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PRINCIPLES FOR A SYSTEMS-THEORETIC STUDY OF CONSCIOUSNESS: A LOGICAL-METHODOLOGICAL ANALYSIS

"So, the rose has teeth in the mouth of an animal.
This would not be absurd,
because one has no notion in advance
where to look for teeth in a rose."
— Ludwig Wittgenstein

The article proposes a set of methodological principles necessary for constructing a coherent and comprehensive systemic account of consciousness. It is argued that existing approaches (neurobiological, computational, phenomenological, or cultural) cannot converge without a meta-theoretical framework capable of coordinating heterogeneous data and avoiding entrenched metaphysical assumptions. Drawing on general systems theory, three principles are formulated: structural-ontological neutrality, which abstracts away from essentialist ontological commitments; differentiation of perspectives, which distinguishes first-person and third-person standpoints as well as the epistemic and ontic layers of these perspectives; and embodiment, which emphasizes the constraining and constitutive role of the substrate in a consciousness system. An analysis of modal counter-examples shows that the absence of any of these principles undermines the very conditions for a systemic science of consciousness. Taken together, these principles provide a methodological minimum for a metaphysically neutral framework for integrating theories, preventing category errors, and clarifying the structural conditions for the study of consciousness.
Keywords: *consciousness, systems approach, systems descriptors, metaphysical commitments, structural-ontological neutrality, embodiment, differentiation of perspectives, modal logic, modeling, meta-theoretical reduction.*

1. Introduction

Despite recent breakthroughs in cognitive science – the most promising candidate for a 'science of consciousness' (e.g. see the most recent [Lakoff & Narayanan 2025]) – the central problems surrounding consciousness remain largely unresolved, especially the so-called "hard problem" (see [Chalmers 1996; Chalmers 2010]). Questions about the ultimate nature and purpose of consciousness continue to be challenging. Two main reasons explain this state of affairs: the complexity of the object of study and the 'hardness' of the phenomenon itself.

By complexity, I mean the multifaceted nature of consciousness, which cannot be approached from a single privileged point of view (e.g., [Van Gulick

2014]). These questions concern *how* consciousness works, *how* it emerges, *how* it is structured. On the other hand, by *hardness*, I mean the metaphysical questions: *what* consciousness is and *why* it exists at all [Chalmers 2010: 3–6]. These 'what' and 'why' questions are significantly more difficult than the 'how' questions, because they rely on metaphysical assumptions that require clarification.

Yet, as soon as we reflect carefully on the metaphysics of consciousness, we see that even the so-called "easy" questions implicitly presuppose a metaphysical framework. Thus, the *what* and *why* of consciousness shape the *how* of it. As J. Westphal writes about the mind-body problem: "the logical part of it must be solved before the scientific and psychological elements of a solution can begin to have any traction" [Westphal 2016: 123]. Conversely, scientific theories about *how* consciousness functions also influence metaphysical views about *what* it is and *why* it exists (cf. "empirically responsible philosophy" [Lakoff & Johnson 1999: 551-568]).

A satisfactory account of consciousness requires integrating its scientific and philosophical dimensions. Consciousness cannot be explained by science alone without metaphysical, logical, epistemological, and methodological analysis; nor can we offer an adequate metaphysics of consciousness without engaging with scientific findings. Cognitive science provides an interdisciplinary approach, but what we increasingly need is a meta-theoretical approach – an overarching framework capable of coordinating diverse theories and types of data. As Van Gulick notes:

"A comprehensive understanding of consciousness will likely require theories of many types. One might usefully and without contradiction accept a diversity of models that each in their own way aim respectively to explain the physical, neural, cognitive, functional, representational and higher-order aspects of consciousness. There is unlikely to be any single theoretical perspective that suffices for explaining all the features of consciousness that we wish to understand. Thus, a synthetic and pluralistic approach may provide the best road to future progress." [Van Gulick 2014]

One promising candidate for such a "synthetic and pluralistic" meta-approach is the *systems approach* or *systems theory*[1] (see [Bertalanffy 1969], [Mobus & Kalton 2015], [Ladyman 2020]). Yet the systems approach alone is insufficient unless it is grounded in explicit philosophical principles. The need for such a structure to define and validate inter-theoretical mappings is a fundamental issue across philosophy of science and general systems theory (cf. [Deguchi 2022]).

My *aim* in this article is to refine and restate three methodological principles that, taken together, support a coherent systems-theoretic study of consciousness (cf. the previous attempt [Lyashenko 2021]). This methodological framework resonates with (yet remains distinct from) current metaphysical approaches that could be applied to consciousness study. Approaches that are based on the conceptions of neo-Aristotelian hylomorphism, ontological dependence and grounding, such as Kit Fine's theory of neutral relations [Fine 2000], mereology in

general, etc., suggesting a fruitful complementarity between systems-theoretic modeling and contemporary analytic metaphysics (see e.g., [Lyashenko 2024]).

