousness research.

**Keywords:** consciousness; review; locality; non-locality; framework; LOQ; ALQ

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## I: Introduction

There exists a broad spectrum of theories in the multidisciplinary field of consciousness studies (Sattin et al., 2021), yet, in surveying this complex literature, a general trend emerges: most theories may be organised into two broad categories. These will be referred to as the Local-Quantitative Category for the Source of Consciousness (LOQ, derived from “local” and “quantitative”), and the Anti-Local-Quantitative Category for the Source of Consciousness (ALQ, derived from “anti,” “local,” and “quantitative”).

This work intends to establish the use of these terms within consciousness literature in an effort to streamline theoretical debates and allow researchers to more clearly identify (and, if applicable, align with) the philosophical implications and assumptions embedded within either perspective. Given the current array of theories and their degree of disconnect,<sup>1</sup> these categories thus represent a supplementary conceptual framework to facilitate the organisation and evaluation of empirical theories of consciousness. By situating these categories alongside traditional philosophical labels, the framework reveals how radically different empirical models often share underlying methodological assumptions.

The ensuing sections will provide explicit criteria for classification under either category in the framework, utilise the examples of various prominent theories to deliver definitional validity, and analyse the implications of both the Local-Quantitative and Anti-Local-Quantitative perspectives.

*Definitions of Terms in the Context of the Article:*

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<sup>1</sup> This will be further examined in section III.

- The term “conservative,” henceforward, refers to the idea that consciousness exists and functions only in the capacity we are currently able to empirically observe it, and/or that there is no means by which one may draw conclusions (outside the realm of neuroscience) from its existence.
- The term “speculative,” henceforward, refers to a phenomenon whose validity must be proven via methods that exceed modern empirical capabilities.
- The term “local,” henceforward, refers to the idea that consciousness is exclusively a physical, neurological product.
- The term “non-local,” henceforward, refers to the idea that consciousness is not exclusively a physical, neurological product (Dossey, 1989).
- The term “quantitative,” (or similar terms such as “quantifiable”) henceforward, refers to the position that consciousness may be empirically observed, measured, or modelled through theoretically testable means. This may include approaches grounded in mathematical formalism, statistical data analysis, computational neuroscience, or related empirical methodologies capable of producing reproducible predictions about the function or mechanism of consciousness.
- The term “non-quantitative,” henceforward, refers to the position that consciousness cannot be entirely captured by empirical measurement, mathematical formalism, or theoretically testable models. It denotes a resistance to the reduction of consciousness into quantifiable data, often due to the belief that the phenomenon either exceeds current scientific capacities or involves dimensions—such as metaphysical, subjective, or extra-physiological elements—that defy empirical operationalisation.
- The term “empirical theory,” henceforward, refers to a model describing specific features of the world—such as neural states, information processing, or quantum states—that are proposed to be causally related to consciousness. Conversely, a “philosophical” or “metaphysical” theory concerns the fundamental nature of reality and the relationship between consciousness and matter (e.g., physicalism, property dualism, or panpsychism).

*Definitions of Concepts:*

- The term “biophysical,” in the context of consciousness theory, refers to any theory that associates consciousness directly with specific biological structures or subcellular processes (Poznanski et al., 2016).
- The term “emergentist,” in the context of consciousness theory, refers to the concept that consciousness arises as a higher-order property from complex interactions of simpler physical components (Chalmers, 1996).
- The “hard problem” refers to how physical processes—such as stimuli causing neurons to fire—give rise to internal and subjective experience (Chalmers, 1996).
- The term “neural network,” in the context of consciousness theory, refers to any theory describing consciousness through interconnected networks of neurons or neuron-like computational units (Aleksander, 1992; Aleksander, 2009).
- The phrase “quantum consciousness theory” refers to any theory positing that consciousness arises directly from quantum mechanical phenomena occurring within neural structures (Hameroff & Penrose, 1996; Penrose, 1994; Hameroff, 1998).

## II: The Local-Quantitative vs. Anti-Local-Quantitative Framework

A proponent of LOQ seeks to explain consciousness as a neurologically local phenomenon, perhaps as a byproduct of natural adaptive processes (i.e., Neural Darwinism (Edelman, 1987)). The LOQ category is the more scientifically conservative perspective, and encompasses theories which quantify the occurrence and function of consciousness. ALOQ theories tend toward a more metaphysical approach. A proponent of the ALOQ category would support non-local or extra-neural sources of consciousness, state that consciousness did not arise exclusively for adaptive benefit, and/or avoid or dissuade empirical/quantitative frameworks altogether.

