On the Computational Necessity of Consciousness

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Abstract

The existence of phenomenal consciousness remains a central problem in the philosophy of mind and cognitive science because it resists explanation in naturalistic terms. A *sufficient* explanation of phenomenal consciousness would require establishing a necessary mapping between mental processes and subjective experience, whereby consciousness would be explained in relation to mental computation. Without such necessity, subjective experience would appear as an optional add-on to cognition, without purpose or function. In this article, we attempt to bridge this gap by identifying the computational role of subjective experience. We argue that a specific class of mental processes cannot be realized without consciousness. We describe these processes and the structural requirements they impose, and we show how subjective experience necessarily arises from the performance of these functions under those constraints. This allows us to explain how subjective experience emerges and to specify constitutive conditions under which it acquires a determinate form. On this basis, we show that, given the existence of these processes, subjective experience could not fail to emerge. We further argue that subjective experience is the only mental property capable of meeting the relevant constraints while explaining the target cognitive capacities. By excluding the relevant counterfactuals, the paper offers a unified response to the hard problem of consciousness.

Introduction

The problem of consciousness is a long-standing issue in both philosophy and cognitive science. While many aspects of cognition have been successfully explained in naturalistic and computational terms, phenomenal consciousness, that is, *what it is like* to have an experience, remains resistant to such accounts (Chalmers 1995, Nagel 1973). Even though it can be internally observed and felt, it fails to be fully explained in naturalistic terms, as such descriptions seem to miss the subjective *experience* of the event. Mental processes are explained functionally; they can reach a sufficient explained with *how* and *why*. Yet this machinery does not extend to consciousness. Consciousness seems be entirely detached, an add-on to a mental machinery which would suffice by itself. In this case, not only is there no apparent way to bridge the gap, but not even an explanatory framework that could warrant connecting the two sides of this chasm. This difficulty has been traditionally described as *the explanatory gap* between the physical and the consciousness, suggesting a potentially unbridgeable divide (Levine, 1983). This gap stems from the very possibly of an explanatory sufficient account for consciousness and subjective experience. In the case of consciousness, the only way to provide a sufficient explanation is to create a necessary mapping between the two sides of the gap. In other terms, it has to give a sufficient account of consciousness within the framework of the natural sciences.

Although no conclusive answer has yet been provided to this problem, progress has been made in its reformulation and clarification. In its most recent form, these two issues have been articulated in a single question: *the hard problem of consciousness* (Chalmers, 1995). The hard problem can be understood as an extension of the explanatory framework of natural sciences into subjective experience. It asks both *how* consciousness emerges and *why* it would do so. The *how* question reframes the explanatory gap and asks how subjective experience could even arise from physical processes. The *why* question, at the heart of the hard problem, is why there would be subjective experience at all.

In a first section, we will lay out the conditions for a possible answer. We describe potential solutions from the literature and identify their failure, most notably that their account did not even allow the possibility of excluding counterfactuals. We then scope out an approach for answer. If there is a class

of observable mental processes that depend on consciousness, then in any possible world in which these mental process holds, consciousness is necessary. Our second section describes such a set of mental processes, which we identify as structurally unbounded mental processes, such as mathematical reasoning or planning. We set out a set of requirements for these processes to be possible, which we derive from computational theory. If the mind is ever to compute, it must abide by this set of requirements. A third section describes how, given the requirements above, subjective experience could not fail to emerge. It arises as a necessary consequence from the computational requirements highlighted above. We then highlight a set of sufficient constitutive conditions for consciousness to arise, thereby providing an answer to the *how* problem. Our fourth section describes how subjective experience is necessary for these processes to be possible in the first place. We explain how there is no other alternative to consciousness to fulfill these requirements, thereby ensuring modal closure for the *why* question. In this way, we can ascribe a *function* to phenomenal consciousness, thereby providing a bridge across the explanatory gap.