2. The Problem of a Science of Consciousness

Different research programs generate different (sometimes mutually inconsistent) models of consciousness. Neurobiological theories emphasize anatomical, biochemical, and physiological features; computational theories stress functional realizability; linguists and anthropologists insist on the irreducibility of culture, language, and society; psychologists and phenomenologists argue for the primacy of first-person experience. As a result, no unified science of consciousness exists today, and it is unclear whether such unification is even possible (cf. [Chalmers 1996: 214–218]).

Researchers often move in parallel or divergent directions, sometimes without even the theoretical possibility of convergence (as in the case of strict functionalists vs. strict neurobiologists). Hence, an interdisciplinary approach alone – without meta-theoretical "gluons" (on gluons see [Priest 2014]) – cannot yield a pluralistic and synthetic theory of consciousness.[2]

2.1. The Way of 'Meta-Theoretical Reduction'

There appear to be three main methodological strategies for constructing a science of consciousness: deductive, inductive, and inter-theoretic strategies (reduction, interpretation, hybridization, etc.).

Given the complexity of consciousness, the deductive path is unrealistic: it is unclear what axioms could serve as foundational principles for deducing everything about consciousness.

The inductive path corresponds to the current state of cognitive science: collecting data across domains, hoping that future insights will clarify the overall picture.

The inter-theoretic path (including reduction) attempts to map statements from one theory *T1* onto those of another *T2* using bridging principles. E.g., this mapping of concepts and axioms between formal theories is a core challenge in systems science, where concepts such as reduction and realization require a precise meta-language to clarify interpretation (see [Deguchi 2022]). But generally speaking, reduction is typically motivated by the relative simplicity, fundamentality, or development of *T2* compared to *T1*. Because nearly every scientific discipline involved in consciousness studies is (in one of these senses) more developed or fundamental than the study of consciousness itself, reduction often seems an attractive option.[3]

However, reductive strategies can face either a well-known regress or an explanatory circle. Suppose we successfully reduce consciousness to neurobiology; biological concepts can in principle be reduced to physical ones; and physical descriptions to mathematical structures (as in [Tegmark 2015]). Conversely, some authors argue that mathematical concepts themselves are grounded in neural capacities [Lakoff & Núñez 2000]. In such cases, reductive chains either collapse back into their starting point or eliminate precisely the complexity that consciousness requires us to explain.

Beyond these conceptual difficulties, such reductive reasoning presupposes monotonic logic[4] (which works well within a fixed domain but fails for complex, cross-domain, non-monotonic phenomena like consciousness). Consciousness resists any 'monotonic reduction' to a single domain (neural, functional, cultural, or phenomenological).

Hence, reduction should not be *ontological* (at least not natural-ontological); but it can be *methodological* (see [Bennet & Hacker 2022: 415-436]). What we need is a meta-theoretical reduction: a correlational, interpretive framework capable of integrating diverse data in a principled way. The systems approach (or systems theory) offers such a framework.

2.2. The Relevance of the Systems Approach

Different sciences study different kinds of systems (mathematical, physical, biological, social etc.) and none of these, by themselves, provide a natural place for conscious systems unless consciousness is reductively identified with one of them. But once again, given the multiplicity of data sources, the science of consciousness could be methodologically reductive or correlative, but not ontologically reductive (cf. [Chalmers 2010: xvii]).

Chalmers frames the task of a science of consciousness as discovering *bridging principles* between first-person and third-person data:

"The task of a science of consciousness…is to systematically integrate two key classes of data into a scientific framework: *third-person data*, or data about behavior and brain processes, and *first-person data*, or data about subjective experience." [Chalmers 2010: 37].

To integrate these heterogeneous data sets, we require a methodology capable of handling complexity, heterogeneity, and multi-level relations (see e.g. [Ladyman 2020], [Mobus & Kalton 2015]). The systems approach – understood broadly as including complexity science, holism, cybernetics, structuralism, functional analysis, dynamical systems theory, general systems theory, etc. is precisely such a methodology. These approaches share Wittgenstein-like family resemblances: each presupposes *relations* prior to the relata. Crucially, the systems approach seeks principles that apply *across domains*, irrespective of the specific nature of the elements involved. As Ludwig von Bertalanffy, a founder of general systems theory, observed: "Thus, there exist models, principles, and laws that apply to generalized systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relations or 'forces' between them. It seems legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general" [Bertalanffy 1969: 32]. This universality is essential for consciousness studies, where data range from neural correlates to subjective reports. "Nothing prescribes that we have to end with the systems traditionally treated in physics. Rather, we can ask for principles applying to systems in general, irrespective of whether they are of physical, biological or sociological nature" [Bertalanffy 1969: 33]. Thus, when we model something as a system, we adopt a framework capable of integrating heterogeneous data without prematurely reducing one domain to another. Here, by 'modeling' is

meant the representation or substitution of one object (the target system) by another (the model system) with respect to specific aspects (properties or relations) via a context-dependent correspondence (morphism). (Modeling allows the investigation of complex or unknown aspects of a target system through the analysis of its counterpart).