This dichotomy raises a number of ontological implications, including that various LOQ theories may in turn be explained by ALOQ theories. Some LOQ theories may appear compatible with broader metaphysical claims, while many ALOQ theories challenge conventional physicalism (Neurath, 1931; Carnap, 1932) altogether. For the purpose of categorization, the framework ignores the possibility that LOQ principles imply the existence of ALOQ principles and vice versa. Unless a theory explicitly incorporates an ALOQ principle in its central claims, it remains classified as LOQ.

To apply this framework consistently, it is necessary to define the structural logic of the classification process. The two categories function as a branching decision tree wherein any theory of consciousness is examined to confirm whether it contains the parameters of either category to determine its placement.

Various LOQ theories include Global Workspace Theory (GWT) (Baars, 1988), Integrated Information Theory (IIT) (Oizumi et al., 2014), Damasio's Theory (Damasio & Dolan, 1999), and Unlimited Associative Learning (UAL) (Bronfman et al., 2016). Various ALOQ theories include Quantum Consciousness Theory (QCT) (e.g., Zhi et al., 2023; in reference to: Stuart, et al., 1978), Orchestrated Objective Reduction (Orch OR) (Hameroff & Penrose, 1996), and metaphysical theories that posit an unobservable "soul" or universal mind. Each of the aforementioned theories include the various parameters defining their respective categorisation, as will be examined shortly.

### III: The Necessity of the Local-Quantitative vs. Anti-Local-Quantitative Framework

At present, a variety of frameworks—primarily physicalism, dualism, computationalism, and phenomenology—dominate consciousness literature. The idea of substance dualism was defined in 1641 by Descartes as a distinction between "res cogitans" ("thinking substance"—referring to non-physical elements capable of producing consciousness) and "res extensa" ("extended substance"—referring to the physical elements of the brain and body) (republished in Descartes, 1996). The contrarian term of "physicalism" emerged with Neurath's & Carnap's assertion that everything, including the mind, is entirely and exclusively physical (Neurath, 1931; Carnap, 1932). It must be noted that the categories of physicalism and dualism do not explicitly posit the quantification or observability of consciousness, instead referring only to the means by which consciousness is produced (see Gamez, 2014; Neurath, 1931; Carnap, 1932; Descartes, 1996). This further necessitates a dichotomous, universal framework wherein categorisation encompasses both such aspects of a theory. The framing of mind as a computational system was then inaugurated by McCulloch & Pitts (1943), who modeled neurons as logic gates—laying the groundwork for "computationalism". "Phenomenology"—the "first-person" study of lived conscious experience—was systematised by Husserl and defined as the science of the essence of consciousness (Husserl, 2012).

One may thus question whether the literature genuinely suffers referential disorganisation. However, due to the vast range of categorisation methods (beyond even the aforementioned distinctions<sup>2</sup>), there exists no single, universally organising framework within consciousness literature. Sattin et al. (2021) specifically noted "21 new sub-classifications" of consciousness theory, rather than a single method of universal categorisation.

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<sup>2</sup> Further traditional distinctions include those discussed in the ensuing paragraph.

Orchestrated Objective Reduction (Hameroff & Penrose, 1996), for instance, may be categorised by the definitions of multitudinous frameworks. Orch OR is simultaneously a “quantum consciousness theory,” as it explicitly locates consciousness in quantum state reductions within neuronal microtubules (Penrose, 1994; Hameroff, 1998); a “physicalist” theory in that the microtubules implicated in consciousness are physical elements of the universe (Hameroff, 1998); a “non-local” theory in that these microtubules are linked to extra-neural quantum elements (Hameroff & Penrose, 2014); an “emergentist” theory in that consciousness is here viewed as an emergent property of orchestrated quantum processes, rather than as a fundamental substance (Penrose, 1994); and a “biophysical” theory in that it ties conscious events to structures at the subcellular level (Hameroff & Penrose, 1996; Hameroff, 1998). Global Workspace Theory (Baars, 1988) similarly exhibits a wide array of designations. GWT is simultaneously an “emergentist” theory, positing that consciousness arises from the non-linear integration of otherwise unconscious processes, rather than existing as a fundamental entity (Baars, 1988); a “computational” theory in that it models the brain as an information-processing architecture that can be described, simulated, and analysed in formal algorithmic and neural-network terms (Baars, 1988; Dehaene & Changeux, 2011); and a “neural network” model in that it presents the global workspace of consciousness as a network of interconnected nodes (Newman & Baars, 1993; Newman et al., 1997).