I. Framing the Problem of Consciousness

Any attempt to answer the hard problem of consciousness must begin by clearly delimiting the space of admissible solutions and their underlying assumptions. The hard problem arises only within the project of a unified theory of the mind, seeking a single explanatory framework applicable across all mental processes (Newell, Chalmers). The failure to apply the same explanatory framework across all mental phenomena thus gives rise to the explanatory gap.

On the one side of this gap lies the domain of mental processes understood in functional and physical terms. This domain includes memory, attention, reasoning, and other cognitive capacities, together with their physical instantiation. These processes are given as matters of fact: they characterize our cognitive condition and biological nature without requiring further metaphysical justification. Explaining them is therefore an empirical task. Because mental processes are defined by the roles they play in the regulation of behavior, they admit a well-defined explanatory architecture. Empirical analysis can then account both for *why* such processes occur their functional role- and for *how* they occur -their physical realization. Taken together, these two dimensions provide a *sufficient* explanation of the processes in question. Contemporary cognitive science and neuroscience operate within this explanatory framework. It is precisely the availability of such a framework that motivates the classification of these questions as the "easy problems" of consciousness: not because they are trivial, but because they are in principle tractable by empirical methods (Chalmers).

On the other side lies the domain of subjective experience. This domain is constituted by phenomenal consciousness: what it is like to see a red rose, to feel pain, or to experience a thought. Here, too, we can enumerate and describe instances of experience. The difficulty, however, is not descriptive but *explanatory*. Subjective experience is itself a mental phenomenon; it occurs within the mind, interacts with other cognitive faculties, and participates in the overall organization of mental life. If the aim is a unified theory of the mind, then subjective experience cannot be treated as an ontologically isolated addendum. It must be integrated within the same explanatory framework used to account for other mental processes on the other side of the gap. Accordingly, subjective experience must also be explained in terms of *how* it arises and *why* it occurs. A complete explanation would therefore require that phenomenal facts be accounted for using the same explanatory resources. The explanatory gap arises in the attempt to extend the explanatory framework used for mental processes to the domain of subjective experience. Closing this gap would require a mapping between physical or functional descriptions and phenomenal facts.

Yet such a mapping must satisfy stronger conditions than those imposed on ordinary empirical laws. A merely empirical mapping is insufficient: it would describe what happens without explaining *why* it must happen, leaving the structure of experience itself unjustified and consciousness as a brute fact. What is required instead is *explanatory sufficiency for the domain of subjective experience*. Such an account must

establish that subjective experience is grounded in the relevant physical and functional states in a way that could not be otherwise. In other words, the explanation must secure a relation of necessity between mental processes and the phenomenal domain to be sufficient. In other terms, it demands modal closure. Without modal closure, there would be no satisfactory explanation for consciousness, as it could have been optional.

From this perspective, the hard problem can be reinterpreted as an extension of Levine's explanatory gap. The hard *how* and a hard *why* result from extending the easy *how* and the easy *why into the phenomenal domain*. *How* without necessity is correlation. *Why* without necessity is just a brute fact. The hard problem exists because consciousness appears contingent on the physical. Solving it requires showing that this appearance is mistaken and for no relevant counterfactuals open. Given the complete physical and functional facts, there must be no alternative way in which experience could be implemented, nor any alternative in which it could fail to occur. This requirement applies both to the determinacy of experience - what it is like- and to its role within cognition and behavior. The necessity involved is modal: the explanation must hold across all relevant possible worlds (Lewis). In other terms, the mapping we have identified must be necessary.

The necessity at stake must be scoped. In an unrestricted sense, one can always conceive of possible worlds in which beings similar to us exhibit radically different behavioral or cognitive profiles. Yet such is not the target of our problem, which aims to explain a given fact: that of consciousness in our current disposition. The relevant necessity is therefore conditional: necessity relative to humans as we actually are, constituted with our specific cognitive organization and behavioral capacities. If it can be shown that both the emergence of consciousness and its existence are necessary relative to the full range of human cognitive behaviors and actions, then we would have an answer to the hard problem would be secured.