In a generalized way, a *system* can be defined as *a set of objects or things with definite or certain relation between them* (e.g., see [Shapiro 1997: 73], [Uyemov 1999: 365]). The notion of a system in a less abstract way can be defined through the notions of wholeness, interaction, order, or complexity (e.g., [Bertalanffy 1969: 19], [Thompson 2011: 40], [Maturana & Verden-Zöller 2008: 176], [Ladyman 2020: 7-8]), but these are just concretizations[5] of the *definite relations* from the generalized definition. Thus, when we model something as a system, we use a systems approach.

To apply the systems approach effectively, however, we must articulate explicit methodological principles that prevent category mistakes, omit metaphysical conflations, or premature reductions. The next section presents three such principles.

3. Three Principles Useful for a Systemic Study of Consciousness

3.1. The Inconsistent Tetrad

The solution (systemic or not) to the problem of consciousness – the *why*, the *how*, and the *what* of consciousness – is closely related to the solution of the mind-body problem, which can be formulated as the classical *inconsistent tetrad* (see [Westphal 2016: 1–4]):

(i) The body is physical.
(ii) The mind is non-physical.
(iii) Body and mind interact.
(iv) The physical and the non-physical cannot interact.

Deny any one of these four, and the remainder becomes consistent, yielding the familiar positions: materialism, dualism, epiphenomenalism, idealism, etc. More sophisticated views (such as non-reductive physicalism or certain variants of biological naturalism or hylomorphism) when pushed to their limits, tend to collapse back into one of these simpler stances. 'Monotonic reasoning' cannot handle such complexity. Non-reductive physicalism affirms the physicality of the mind while denying the reducibility of mental predicates to physical ones. John Searle, for instance, appeals to a distinction between ontology and causality to avoid contradiction (see [Searle 2004: 79], [Lyashenko 2022]) and so on.

Thus, to address the problem of consciousness coherently, we must 'bracket' metaphysical commitments and analyze the structure of the problem first. One way to do so is to adopt *a structural-ontological stance* toward *metaphysical commitments*.

By *structural ontology* (following Arnold Tsofnas' terminology), I refer to a form of relational ontology – a framework concerned with the formal, relational structure of the world, independent of *natural-ontological* questions (i.e., questions regarding the essential nature of things, such as materialism versus idealism). Its

primary role is to describe structures and patterns from within a stable conceptual standpoint, enabling the relative and systemic modeling of any object irrespective of its natural or essentialist constitution.

By *metaphysical commitments* I mean substantive claims about what exists fundamentally (grounding, dependence, essence, modality, etc.).

3.2. Principle of Structural-Ontological Neutrality

What would change in our analysis if consciousness were ontologically non-physical? What if consciousness were an illusion? What if it were identical with brain states? In each case, the *formal fact* remains: we have first-person data (*1p*) and third-person data (*3p*) to account for. Metaphysical commitments cannot eliminate these data. Almost nobody argues against the *3p* data, as for the *1p*, we should keep in mind that the subject matter can only be 'seen' (let alone studied) through some kind of conceptual framework. As Donald Davidson says on a related subject, "in order to describe and explain thought we need concepts that cannot be defined in the vocabulary of physics (or any of the natural sciences)." [Davidson 2001: 123]. As the inconsistent tetrad shows us, that researchers argue about the matter of metaphysical (natural-ontological, essentialist) aspects of consciousness nevertheless using both 'mental' and 'physical' vocabularies laden with all their inconsistent metaphysical commitments. If we, for the time being, deprive the 'essentialist' content of these vocabularies and consider just the structure of the problem we would be able to study it further without inconsistency. (Imagine, for example, if the 'first mathematicians' instead of agreeing with each other that 2 plus 2 equals 4 throughout different domains of discrete things, would continue to argue that it depends on the nature of objects or on the contextual aspects of the counting situation).

Thus, we must adopt the *principle of structural-ontological neutrality*, that stems from formal sciences (cf. Carnap's principle of tolerance) and is also related to Husserl's metaphysical neutrality, i.e., temporarily suspend claims about the metaphysical nature of mental or physical entities, and focus instead on their *structural* or *formal* roles. To paraphrase Quine: *what matters to a theory is its structure, not the intrinsic nature of its objects* [Quine 1981: 20].

This principle is not new to systems theory; it is implicit in Bertalanffy's original vision [Bertalanffy 1964; Bertalanffy 1969]. He explicitly described the system concept as a "psychophysically neutral" framework [Bertalanffy 1969: 220] and argued for "universal principles applying to systems in general" irrespective of their "physical, biological, or sociological nature" [Bertalanffy 1969: 32–33]. He wrote: "The system concept provides a theoretical framework which is psychophysically neutral. Physical and physiological terms such as action potentials, chemical transmission at synapses, neural network, and the like are not applicable to mental phenomena, and even less can psychological notions be applied to physical phenomena. System terms and principles like those discussed can be applied to facts in either field" [Bertalanffy 1969: 220]. Consciousness studies should therefore focus first on patterns, relations, structures, and only later on metaphysical questions. This principle allows us to avoid the deadlocks of the

inconsistent tetrad and treat mental and physical vocabularies *modulo their formal role*.