Evidently, traditional distinctions are numerous, specific, and often apply simultaneously to radically opposed theories. For instance, the designation of “physicalist” naturally aligns with local models of consciousness for their physical, neurological basis. Orch OR, though physicalist, is a fundamentally non-local theory (Penrose, 1994). Thus, the presence of copious, overlapping<sup>3</sup> distinctions creates significant ambiguity concerning the exact ontological commitments associated with each term, as well as confounds the field with overly-complex categorisation methods. It is, therefore, imperative to adopt the dichotomous LOQ vs. ALOQ framework for the purpose of creating clearer discussion and collaboration. This will allow researchers to identify theories with the foundational assumptions of a dichotomous system, thereby making underlying philosophical alignments and disagreements less conflated.

Previous dichotomous frameworks—such as physicalism and dualism—placed categorical emphasis on metaphysical commitments rather than a theory’s explanatory structures. The LOQ vs. ALOQ framework is explicitly designed to avoid these pitfalls by delineating explanatory and methodological criteria<sup>4</sup> (as well as metaphysical commitments), incorporating various methods of categorisation into a single framework. A critical distinction must be made between philosophical (metaphysical) theories and the empirical theories discussed in this framework. Philosophical theories—such as property dualism or a posteriori physicalism—concern the metaphysical nature of the relationship between consciousness and the physical world. In contrast, empirical theories describe the specific features (neural states, information processing, quantum states) causally related to consciousness. While these dimensions are not rivals and can often be combined, this framework specifically targets empirical models; its goal is to clarify methodological commitments by decoupling a theory’s metaphysical category from its empirical strategy.

While the criteria of locality and quantifiability could support alternative models for organizing theories, this paper employs the dichotomous LOQ vs. ALOQ framework for pragmatic and analytical demarcation. Currently, most prominent empirical theories cluster at these two poles: the conservative, neurologically-local and measurable (LOQ), and those that challenge these boundaries through extra-physiological or speculative claims (ALQ). By focusing on this divide, the framework builds upon the most significant point of friction in contemporary research: whether consciousness is reducible to standard neuro-computational metrics or requires an expansion of the contemporary scientific paradigm.

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<sup>3</sup> The term “overlapping” refers to the fact that traditional distinctions may apply to theories with conflicting ontological implications (i.e., physicalism applying to both Orch OR and GWT).

<sup>4</sup> These will be introduced in sections III and IV.

## II.II: Utility of the Framework

The aforementioned categories (physicalism, dualism, etc.) are certainly numerous and conflated, but have long been used in the literature and indeed have their utility in discussion. The LOQ vs. ALOQ framework is not intended to replace any of these methods of categorisation; rather, it is intended to supplement them by providing a higher-order schema for organising these views based on their empirical “entry points.” Its primary advantage lies in revealing underlying methodological disagreements that traditional labels obscure.

For example, two researchers may both identify as “physicalists,” yet find themselves in fundamental opposition if one proposes a Local-Quantitative theory (e.g., GWT) and the other a non-local, speculative theory (e.g., Orch OR). While they share the same philosophical stance, they fundamentally disagree on the empirical observability and the specific source of production of consciousness. Ultimately, by distinguishing empirical strategy from philosophical commitment, this framework offers a pragmatic pathway for researchers to identify the necessary evidentiary standards for their respective models, providing a step toward coherence in such a conceptually fragmented field.

## III: The Local-Quantitative Category for Theories of Consciousness

To be categorised as Local-Quantitative, a theory must satisfy<sup>5</sup> the following two parameters: (A) the theory must contain a declaration or acknowledgement that consciousness is neurologically localised; and (B) a declaration or acknowledgement that consciousness may be quantified. Additionally, while not a categorical parameter,<sup>6</sup> LOQ theories tend to view consciousness as a scientifically conservative phenomenon. These parameters were formulated due to their being the most consistently shared aspects of a great number of theories of consciousness (Sattin et al., 2021), which, when compared to differing theories (those that formed the alternative ALOQ theories), present a pattern of conservatism in their approach to consciousness, creating easily definable features of the LOQ.

To best explain each of the mentioned parameters, we will examine two LOQ-aligning theories of consciousness: Global Workspace Theory (GWT) and Integrated Information Theory (IIT). GWT and IIT are perhaps the most quantitative modern theories of consciousness, and contain the listed parameters of the LOQ. In addition to discussion of the LOQ parameters, these sections will examine the arguments for why either theory falls within the LOQ, providing further criterion for defining this perspective on consciousness theory.

### III.I: Foundational Context for the Local-Quantitative Category from GWT and IIT

IIT and GWT seek to explain the mechanisms of consciousness from varying perspectives. IIT focuses on the intrinsic properties of consciousness and how these may be mapped onto physical systems via a mathematical framework (Tononi, 2004), while GWT emphasises the global broadcasting of information across specialised neural processors to achieve conscious awareness (Baars, 1988).