Potential answers can be distinguished by their explanatory strength. At one end of the spectrum are fully naturalistic accounts, which aim to fully integrate subjective experience within the explanatory framework of mental processes. If successful, such accounts would provide the strongest form of explanation. At the other end are weaker approaches, which offer partial or deflationary explanations that stop short of full integration. The central issue, therefore, is not merely to find an answer, but to identify the strongest possible explanation.

Framing the problem in this way provides an overview of the range of existing responses to the hard problem. These have been largely covered by the literature both in philosophy and in cognitive science (Signorelli, 2020). A first approach is to add another ontological category to explain consciousness. Consciousness becomes an irreducible fact of existence and must be treated as a given. This approach has the advantage of giving a clear answer but at the cost of explanatory strength. Although modern positions have attempted to improve its integration with mental processes, any such attempt close the door to a full naturalistic bridge by design. This approach includes, for instance, dualist theories, which place consciousness alongside the physical (Chalmers), panpsychist views that treat consciousness as ontologically fundamental (Strawson, Goff), and anomalous monism, which allows irreducible mental properties within a physical ontology (Davidson). Such explanations create a category that escapes full naturalization, thereby avoiding a strong answer to the hard problem. The necessity is inbuilt but comes ad hoc, from external principles, which are of a different ontological class. A stronger explanation would therefore provide as clear an answer, but without requiring a different ontological category.

A second strategy seeks to collapse consciousness entirely into the physical domain. Its main advantage lies in fully using the explanatory framework of mental process but its ability to capture the phenomenological domain remains contested. Physicalist accounts span a range of positions, from fully reductive theories to non-reductive materialist views (Kim). Despite these differences, contemporary physicalist approaches share the common explanatory framework described above. The mind is understood as a functional system, typically modelled as an input–output architecture whose role is to generate behavior

(Friston, Clark, Howhy). Within this framework, mental activity is described in terms of processes and features instantiated by those processes. The explanatory task is then to identify, within this functional organization, the elements capable of grounding consciousness without introducing further ontological commitments. In effect, the explanatory challenge is to carry over the *how* and the *why* of consciousness into the same domain as mental processing itself. These theories broadly cluster around two major explanatory strategies. One locates consciousness in the structure of cognitive processing itself and identifies it with specific computational patterns within the system. The other locates consciousness at the level of representation and the presence of representational formats or contents.

The first category comprises a variety of theories which identify different levels of structures, amongst which a few dominant contenders. Some consider the structure to be the relationship between different components (Baars, Dehaene) or others in terms of the information structure (Dretske, Tononi). Related approaches emphasize dynamical features of processing, such as recurrent activity within the brain (Edelman). Yet all structural theories are faced with the same difficulty. Although we find *association* between reported phenomena of consciousness and these structures, it does not explain why this exists in the first place. Given these approaches mental processes are first and explain fully, consciousness acquires a role after within a pre-organized mental framework. Yet such an approach has difficulties facing the hard problem. These approaches measure *association and do not explain counterfactuals*. Consciousness can be accompanied by these processes, but it still fails to address the *necessity* of consciousness.

Theories of the second type locate consciousness at the level of representation rather than in processing. Consciousness arises when certain representational states, such as perceptual contents, predictions, or self-models, are present within the cognitive system. Conscious experience is thus identified not with processing per se, but with the output or representational products of mental activity. These representations come in multiple forms. First-order representational theories treat consciousness as directly given in perceptual representation, but they struggle to explain why some representational states are conscious while others are not. Higher-order theories, whether in terms of thought or perception, attempt to address this by introducing an additional representational level; in both cases, consciousness is located within the domain of representation rather than basic processing. More recent self-representational accounts (McClelland, 2020) refine this strategy, yet similar explanatory difficulties remain. They defer the problem to an inner process that itself still requires explanation and grounding in mental activity. The explanatory strategy remains one of structure and function, now relocated to representational space. As a result, these theories remain vulnerable to zombie-style objections and to access-based critiques: they account for reportability and cognitive accessibility, but do not discuss the necessity of consciousness, both in how and why. Representation can be fully specified without consciousness

We can then directly observe a fundamental difficulty with naturalistic approaches. *They fail to exclude the counterfactuals*. No necessary link is established between function and phenomenality, and the space of counterfactual alternatives remains entirely open. Their account of the mind are constructed in a way that leaves counterfactual explanations intact. In such models, any alternative realization of the same functions remains intelligible. An answer to the hard problem would therefore require a framework in which alternatives without consciousness are excluded as impossible or incoherent. Yet this is only possible if there are behaviors and mental processes which *cannot be explained without consciousness*.