Methodological neutrality should be distinguished from, yet may be seen as pragmatically aligned with, ontological theories positing fundamentally neutral relations (e.g. [Fine 2000]). Where Fine posits neutral relations that are inherently non-positional and order-independent, thus capturing a single, unbiased state of affairs in reality (as part of reality's fundamental structure), systems' principle treats neutrality as a provisional, integrative stance for cross-theoretical modeling. Thus, Fine's thesis is a metaphysical claim about reality's structure, while here we are dealing with a meta-methodological prescription for a theory construction. However, they may be seen as complementary, a systems model, built under these principles, might be viewed as formally capturing the kind of relational structure that Fine's metaphysics describes.

3.3. The Principle of Differentiation and System Modeling (P–R–M)

3.3.1. Systems Descriptors: P–R–M

The principle of structural neutrality plays the role of a necessary prerequisite for the system study of consciousness, but there is nothing *per se* systemic in the use of this principle. If you apply mathematical modeling to the study of consciousness or consider it through the framework of Husserl's phenomenology, your study will remain metaphysically neutral unless you interpret it in one or another metaphysically laden way. On a par with it, if you are to study consciousness systemically you should deprive it of its metaphysical commitments, because a system is not a thing in the world it's a set of objects of any nature with definite relations instantiated on them (or it could be said that it's a set of specifically structured objects)[6].

There are many systems theories in general, and a growing number that address consciousness. My aim here is not to apply a systems approach directly to experimental data – for that, there are well-developed frameworks such as Integrated Information Theory (see [Koch 2019]), Predictive Processing (see [Reynolds 2024]), or enactivist theories (Maturana, Varela, Thompson, Noe, etc.). Nor am I proposing yet another meta-theory to unify all approaches to consciousness (à la [Wilber 1997] or [Combs 2009]). Rather, I want to underscore once more, and in one place, that a phenomenon as complex as consciousness must be treated *complexly* and without metaphysical reduction (at least at first). For this purpose, I propose a conjunction of necessary methodological principles. These principles are intentionally abstract – they are not tied to any specific system model already used in consciousness studies, which is why they can be applied both to consciousness itself and to the theories that seek to explain it. Unlike IIT (which privileges integrated information as an ontological primitive), enactivism (which foregrounds sensorimotor coupling), or PP (which centers on prediction-error minimization), this framework does not presuppose a privileged substrate, mechanism, or metaphysical commitment. Instead, it offers a neutral scaffold for systematic comparison and integration. For these reasons I use a more foundational, metaphysically neutral approach, and draw on Uyemov's General

Parametric Systems Theory – a logically grounded, non-extensional methodology that structures systems in terms of things, properties, and relations, without prior reduction to set theory or standard mathematics (see [Uyemov 1999; Uyemov 2002; Uyemov 2003]).

In Uyemov's systems approach we should distinguish three basic levels of any system: *Concept* (*P*): the perspective, function, or epistemic frame. *Structure* (*R*): relations imposed according to *P*. *Substrate* (*M*): the elements being structured. A system is thus represented as the triplet $S = \langle P, R, M \rangle$, where: *P* determines allowable relations, *R* organizes the substrate, *M* contains the elements being related.

Let's consider an example. Several professionally trained individuals – a doctor, a police officer, a physicist, a philosopher, and a janitor – witness a quasi-tragic event: a human-like dummy flying out of an eighth-floor window. Beyond natural human reactions, each interprets the event through their professional lens. The doctor frames it as a patient-doctor system, focusing on survival and emergency procedures. The police officer sees a potential crime scene, attending to victims, offenders, and crowd control. The physicist calculates trajectories and impulses, treating it as a physical system. The philosopher reflects on observer moments, on the nature of temporality, and causal grounding, free will, and Aristotle's notion of natural motion, briefly noting the janitor's forthcoming task.

Systemically, all engage with the same substrate $M = \{o, s, w, H, c\}$, where *o*= human-like object, *s*= street, *w*= window, *H*= {doctor, police officer, physicist, philosopher, janitor}, and *c*=contextual factors (air resistance, bystanders, etc.). Relations *R* and concepts *P* (medical, legal, physical, metaphysical, etc.) act on this substrate, producing distinct systems. Each concept highlights certain aspects while reducing others, showing that systemic analysis depends on the scope and instantiation of *P* through *R* rather than being intrinsically holistic or reductionistic. Strictly speaking, substrates are not coextensive – e.g., there cannot be the same substrate if the concept *P* is different – because every concept hides some aspects and reveals others. This is why having the results of scientific experiments – raw data – is not the same as having scientific facts: facts necessarily involve interpreting data through certain relations by some observer.