It must be understood for the examination of the LOQ that GWT declares the critical role of the prefrontal cortex in broadcasting information across brain regions, enabling conscious perception and decision-making (Baars *et al.*, 2021). However, it is not the sole region responsible for consciousness and is viewed rather as part of a dynamic, *global* network including the thalamus and posterior cortex (Baars *et al.*, 2021). This neurological origin will be relevant in discussion of the local parameter (A).

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<sup>5</sup> See the final paragraph of section III.II for a discussion of exceptions to this rule of “involving both parameters” to be declared LOQ.

<sup>6</sup> Conservatism may be taken into consideration when ambiguity arises in regards to a theory’s exact categorisation.

Also relevant for the remainder of this discussion are the axioms upon which IIT operates. These axioms state that the experiences of consciousness exist and are undeniable, and that “every experience is for the experiencer (intrinsicity), specific (information), unitary (integration), definite (exclusion), and structured (composition).” (Albantakis et al., 2023) This paper has, and will, continue to approach consciousness from the axiom that it does indeed exist (see Tononi, 2004).

### III.II: Examination of the Parameters

Restatement of parameter (A): For any theory to be considered a LOQ theory, it must contain a central explanatory commitment that neurology, exclusively, produces the phenomenon of consciousness. Any central commitment to non-locality<sup>7</sup> would cause a theory to be categorised under the ALOQ perspective. GWT and IIT both posit that consciousness is an entirely local phenomenon.

GWT has proposed that consciousness is a local phenomenon, though not a phenomenon exclusive to a single neural region, rather—as implied by the “global” aspect of the theory—a network of coordinated neurons (Baars, 1988; Newman et al., 1997). This neural grounding implies a lack of any alternative means for the production of consciousness, and, considering that a non-local source would invalidate the theory of a solely-neural network, it would be impossible to consider a non-local source of consciousness within GWT. Not only does this locality support the (A) parameter of the LOQ, it demonstrates the theory’s conservatism, as this declaration was only produced in congruence with empirical observation of such neural structures (Newman & Baars, 1993; Newman, 1997; see Newman et al., 1997<sup>8</sup>). For example, there exists an emphasis on uncovering the local function and source of said structures (Whyte & Smith, 2021). Sensory cortices, in particular, have been examined as support, with a number of papers finding evidence of correlation of activity in said sensory cortices and parietal/prefrontal regions (as reviewed in Dehaene & Changeux, 2011; Mashour et al., 2020). This exclusive focus on neural activity places GWT firmly within the LOQ.

IIT similarly emphasizes locality, although it places greater value on computational aspects than GWT (in that IIT views the brain as a decision-economy focused computer) (Sattin et al., 2021). This computational aspect of IIT has led to an interest in understanding “to what extent simple systems of mechanisms, such as logic gates or neuron-like elements, can form complexes that can account for the fundamental properties of consciousness.” (Oizumi et al., 2014) With its proposed source of computation being that of neuronal pathways and brain-based analyses, IIT suggests clear localisation (Tononi, 2004).

Restatement of parameter (B): For any theory to be considered a LOQ theory, it must contain a central explanatory commitment that consciousness is a quantifiable phenomenon. Any central commitment to non-quantifiability<sup>9</sup> would cause a theory to be categorised under the ALOQ perspective. GWT and IIT both posit that consciousness is an entirely quantifiable phenomenon.

IIT tends toward the mathematical, viewing consciousness as the intrinsic cause-effect power of a system (Tononi, 2004). Central to this view is the concept of integrated information, proposed to reflect the capacity of neural networks to generate consciousness, and operationalised through the metric “ $\Phi$ ”—defined as “the amount of integrated information in a physical system, which is postulated to have an identity relationship with consciousness.” (Kim et al., 2018;<sup>10</sup> see also Tononi,

<sup>7</sup> This will be further examined in section IV.

<sup>8</sup> For instance, Newman et al., 1997 refers back to “three decades of experimental evidence indicating that these midbrain collaterals serve as the basis for an initial ‘spatial envelope’, or global map, of the environment surrounding the animal.” (see Scheibel, 1980)

<sup>9</sup> This will be further examined in section IV.

<sup>10</sup> It must be acknowledged that Kim et al., 2018 is, in addition to being the source of the provided quote, being referenced for its attempt at measuring  $\Phi$ , though the concept was initially proposed in Tononi, 2004. This

2004) The attempt by Kim *et al.* (2018) to estimate  $\Phi$  (via EEG data) exemplifies a commitment to data-based analysis and represents the application of quantification to imply that consciousness may be numerically assessed and compared across different states (i.e., during sleep, wakefulness, or non-ordinary states such as the psychedelic state (see Dai *et al.*, 2024)). In further support of this quantitative framework, Oizumi and colleagues (2014) have developed detailed mathematical formulations to describe the mechanisms underlying integrated information, thus providing additional measures by which the operation of consciousness may be assessed (Oizumi *et al.*, 2014; Oizumi, 2004).