Consciousness can be shown to be conditionally necessary only if it is required for a determinate class of mental processes. Its necessity must therefore be established relative to the cognitive tasks the system performs. On this account, consciousness operates within the economy of mental processes by enabling task execution and the corresponding behaviors. If consciousness is removed, these behaviors fail or lose their explanatory grounding. This necessity can be made precise by excluding counterfactual alternatives. If consciousness is required for a class of operations that cannot be specified independently of it, then alternative non-conscious implementations are structurally impossible and necessity results. What is

required, therefore, is the identification of a set of properties or operations that cannot be otherwise possible. These properties, naturally, must be identifiable from a third-person perspective. If consciousness is necessary for these operations, and if these operations themselves are necessary and empirically accessible, then the necessity of consciousness follows. If identifying such processes is not possible, then we would have to accept consciousness as a brute ontological fact.

II. Behaviors and Computations

This section aims to identify a class of cognitive processes that are reliably produced and to determine the conditions that are *necessary* for their computation. From the occurrence of these behaviors, we infer the necessity of the mechanisms without which they could not be realized. This analysis establishes the foundation for the subsequent discussion of consciousness.

The hard problem concerns whether consciousness can be explained within the same explanatory framework as mental processes. If the mind is computational, it must obey the constraints of computational theory. Where a required output is *necessarily* dependent on a specific mechanism, the possibility of the behavior entails the necessity of that mechanism. Mental computations are just a subset of the set of computational process. We have previously described mental processes as a dynamical coupling between mind and environment, which aims to regulate our behavior. In doing so, mental processes generate an output. This picture underlies conceptions of the mind, from older forms of functionalism to modern predictive coding. Any output is the result of a computation and thereby has to follow the rules of computation.

A. Recursive Functions

Let us therefore identify a class of outputs that are empirically observed. Humans routinely generate outputs involving intermediary computations, such as planning or mathematical reasoning. These involve performing computations then feeding back elements of the output back into the input. These tasks are not characterized by a fixed upper limit; for any given step of the task, a further step is in principle possible. These processes are called *structurally unbounded*. This is a structural feature of the tasks themselves. If, for example, mathematical reasoning were structurally bounded, this would contradict the very definition of formal systems. For instance, we can always add a number to another number, *ad infinitum*. Mental processes instantiate structurally unbounded processes. Humans are cognitively limited in practice, but structurally unbounded in principle. The limits we encounter are contingent constraints of memory, attention, or time, not limits imposed by the structure of the computation itself. This is evident from the fact that humans routinely externalize computation, for instance via notebooks or computers, to extend the depth of reasoning.

For structurally unbounded tasks, the space of possible solutions quickly grows beyond any fixed bound. In such cases, it is not possible to precompute or store all mappings between input and output: a finite-state system would require an intractable number of states, exceeding any physically realizable memory, biological or artificial. The inability to store this information is therefore structural and also cannot be implemented by finite-state computation. This therefore applies to the physical implementation of human mental processes. Even if we admit that the weights are dynamic and that mental capacity can evolve and grow, it cannot be unbounded.

For such outputs to be possible at all, the computational process must be recursive. The processes must be able to feed its own outputs back into subsequent stages of processing, thereby generating new states in an intermediate workspace. When a task involves nested dependencies, successful computation requires recursion on intermediate results. This intermediate state is not optional. It is a necessary component of

recursive process and enabling the system to handle structurally unbounded tasks while remaining physically realizable.