Applying this to systems consciousness studies, different theories can be distinguished by the meta-language of *P*–*R*–*M* descriptors they foreground. In Integrated Information Theory (IIT), the conceptual core *P* is cause–effect power, structured *R* through self-acting compositional relations, and realized in any mechanism *M* that instantiates intrinsic causal structure (see [Koch 2019: 79-91]). In contrast, Predictive Processing (PP) takes prediction-error minimization as *P*, approximate Bayesian calculations (updating prior expectations against likelihood) as *R* and a hierarchical neural substrate *M* (see [Reynolds 2024]); in Maturana's autopoietic framework, consciousness emerges from the embodied organism's recursive structural coupling with itself and its medium – *M*, specifically manifested through relations established in the linguistic domain and sustained through ongoing conversations – *R*, constrained by the system's fundamental aim

of self-production (autopoiesis) – *P* (e.g., [Maturana 1988: 63–64], [Maturana & Varela 1998: 231–235]). The *P–R–M* framework thus offers a structurally-ontologically neutral, meta-theoretical language for analyzing different models of consciousness.[7]

3.3.2. Epistemic and Ontic Differentiation

Even after applying structural neutrality, we still have a possibility of an ontological reduction of one set of terms (e.g., mental vocabulary or *1st* person terms) to another one (e.g., *3rd* person or physical vocabulary) because the principle of structural neutrality does not differentiate between perspectives by itself, we need in addition another principle. I.e. we still need to distinguish epistemic perspectives (*1p*-knowledge, *3p*-knowledge) from ontic layers (*1p*-ontology, *3p*-ontology). This yields a fourfold differentiation. In my previous paper on these principles [Lyashenko 2021] I used the term "experience", but this term could be misleading unless one presupposes a qualitative or phenomenological interpretation of consciousness. Under the principle of structural-ontological neutrality, however, we bracket all metaphysical assumptions about the intrinsic nature of mental or physical relata. What matters for system modeling is not the essence of the relata but their structural-ontological role within the system. Within this framework, relata are identified not by their metaphysical nature, but by their structural position stripped of their essentialist or natural-ontological commitments. The most fundamental such distinction is between the agent (self, subject, system-internal) and the environment (not-self, object, system-external). These are numerically and structurally-ontologically distinct relata.

Thus, instead of speaking of first- and third-person *experience*, we should speak of first- and third-person ontology (structural ontology). *1pK* – first-person knowledge; *3pK* – third-person knowledge; *1pO* – first-person ontology (subjectivity, interiority); *3pO* – third-person ontology (objectivity, exteriority). The *principle of differentiation* maintains explicit distinctions among different epistemic and ontic layers to avoid category errors or illegitimate reductions. It prescribes *how consciousness should be studied* by rigorously analyzing the distinctions between first- and third-person perspectives (1p/3p) and between ontic and epistemic layers. When we attempt reductions (e.g., *1p* to *3p*), we are imposing a structure *R* on *M* according to a specific concept *P*. If *P* restricts all perspectives to *3p*, the resulting theory is necessarily materialist; if *P* restricts all perspectives to *1p*, the result is idealist.

From a system view, consciousness could be modeled as the system of modeling *R* of ontic elements *M* through epistemic perspectives *P*.

This methodological commitment to differentiation is not without precedent in systems thinking. Ludwig von Bertalanffy's work already pointed toward the necessity of distinguishing perspectives. He described differentiation as a fundamental process in development, where consciousness evolves from relatively undifferentiated state to a differentiated and hierarchically ordered state. [Bertalanffy 1969: 211–213]. Bertalanffy claims that the self emerges from an undifferentiated unity with its environment. "Thus "I" and "the world," "mind" and

"matter," or Descartes's "res cogitans" and "res extensa" are not a simple datum and primordial antithesis. They are the final outcome of a long process in biological evolution, mental development of the child, and cultural and linguistic history, wherein the perceiver is not simply a receptor of stimuli but in a very real sense creates his world." [Bertalanffy 1969: 212].

The semi-metaphysical consequence of the principle of differentiation is the claim that: *consciousness models 'reality'*,[8] and distinguishes itself from what is not itself – but to what end? Empirical observation suggests a functional answer: to predict and reconstruct events (cf. [Clark 2013]). Before acting in a survival-relevant situation, a conscious system can simulate possible outcomes to guide decisions; similarly, it can reconstruct past events to learn from experience. This points toward a pragmatic heuristic: treat consciousness as if its core function is to model reality in non-trivial contexts. This premise enables systematic integration of *1p* and *3p* data and offers a tentative answer to the *why* of consciousness: it exists to model reality through perspectival differentiation. While contexts evolve (not every situation demands hunting mammoths or navigating predators) the fundamental epistemic role of consciousness remains: the modeling of ontic perspectives.

While this predictive heuristic aligns with dominant neuroscientific frameworks, it should be noted that enactive and autopoietic traditions [Maturana & Varela 1998; Varela et al., 2017] offer a non-representational alternative. In their view, the organism does not "predict" but *enacts* or *brings forth* a world through structural coupling, while predictability reflects only an isomorphism between relational domains – not access to an objective, observer-independent reality (see [Maturana & Varela 1980: 122]). Nevertheless, for our system modeling this distinction is largely one of concrete interpretation and metaphysical commitment, because even this enactive process can be formally described as a relational modeling between a system and medium – a description fully consistent with our structural-ontological neutrality, differentiation of perspectives, and the subsequent principle of embodiment.