GWT alternatively posits the quantification of consciousness as supported in its attempt to generate predictions for conscious aspects of perception and emotion (Baars, 2005) through study of neural correlates (such as the previously discussed example of sensory cortices) (Dehaene & Changeux, 2011; Mashour *et al.*, 2020). This quantification is emphasised by experiments allowing testable predictions at both behavioural and neural levels, implying the measurability of consciousness (Whyte & Smith, 2021).

The observability of phenomenon and the measurability/quantification within both theories is evidently the result of a scientifically conservative approach to consciousness. Conservatism and observability are, however, not exclusive to the LOQ. Various ALOQ theories seek to gather empirical evidence, though the manner in which this empirical evidence is gathered and interpreted differs between the LOQ and ALOQ: a proponent of the LOQ seeks only to gather and interpret indisputable fact, while a proponent of the ALOQ might seek data that is more theoretical, or perhaps, untestable with modern technology (though this is not an absolute). ALOQ theories occasionally neglect to involve the quantification of consciousness due to quantification often implying a local, empirically observable source. However, certain theoretically observable theories may contain a degree of empiricism, as seen in various quantum consciousness theories proposing theoretically quantitative phenomena (e.g., Li, 2017).

As explained, both parameters (A) and (B) must be met in order to categorise a theory of consciousness as LOQ. Theories that are conservative by the given definition tend to have both of these parameters in common, while less conservative theories (e.g., a majority of ALOQ theories) either exclude these parameters (either one, or both) or include ALOQ parameters (in the case that only one LOQ parameter is included in a given theory). There exists one exception: a hypothetical theory that includes (A) alone, though implies to even a small degree that consciousness may be quantified due to its local observability. A theory such as this would be considered a LOQ theory.

#### IV: The Anti-Local-Quantitative Category for Theories of Consciousness

To be categorised within the Anti-Local-Quantitative perspective, a theory must satisfy at least one of the following parameters: (A<sub>A</sub>) the theory must contain a declaration or acknowledgement that consciousness is not exclusively neurologically localised, (B<sub>A</sub>) a declaration or acknowledgement that consciousness is not entirely an observable phenomenon, or is a phenomenon whose proof is speculative, and/or (C<sub>A</sub>) contain the “exclusionary parameter”—a lack of any attempt at quantification, empirical observation, or other previously mentioned conservative principle.

The inclusion of any single ALOQ parameter in a theory would lead to its categorisation under the ALOQ, regardless of whether a theory includes a LOQ parameter (mentioned exceptions and notes (see LOQ sections) are deviations from this rule). Failure to align with both LOQ parameters leads, by default, to a theory’s categorisation within the ALOQ. The inclusion of both quantum consciousness theories (like Orch OR) and metaphysical/spiritual theories within the ALOQ category is not intended to suggest they are identical in content, but rather to highlight their shared structural commitment to non-local or currently non-measurable sources of consciousness. This grouping

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reference was included to present that, based on Tononi’s proposal, attempts have been made to quantify  $\Phi$  using empirical data.

identifies theories that collectively resist standard neuro-reductionism, thereby requiring similar shifts in evidentiary standards.

To best explain each of the mentioned parameters, we will examine various ALOQ-aligning theories of consciousness: quantum consciousness theory (QCT), Orch OR, and the various implications of near death experiences (NDEs). In addition to discussion of the ALOQ parameters, these sections will examine the arguments for why these theories fall within the ALOQ, providing further criterion for defining this perspective of consciousness theory.

#### *IV.I: Examination of the Parameters*

Restatement of parameter (A<sub>A</sub>): For any theory to be considered an ALOQ theory, it must contain a central explanatory commitment that neurology does not, exclusively, produce the phenomenon of consciousness. Any central commitment to locality would cause a theory to be categorised under the LOQ. While ALOQ theories may contain the perspective that consciousness is a non-local phenomenon, this is not the sole interpretation for certain theories (e.g., quantum consciousness theories may imply that local phenomena are influenced by non-local phenomena (see Hameroff & Penrose, 1996)).

Orchestrated Objective Reduction (Hameroff & Penrose, 1996) claims consciousness to be a non-local phenomenon, the result of particles exhibiting correlated behaviours over vast distances instantaneously (see Penrose, 1989). It is stated to be explicitly non-local in that Orch OR posits the link between neuronal microtubules and extra-neural quantum processes (Hameroff & Penrose, 1996; Penrose, 1994; Hameroff, 1998; Hameroff & Penrose, 2014). In proposing a source of consciousness beyond neurology, as well as positing a theoretical framework for proof of these quantum processes (parameter (B<sub>A</sub>); see Hameroff & Penrose, 1996; Penrose, 1994; Hameroff, 1998), this theory remains an excellent example of the ALOQ, particularly of parameter (A<sub>A</sub>).