Any other alternative would violate laws of computation and thereby leave the unbounded processes we described above unexplained. It is thereby a *necessary* description of our mental processes. An alternative would imply a combinatorial explosion of possibilities. In other terms, a non-recursive zombie would be under the impossibility to learn it unbounded processes. This would imply an infinite computational capacity of the philosophical zombie, which is a much costlier commitment than admitting the necessity of consciousness for a subset of observed cognitive processes. This gives recursion a functional role within computation. These mental processes therefore require recursion and the preservation of intermediary states. Encoding all possible cases as a fixed set of objects would be computationally intractable. For a computationally bounded system such as the human mind, recursive state-preserving operations are necessary for such processes to occur.

B. Recursion and Type Consistency

We have seen the necessity of recursion within our mental processes. It requires an intermediate state to store information. The only condition for the scratchpad is to be used as an input of another function and do so in a computable way. To be used recursively, it must be of an acceptable input type.

There cannot be ever evolving or infinite types. Function would need to learn to operate on different types of inputs. You would need an adapter, and the said adapter is itself in need of justification. Yet there is no possibility to learn an infinite number of adapters because of the boundedness of the process. It is not possible to learn an adapter for a unbounded process, as we would need an infinity of adapters, which would not be possible. Type changing transformations have to be closed. If recursive steps require *type-changing transformations that are not closed under reuse*, then unbounded recursion becomes impossible in a bounded system. There is then a finite state of intermediary states in this mental cognitive process.

Let us recall that mental processes produce an output, to solve a task. As defined above, this one has a function in relation to the environment. The interface with the environment is perception. The process can only be evaluable in regard to output, which is behavior and of the type of perceptive data. It can only meet a function in relation to this type of data. Otherwise, the computation could not guide behavior or action. A mental processes is therefore evaluable in terms of the same input and output.

Yet some of these processes must be evaluable in stages and stopped, that implies these intermediary states are also of this same data type as the input and output. For instance, if we decide to interrupt the process because we realized along the way that the proof could be done better in another way. If an intermediate state cannot be evaluated *as it stands*, recursion cannot proceed. Therefore, recursive intermediate states must be intrinsically evaluable and action-guiding, without requiring transformation at each step. Intermediary states must have the same data type as the input or the output. We call this property *cognitive type consistency*. In a way, it is the optimal system, as it allows the reuse of functions because of a basic data type.

This does not imply that computation is not done in other data types for other processes, simply that for this type of process, we need intermediary states that are perception-like. A latent representation, by definition, is not intrinsically evaluable or action-guiding; it acquires functional significance only via a decoding or interpretation mapping. It will have to be converted back to the same input at one point in the processing, which ends up being the same as the initial processing.

There cannot be any other data type than perception-like information. That does not mean that directly perception, but an intermediary process that encodes exactly the same information for the sense. It is then

a perceptual-type states that are simultaneously present and re-enterable. The recursion applies on the same format as the original input. This data type is our original input perception that we, and that we then simulate. Its aggregate has to keep the same data type for it to be possible.

Our key claim is that some of these output predictions can reactivate perceptions from the outside environment. In other terms, some of our predictions become part of the perceptive environment, whoever dimly or strongly it might be. They are not disembodied but becomes part of our sensory apparatus. By predicting a specific state of the world, they reactivate the sensations they model. For example, a prediction of an existing event produces a set of perceptions. The prediction of future challenges or difficulties can be as visible as our present perceptions. As the external world keeps on providing input, the predicted input from our mind can merge with sensory input. We do not claim for our argument that this is a constant feature of our mental processes, but simply that it is *possible* for these two types of perceptions to coexist. We call this the *extended perceptual space*. It includes not only what is perceived but also from the mental generation, which includes mental properties such as memory or imagination. This becomes a structured space built from elementary awareness.

This extended perceptual space can then take a variety of structures. Perception-like inputs can coexist, be nested or dependent, based on the mental prediction, for instance, a complex math proof kept in context. This creates a set of counterfactual perception-like states of the current state, which have been predicted, and are now entered back as inputs.