3.4. The Principle of Embodiment

Reconsider the systemic explication of consciousness: a system that models ontological relata (*1pO/3pO*) through epistemic perspectives (*1pK/3pK*). Structural neutrality permits multiple realizability – nothing in the framework commits us to a privileged substrate. In contrast, in purely structuralist or functionalist analyses, the substrate *M* is often minimized, foregrounding relational or conceptual aspects.

Yet systems theory also allows that *M* is not a passive bearer of relations. The substrate exerts formative influence: it constrains which structures *R* can be realized and thereby shapes how the conceptual descriptor *P* is articulated and revised. Thus, we observe a dialectic between concept, structure, and substrate – a movement from *ante rem* patterns toward material instantiation, and a counter-movement in which the properties of *M* determine which structural possibilities of *R* become actual. This interplay grounds our third principle: *the principle of embodiment*.

The composition of *M* in a conscious system is therefore foundational. Our systems approach remains neutral (at least intrinsically) as to whether *M* is narrowly internal (e.g., neural states) or broadly extended (e.g., organism-environment nexus, including physical, ecological, social, and cultural dimensions). Accordingly, *R* must capture not only concept-driven structuring but also the formative (and restrictive) influences arising from these environmental embeddings. Biological systems, in particular, are shaped by morphological, physiological, ecological, technological, and cultural constraints. Embodiment is thus unavoidable in a comprehensive systemic study of consciousness.

Like other principles, this principle is historically consistent with systems theory. "It would be perfectly possible that rational beings of another structure choose quite different traits and aspects of reality for building theoretical systems, systems of mathematics and physics." [Bertalanffy 1969: 245-246]. Moreover, Bertalanffy extended the concept of embodiment far beyond the individual organism to include cultural and symbolic systems as constitutive realms [Bertalanffy 1964: 42-43; Bertalanffy 1969: 239-248].

The embodiment principle does not render structuralist or functionalistic approaches invalid; rather, it refines their scope. Modeling specific relations on a specific substrate yields specific outcomes – not generic ones.[9] Whether and how the body *produces* consciousness biologically may remain an open question, but it is undeniable that consciousness is profoundly shaped, structured, and conditioned by embodiment and its environmental coupling. (see [Capra & Luisi 2016], [Lakoff & Johnson 1999]; [Lakoff & Narayanan 2025], [Maturana & Varela 1998], [Noë 2010], [Thompson 2011], [Varela et al. 2017]).[10]

Crucially, the principle of embodiment is advanced *here* not as an empirical claim to be verified (as it might be in specialized cognitive science or neuroscience) but as a methodological commitment. It serves as a regulative presupposition, ensuring that systemic models acknowledge the formative constraints of a realizing substrate without presupposing its metaphysical nature.[11] As Sanches de Oliveira notes, embodiment "is not a hypothesis about particular instances… but is rather the starting assumption that informs how we conceptualize, investigate and understand any and all psychological and behavioral phenomena" [de Oliveira 2023: 2]. In this light, embodiment functions as a research-programmatic orientation, not merely a complement to traditional approaches.

Thus, the principle of embodiment is fully consistent with structural neutrality and perspectival differentiation. It introduces no intrinsic essences (mental or physical) but concerns the conditions of manifestation for consciousness. Different embodiments yield different conscious possibilities: human, octopus, alien, artificial, angelic. In this way, embodiment completes the triad of principles necessary for any coherent systemic study of consciousness.

4. Counter-World Argument for the Necessity of the Three Principles

I do not claim that these three principles constitute an exhaustive list of all principles relevant to the study of consciousness. Rather, they are the three

principles that are necessarily presupposed by any comprehensive and coherent systemic study of consciousness.

They arise directly from the internal logic of system modeling itself, that requires (i) an *invariant* or neutral domain of possible realizations (addressing the question *how* of consciousness operates), (ii) an internal *differentiation* of relata and perspectives (addressing the question *why* consciousness exists), and (iii) a domain of *material realization* and constraint (addressing the question *what* consciousness is).

For these reasons, the triad is not contingent, and therefore necessarily included in any comprehensive systematic account of consciousness, even though additional principles may be introduced for specific theoretical purposes.

Let M be a model with the frame $\langle W, R \rangle$, where W is the set of all possible worlds, and R an accessibility relation that is reflexive, symmetric, and transitive (S5). Let the actual world be $w_0 \in W$. Since R is an S5 accessibility relation, all worlds in W are mutually accessible.

Let's define three key propositions:

N: "*Any comprehensive systemic consciousness study is structurally-ontologically neutral*."

D: "*Any comprehensive systemic consciousness study takes into account perspectival differentiation: 1pO/3pO and 1pK/3pK*."

E: "*Any comprehensive systemic study of consciousness includes embodiment (substrate limitations, feedback)*."