Restatement of parameter (B<sub>A</sub>): For any theory to be considered an ALOQ theory, it must contain a central explanatory commitment that consciousness is not an entirely observable phenomenon, and that if it may be observed, this empiricism involves, to even a small degree, the observation of a speculative process.

The “hard problem” of consciousness (Chalmers, 1995; Chalmers, 1996) refers to the difficulty in explaining subjective experience through objective means. This issue is particularly evident in materialistic theories that attempt to reduce consciousness to neural correlates. As Wahbeh et al. (2022) proposed, consciousness may exhibit non-local properties that cannot be explained exclusively through neural activity, suggesting the phenomenon extends beyond what may be empirically observed by current scientific methods. This aligns with the recognition that reductionist approaches fail to capture the full scope of conscious experience, necessitating speculation<sup>11</sup> (Wahbeh et al., 2022). Theories following this ideology often propose that consciousness involves mechanisms or dimensions not yet accessible to science (see Li, 2017). Some researchers have proposed quantification of these speculative concepts and provide hypothetical means by which to prove the quantum correlates of consciousness; even proposing dark matter’s involvement in the production of consciousness, with posited experiments involving rat brain tissue removal and the observation of dark matter activity between tissues (Li, 2017). As stated, these theories and hypothetical experiments exceed our current understanding of the physical sciences, yet, they propose the observation of non-locality and thus fall within the ALOQ.

Some theories, however, posit means of observing non-locality with modern technology. Near death experience research, for instance, may be taken as admission of our lack of understanding of consciousness, and theoretically stand as observable proof of non-locality (Van Lommel, 2006). Theorisation involving the experiences of NDE survivors—in that NDEs imply non-locality due to the vivid experiences described by NDE survivors (Van Lommel, 2006)—implies the observation of non-local consciousness, independent of functional neurology (Van Lommel, 2006). This lends Van

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<sup>11</sup> See definition of “speculative” in “definitions of terms in the context of the article”.

Lommel's theory to the ALOQ with its suggestions of empirical non-locality. As seen here, should a theory mention empiricism in the context of a speculative or non-local concept, it is inherently metaphysical and/or speculative and therefore falls within the ALOQ.

Restatement of parameter (CA): Should a theory not propose any means by which to quantify or empirically observe consciousness, it would be categorised as an ALOQ theory under the "exclusionary parameter."

Parameter (CA) encompasses theories that abstain from attempting empirical verification or quantification, perhaps choosing to focus on the purely theoretical or philosophical aspects of consciousness. Such theories might imply that the very nature of consciousness precludes it from measurement or observation in any conservative sense.

## V: Ontological Implications of Either Perspective

While not a *central* determinant of categorisation, ontological implications may aid in understanding the perspective a proponent of either category might take.<sup>12</sup> Specifically, examining these implications yields theoretical insights into experimental boundary-setting and the distinct research requirements of each category. This allows for a deeper understanding of the gap between conservative and speculative models. Ontology may, however, *aid* categorisation should a given theory fail to include the framework's parameters. In such a case, a theory's alignment with the implications discussed in this section may lend toward categorisation.

To establish the perspectives held by a proponent of either perspective, this section provides an examination of either category's parameters in the context of conditional reasoning: hypothetically assuming that a given parameter is proven irrevocably true.<sup>13</sup> This allows for an analysis of a number of speculative examples (e.g., consciousness being proven irrevocably local/non-local) to provide concepts for the ultimate, ideal approach to consciousness within either perspective (i.e., the ontological implications), and the direction that various theories, if proven, may lead in the future.

### V.I: Ontological Implications of the Local-Quantitative Category

LOQ theories, if proven valid, would imply a lack of extra-physiological influence on consciousness. For instance, Memory Theory of Consciousness (MToC) posits that consciousness evolved from episodic memory systems and functions as part of a broader memory framework (Budson et al., 2022). Locally, "[t]he entire cerebral cortex and hippocampus function together to serially integrate and time stamp parallel unconscious brain processes to form a linear, coherent stream of conscious experiences." (Friedman et al., 2023; in reference to Budson et al., 2022) If this theory were validated, it would reinforce the claim that consciousness is an emergent property of neural computations tied to local processes. Ontologically, this would prove consciousness to be something of a byproduct of memory systems, simply produced to consolidate and activate previous experiences for adaptive advantages (Budson et al., 2022). Such evolutionarily beneficial origins of consciousness are ontologically foundational to the LOQ perspective.