The above satisfies the requirements for a computational description of mental processes according to the explanatory framework described above. The closure of the physical is respected and respects the rules of computational theory. It keeps the same computational primitives as current models of the mind and cognition.

III. Necessity of Structure

We have described above a process that is necessary for us to be able to compute the whole set of behaviors. The intermediary requirements we have found, recursion and cognitive type consistency are thereby also necessary for this structure to hold. It seems the above could function only with access consciousness (Block, 1995). We now have to solve the problem of phenomenal consciousness. We have to answer *how* is experience even possible, which implies showing that (1) experience must occur and (2) experience must occur in this way.

3.1 Subjective Experience and Determinacy

Within the proposed framework, mental processing operates over an expanded input of perception-like inputs. These are simulations generating multiple ways the world could be. Around given elements in the input, there emerges a space of possibilities: a set of counterfactual alternatives produced by the system itself, which are then the input of mental processes. In the above framework, we have a larger set of simulations which are now present as input of our mental processes. There are then multiple different simulations in the input, sensory simulations of perceptions-like type. We find a set of different ways that things could be. This means that around something, we find a set of possibilities.

To clarify how experience arises in such a framework, let us first recall a minimal definition: *An element is determinate iff it is uniquely specified within a defined space by a set of constraints or relations*. Determinacy therefore requires three components:(i) a space, (ii) a position within that space, and (iii) constraints that exclude alternative positions. The present framework satisfies all three conditions.

First, there is a defined space of counterfactuals. What was previously implicit in the dynamics of the mental process becomes explicitly identified: the input constructs a space of possibilities representing how things could have been otherwise. This space is no longer merely implicit in the weights or transition dynamics of the computation. It is instead represented directly as input to ongoing mental processing.

Second, there is a position within that space: the state that is realized now. This position is not given independently of the space but is defined relative to it. The present state is thus constituted as a position within a constructed space of alternatives.

Third, there are constraints, understood here as exclusions. To be in a determinate state is for certain alternatives to be excluded as not-the-case. Determinacy is therefore not merely additive but contrastive: for something to be this way is for it not to be other ways that are simultaneously available as counterfactuals.

In other terms, we can now identify *what it is like.* What it is like is to be this specific thing implies what it is like not to be something else. This is a condition for the experience to be like something at all and to be identified as such. What it is like is a direct consequence from conditions described above. If we admit recursion and cognitive type consistency, it cannot fail to emerge. Experience *must* appear once these conditions are met.

This also explains why consciousness is necessarily scoped and limited. Determinacy is always local: it arises only within a restricted space of counterfactuals generated for a specific task or context. The mind does not represent all possible alternatives, but only a selected subset relevant to the current situation. For example, when one is conscious of the redness of a scarf, the experience is determinate because it is situated within a space of nearby counterfactuals—other possible colors the scarf could have had. Likewise, in choice, consciousness presents alternative possible actions as counterfactual paths, against which the actual choice is fixed. By contrast, what is not conscious is not determinate *within consciousness*. If a property or object does not generate counterfactual simulations and a space of alternatives, it does not appear as a determinate element of experience. The color of an unattended object, for instance, is not conscious precisely because it is not positioned within such a counterfactual structure.

If the conditions described above are constitutive of consciousness, then consciousness cannot be coherently conceived in their absence. Removing any of these conditions does not yield a weakened or impoverished form of experience; it eliminates experience altogether. Their role is therefore not contingent but logically necessary: they specify what it is for a state to count as conscious at all. The lack of determinacy undermines the very possibility of subjective experience. It could not be said what it is like compared to another one. This can be clarified by a simple thought experiment. Consider a mathematical object such as a Riemannian manifold. To be conscious of such an object is not merely to token a symbolic description of it, but to grasp it within a structured space of possibilities, for instance the transformations and potential operations. Even when only dimly apprehended, these simulations are essential. In their absence, the object cannot be brought into consciousness at all. There is no experience of this specific thing and *what it is like to have this specific experience*, but of something else.