In our world w_0 all three hold:

$M, w_0 \vDash N \wedge D \wedge E$

4.1. World without perspectival differentiation

Let $w_1 \in W$, where:

$M, w_1 \vDash N \wedge \neg D \wedge E$

In w_1, scientists cannot distinguish between *1p* and *3p* perspectives. The very conditions for knowledge, research, representation, intention, communication, or self-referential awareness disappear. Without perspectival differentiation, there is no possible distinction between internal and external states, subjectivity and objectivity, individuality and collectivity, or any boundary between agent and environment. Science becomes impossible – not merely because this resembles rejecting Plato's distinction between *epistēmē* and *doxa*, but because objectivity and subjectivity themselves lose meaning.

Consequently, what *humans*$_1$ could call consciousness in w_1 would be a monolithic, undifferentiated field rather than a modeling perspective embedded in a world. The principle of differentiation is therefore not optional; without it, coherent consciousness study cannot exist.

4.2. World without structural-ontological neutrality

Let $w_2 \in W$, where:

$M, w_2 \vDash \neg N \wedge D \wedge E$

In such a world, the concept of consciousness becomes substance-bound: it is identified with a particular physical (or mental, or protoplasmic) realization.

Consequently, no abstraction across levels is possible. *Scientists*$_2$ cannot identify structural invariants, cross-species commonalities, or functional analogies; nor can they meaningfully study artificial or alien consciousness. Consequently, their own consciousness could even become indistinguishable for them.

System-theoretic modeling collapses into reductive materialistic eliminativism (or its idealistic analogue). A general science of consciousness is impossible in w_2 because there is no principled way to abstract from substrate to structure. This shows that structural neutrality is indispensable for any systemic theory of consciousness.

4.3. World without embodiment

Let $w_3 \in W$, where:

$M, w_3 \vDash N \wedge D \wedge \neg E$

In w_3, consciousness is studied as a pure formal pattern without substrate constraints. Without such constraints, one cannot distinguish (or explain) modality-specific experiences, species-specific organization, or developmental trajectories. 'Consciousness' becomes an abstract mathematical structure, without any traceable relation to the world. Consequently, *scientists*$_3$ would be forced to claim that the consciousness of *humans*$_3$ is identical for all *humans*$_3$, and not distinguishable from that of any other conscious species.

4.4. Necessity of the principles

In S5, if a statement is true in all accessible worlds, it is necessarily true. We argue that in any world $w \in W$ in which a systemic study of consciousness is coherent and comprehensive, the following holds:

$M, w \vDash N \wedge D \wedge E$

Therefore, *N*, *D*, and *E* are necessary conditions for such a study.

The counter-worlds argument does more than test necessity – it claims that every choice of methodology is also a choice of world and vice versa. For example, to deny *differentiation* is to choose a world where science cannot distinguish observer from observed; to abandon *embodiment* is to choose a world where consciousness floats free, untethered from life or development – a view reminiscent of Cartesian abstraction. These are not just logical possibilities; they are metaphysical programs already present in today's research. Some reduce consciousness to neural correlates (denying neutrality), some collapse *1p* experience into *3p* data (denying differentiation), some treat mind as pure information (denying embodiment). But in doing so, they unwittingly inhabit one of these diminished worlds – worlds in which a *general* science of consciousness becomes impossible.

The principles function as enabling constraints: they do not prescribe what consciousness *is*, but they delineate *how it can be systemically studied*. This formal, structural approach aligns with the view that science, in Bertalanffy's words: "does not make metaphysical statements, whether of the materialistic, idealistic, or positivistic sense-data variety. It is a conceptual construct to reproduce limited aspects of experience in their formal structure. Theories of behavior and of psychology should be similar in their formal structure or isomorphic" [Bertalanffy

1969: 220]. Our triad of principles aims to provide precisely such an isomorphic scaffold (neutral, differentiated, and embodied) enabling coherent mapping between phenomenological, neural, and functional accounts of consciousness.

5. Conclusion

I have argued that any comprehensive and coherent systemic study of consciousness should presuppose at least three methodological principles: structural-ontological neutrality, differentiation of perspectives, and embodiment. These principles do not arise from speculative metaphysics but from the intrinsic requirements of system modeling itself. Without neutrality, theories collapse into reductivism; without differentiation, the subject-object structure of cognition disappears; without embodiment, consciousness becomes an abstract pattern. The counter-world analysis shows that these failures are not contingent or accidental but structurally inevitable. The principles articulated here therefore function as enabling constraints: they open the space in which consciousness can be studied without confusion of categories or premature metaphysical commitments. Their purpose is not to resolve the mind-body problem but to clarify the formal conditions under which an integrative science of consciousness can proceed. While developed independently within a systems-theoretic tradition, the principles articulated here could be aligned in dialogue with contemporary analytic metaphysics. For instance, the *P-R-M* framework's relational focus parallels the ontological priority of relations in certain metaphysical systems, and the principle of embodiment naturally calls for grounding-theoretic explication, and this is not to mention the clearly systemic nature of hylomorphic theories of consciousness.

Notes

1. These are different terms but at our level of abstraction their differences are not crucial.

2. If this were not the case, then we would already have the science of consciousness, simply by summing up data from various approaches.