Studies on the claustrum have dictated its position as a "functional anatomical [link] between the frontal cortices and the posterior sensory/association cortices" (Zhao et al., 2019; in reference to White & Mathur, 2018) for integrating information to ultimately generate conscious experience. Researchers have also noted that damaging the claustrum may lead to impaired levels of consciousness (Chau et al., 2015), suggesting its plausible role in localised production. Should research continue in this area, and this hypothetically come to prove the undeniable role of the

<sup>12</sup> This is not to say that all researchers hold these beliefs—this section moreso examines ontology to best understand examples of opinions that might be held by proponents of either perspective, as well as to provide further analysis of the parameters.

<sup>13</sup> It is likely impossible to find any theory or parameter irrevocably true. This conditional reasoning simply provides insight into ontological implications by assessing ultimate assumptions.

claustrum in the production of consciousness, the observable locality of consciousness would be confirmed. Once more, LOQ proponents would be capable of declaring that consciousness is nothing more than a result of neural circuitry and the physiological events that came to produce said circuitry.

Observing this in the context of parameter (A), should the locality of consciousness be generally proven true, the conclusion that consciousness is a purely biological process would be logical. This conclusion, theoretically, may imply the production of consciousness via neurological evolution (in a similar vein as MToC or the claustrum's role in consciousness), a process which involved no external<sup>14</sup> force operating upon it. This would imply a lack of Penrose & Hameroff's Orch OR (1996), or any other theory akin to a "quantum consciousness" or "universal consciousness". As in, proving parameter (A) would indicate that consciousness exists only to the capacity that the brain has evolved it: a biological process to increase an organism's fitness, with no purpose for the existence of consciousness beyond this (as far as would be understandable with modern science).

In the context of parameter (B), should the quantification of consciousness be achieved and proven absolutely infallible, it may be concluded that science is able to observe, empirically, the existence of consciousness. This might confirm IIT's postulates and axioms (see Albantakis et al., 2023), and would be, generally, a step toward understanding the fundamental nature of reality.

Proponents of the LOQ support that consciousness is reducible to physical processes within the brain, and that non-quantifiable, perhaps metaphysical, interpretations of consciousness are invalid, framing consciousness instead as an empirically observable phenomenon, born out of its adaptive utility. Drawing these ultimate conclusions—should a theory fit none of the parameters within the LOQ—would classify said theory under the LOQ.

If LOQ models continue to dominate empirical data without accounting for subjective "unity," it suggests that ALOQ theories—despite their occasionally speculative nature—provide the necessary theoretical scaffolding for developing next-generation detectors that look beyond traditional neural correlates, such as proposed resonance studies in subcellular structures. By situating Orch OR and NDE research along the same ALOQ axis, researchers can better identify which "speculative" theories may eventually transition into the LOQ category as our ability to quantify extra-neural phenomena matures.

## *V.II: Ontological Implications of the Anti-Local-Quantitative Category*

Conversely, ALOQ theories, if proven valid, would imply a degree of extra-physiological influence on the production of consciousness. Craddock et al. (2015) suggests that "quantum channels" in microtubules might facilitate  $\pi$ -electron resonance energy transfer, potentially serving as the basis for conscious experience (Craddock et al. 2015; see Hameroff, 1998). Experimental validation—such as through hypothetical studies on anaesthetic effects disrupting quantum coherence (Craddock et al. 2015)—would support the ALOQ's assertion that consciousness cannot be fully explained through classical physics or that it is sourced non-locally. Should this be irrevocably proven, our understanding of reality would certainly need to be reevaluated, as this would be an earth-shattering revelation: Human consciousness is influenced by extra-physiological forces, the nature of which exceeds scientific understanding/empiricism.

In the context that the specific parameters of the ALOQ have been hypothetically proven true,<sup>15</sup> we will first discuss Parameter (A<sub>A</sub>), whose implications are similar to that of the previous discussion of Orch OR. Should the non-locality of consciousness be proven beyond doubt, a greater intersection

<sup>14</sup> The term "external" here refers to concepts non-local to neurology/evolution (i.e., theoretical quantum processes, intangible meddlings in consciousness, etc).

<sup>15</sup> Parameter (C<sub>A</sub>) has not been included in this discussion as it is simply an exclusionary parameter for defining the ALOQ. Because it serves simply as a definition for the ALOQ, it is therefore not a testable parameter in this hypothetical context, and is thus not examinable in the same capacity ("if proven to be correct...") as (A<sub>A</sub>) and (B<sub>A</sub>).

between theology/philosophy and metaphysics would likely be considered, as non-locality would imply that consciousness is sourced extra-physiologically (to some degree). This may imply that NDEs contain a degree of objective reality, for instance.

Should parameter ( $A_A$ ) be proven true, our scientific perspective on reality, as stated previously, would be greatly altered in its expansion away from empirical, quantifiable observations. Proponents of the ALOQ tend to support such claims, either in that proof of non-locality would ultimately lead to a less empirical approach to consciousness, or in that non-locality suggests (theoretically) yet speculative extra-physiological processes to produce consciousness.<sup>16</sup>

Should it be proven, beyond doubt, that empirically observing consciousness does not require modern scientific methods or that the current methods are inadequate (parameter ( $B_A$ )), researchers may draw the short-term conclusion that consciousness is a non-physical or emergent phenomenon resisting direct measurement. Should technology be developed to empirically observe consciousness, alternative conclusions might be drawn (i.e., it being reducible to physical processes or other empirical interactions), but until that time science would operate under the prior assumption. If it is found to be irrevocably impossible to observe consciousness, researchers may conclude that consciousness exists beyond the boundaries of empirical science, potentially residing in unreachable metaphysical, subjective, or immaterial realms. However, it is always possible that technology continues to advance to a point that conclusions may surpass such immateriality.

Proponents of the ALOQ state that consciousness is not solely reducible to physical processes within the brain, framing consciousness instead as a phenomenon not solely born of adaptive utility. Drawing these ultimate conclusions—should a theory fit none of the parameters within the ALOQ—would classify said theory under the ALOQ.

## VI: Concluding Remarks and Discussion of Limitations

This paper has proposed a novel dichotomous framework for organising theories of consciousness: the Local-Quantitative (LOQ) and Anti-Local-Quantitative (ALOQ) categories. By delineating explicit classification parameters, the framework enables a systematic method for categorising theories according to both their central explanatory and ontological commitments. This paper has also demonstrated the utility of these categories in capturing the philosophical and methodological cores of contemporary consciousness research. As discussed in Section II.I, consciousness theories are often subject to a conflation of distinctions that blur ontological boundaries and complicate productive debate. The LOQ vs. ALOQ framework responds to this issue by providing a higher-order schema—one that orients these various designations along a clearer axis of empirical and metaphysical commitment.

This framework is, however, not without limitations. Strict binary classification may risk oversimplification or fail to categorise theories that straddle the line between quantifiability and speculation, though simplifies argumentative alignment. Additionally, as scientific and technological capacities progress, theories currently classified under the ALOQ may later become testable (thereby altering their classification as “speculative” by the operational definition of this proposal). The framework also presumes clarity in a theory’s central explanatory commitments. This is not always present; some theories may be ambiguous in regards to key parameters, requiring interpretive judgment that introduces subjectivity into classification.

Despite these limitations, the LOQ vs. ALOQ framework serves as a conceptual scaffold to encourage clarity, promote philosophical commitment, and facilitate interdisciplinary discourse. It enables researchers to foreground the assumptions embedded in their models and identify the broader ontological implications of the perspective under which their theory aligns. Thus, the LOQ vs. ALOQ framework provides a step toward coherence in such a conceptually fragmented field as the study of consciousness.

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<sup>16</sup> This would perhaps emphasise a greater multidisciplinary approach in consciousness studies.

## Abbreviations

### *Core Framework Categories*

1. LOQ (Local-Quantitative): Derived from “local” (LO) and “quantitative” (Q).
2. ALOQ (Anti-Local-Quantitative): Derived from “anti” (A), “local” (LO), and “quantitative” (Q).

### *Theories of Consciousness*

1. GWT: Global Workspace Theory.
2. IIT: Integrated Information Theory.
3. Orch OR: Orchestrated Objective Reduction.
4. UAL: Unlimited Associative Learning.
5. QCT: Quantum Consciousness Theory.
6. MToC: Memory Theory of Consciousness.

### *Scientific and Empirical Terms*

1.  $\Phi$  (Phi): The mathematical metric used in IIT to define the amount of integrated information in a physical system.
2. NDEs: Near-Death Experiences.
3. EEG: Electroencephalography

### *Framework Parameter Labels*

(Used to denote specific classification criteria)

1. (A) and (B): The two parameters required for a theory to be categorised as LOQ (Neurological localisation and Quantification).
2. (A<sub>A</sub>), (B<sub>A</sub>), (C<sub>A</sub>): The parameters used to categorise a theory as ALOQ (Non-locality, Speculative/Non-observable, and the Exclusionary parameter).

**Funding Statement:** The author declares that there was no source of funding for this research.

**Institutional Review Board Statement:** Not applicable.

**Informed consent Statement:** Not applicable.

**Data availability Statement:** Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

**Acknowledgments:** Editing was contributed by Dr. Dinesh Pal, Dr. Jacinta Beehner, Dr. George Mashour, and Dr. Nicolas Glynos. The author personally thanks each of these contributors for their kindness and effort.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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