3. Reduction is understood here as the explanation of one theory, data set, or science from the perspective of another, i.e. it is intrinsically related to the notion of *modeling*, by which I mean the construction of a relational (not necessarily formal) counterpart (the model) to a target system via a structure-preserving mapping (morphism), enabling the study (understanding etc.) of the target through analysis of the model. It is helpful to distinguish between methodological reduction (a scientific modeling) and ontological reduction – metaphysical modeling, the source of reductionism as a metaphysical position. (cf. [Chalmers 1996])

4. Monotonic logic assumes that if a sentence *B* can be inferred from a set of hypotheses *A*, then it can also be inferred from any superset of *A*. This can produce misleading conclusions when applied to consciousness: for example, if 'thinking' is identified with 'calculation,' then adding further information does not block the inference, and even a pocket calculator might end up counting as conscious.

5. Compare with Frigg's "concrete structures" [Frigg 2022: 198].

6. According to the principle of neutrality, a system is not constrained by the intrinsic nature or origin of its objects; only by structural features (such as wholeness, complexity, closure, or isomorphism).

7. Moreover, the full machinery of system-theoretic analysis (including systemic parametric modeling with possible systems law-like generalizations) can be applied to deepen the analysis (see [Uyemov 1999; Uyemov 2002; Uyemov 2003]).

8. The term 'reality' is not intended in a strict metaphysical sense but only as a neutral placeholder for whatever is modeled.

9. The methodological necessity of accounting for the realizing substrate *M*, as demanded by the principle of embodiment, finds a sophisticated metaphysical treatment in Kit Fine's mereology of embodiment. Fine distinguishes between rigid embodiment (essential, time-independent parts, e.g., atoms in a molecule) and variable embodiment (time-relative parts, e.g., cells in an organism). This distinction provides a formal ontology for describing how *M* can remain a coherent system despite material flux – precisely the kind of substrate unity presupposed by systems-theoretic modeling of living or conscious entities. Thus, Fine's framework offers intermediate formal tools between our abstract methodology and empirical research (see [Fine: 1999]).

10. As seen in Bertalanffy's systemic work (and later in constructivist and enactive approaches), embodiment has two vectors: an 'interior' one, referring to the constitutive context of consciousness, and an 'exterior' one, referring to its enactive role in shaping or "bringing forth" the world. The embodiment principle aligns with enactivist accounts that stress the constitutive role of sensorimotor coupling, lived experience, and organism–environment interaction in forming mind [Maturana & Varela 1998; Noë 2010; Thompson 2011; Varela et al. 2017]. Yet, whereas enactivism highlights biological and phenomenological specificity, our principle treats embodiment as a methodological and structural constraint applicable to any realizing substrate, biological or not. A detailed engagement with enactivist theory, although relevant, lies beyond the scope of this meta-methodological analysis.

11. The distinction between our methodological constraint and empirical claims is crucial when considering counter-arguments to embodiment, such as in [Turner 2020]. Turner argues that if strong cognitive phenomenology exists independently of sensory experience, phenomenal consciousness might not require a sensory-coupled body. For the systems model, this counter-possibility does not invalidate embodiment, but rather necessitates its interpretation as a general principle of a substrate constraint, even a disembodied AI requires an explicitly defined, non-biological realizing substrate *M*, (e.g., a computational architecture) that imposes formative constraints on the system's structure *R*, thereby preventing the model from collapsing into unconstrained abstraction.

12. This aligns with eliminativist materialist views such as those of the Churchlands.

13. Such a view is reminiscent of Cartesian dualism and some idealist traditions that abstract mind from material constraints.

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ПРИНЦИПИ ДО ТЕОРЕТИКО-СИСТЕМНОГО ДОСЛІДЖЕННЯ СВІДОМОСТІ: ЛОГІКО-МЕТОДОЛОГІЧНИЙ АНАЛІЗ

В статті пропонується набір методологічних принципів, необхідних для побудови цілісного системного опису свідомості. Стверджується, що наявні підходи (нейробіологічний, обчислювальний, феноменологічний чи культурний) не можуть конвергувати без метатеоретичної основи, здатної координувати гетерогенні дані та уникати «інерційних» метафізичних припущень. Спираючись на загальну теорію систем, сформульовано такі три принципи: структурно-онтологічна нейтральність, для абстрагування від есенціалістських онтологічних зобов'язань; диференціація перспектив, що розрізняє позиції першої та третьої особи, а також епістемічні та онтичні рівні цих перспектив; та втіленість, що підкреслює обмежувальну та конститутивну роль субстрату системи свідомості. Аналіз модальних контр-прикладів показує, що відсутність будь-якого з цих принципів руйнує самі умови для системної теорії свідомості. Разом ці принципи забезпечують методологічний мінімум метафізично нейтрального каркасу для інтеграції теорій, запобігання категоріальним помилкам та прояснення структурних умов дослідження свідомості.

Ключові слова: *свідомість, системний підхід, системні дескриптори, метафізичні зобов'язання, структурно-онтологічна нейтральність,*

втіленість, диференціація перспектив, модальна логіка, моделювання, мета-теоретична редукція.

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