3.2 Constitutive Conditions of Subjective Experience

We have explained how experience must occur, and we will now turn to why it must occur in this way. In this sense. We have to give it a necessary mapping to cross the gap we identified above. This mapping must hold given the recursive structure we have identified. In doing so, we can offer an initial resolution of the *how* aspect of the explanatory gap: why this particular organization yields experience with a determinate qualitative character, rather than something else or nothing at all.

Given the above requirements, experience is constituted by three factors.

(1) First, there exists a set of possible perceptions. Counterfactual alternatives are generated based on something that is directly experienced. In other terms, the perceptions from the environment are the basis on which the simulations are generated.
(2) Second, there exists a set of counterfactual variations. These counterfactuals are varied. They may concern minor variations (such as choosing a different breakfast) or major ones (such as adopting a different career or value system). What matters is that they are all generated within the same mechanism of simulation.
(3) Third, there can be multiple counterfactual clusters simultaneously active. The system may generate counterfactuals around several perceptions at once: for example, simulations concerning a tree and an animal within the same perceptual scene.

The Cartesian product of these sets determines the space of possible experiences. Each conscious experience corresponds to a specific configuration within this space: the set of possible *what it is like.* Consciousness of something is a specific configuration of this sphere of simulations. On this view, consciousness of something consists in the perceptual availability of multiple simulations of that thing. Subjective experience is not an additional layer laid on top of perception, but a structured compound of perceptual processes themselves, directly experienced. Qualitative character (qualia) should therefore not be understood as a non-physical or irreducible property. It is simply the physical perception of a multiplicity: the perception of how things are *against the background of how they could have been*. In this case, the set of the three conditions above is a constitutive condition of consciousness.

This framework remains fully compatible with functionalist commitments. Representations, on this account, are compounded perceptual structures defined by their causal roles within mental processes. They are constructed from the same primitives as functionalist models posit. What consciousness does is not to create representations, but to make them perceptually available and embed them within a space of counterfactuals that yields determinacy.

Of the conditions, the sensory inputs in (1) can be explained by appeal to the environment. We now have to explain how these sets of simulations in (2) and (3) arise. It seems multiple similar configurations can both give rise to consciousness or fail to do so. These sets of simulations depend on a generative process. They depend on what the mind considers relevant, that is the mental processes decide to keep for recursion. Some information is predicted because relevant while others are discarded. Simple tasks can be processed automatically and thereby do not become conscious. The higher the complexity of the problem and the higher the difficulty of the task, the higher the need for recursion. Attention is a way through which mental processes select information and decide or not to use recursive processes for it. In the same way, we can gain consciousness of an object through intentionality, which thereby generates the set of background simulations required. Let us take an example. For instance, if there is a sensory input of the shape of a threatening animal, the predictions will depend upon this sensory input. There will be a set of actions, from running and fright to standing still. If this animal is behind a glass, the predictions will be adjusted, giving rise to a specific form of consciousness of this situation.

For this to be an answer to the how question, this mapping must be necessary. These constitutive conditions must hold necessarily to explain the whole set of behavior we have outlined. The above three criteria are a set of sufficient conditions for determinacy. Any change in the perception changes the simulations that could be possible. Any change in the simulations also changes the experienced. Determinacy of a specific state is required to be processed recursively downstream. Without determinacy, the state does not carry the information for recursive processing. Subjective experience is then just a consequence of the structure. It has to be present to be computed if we have cognitive type consistency. If it would be otherwise, experience incoherent rather than merely absent. There would be a lack of ground for a key process in human behavior

IV. Necessity of Function

In the above section, we have attempted to answer the how question and show why it was necessary that consciousness arose in this way. Yet despite having given an account of what and how consciousness would emerge, the why problem is still not solved. Why then there would have to be consciousness rather than nothing?

4.1 Necessity and Computation

We have identified a set of behaviors above which are part of our mental processes. If we are to have the recursive mental processing we described above, we require a specific organization of perception which cause consciousness. The recursion would not be possible without consciousness. Given cognitive type consistency and recursion are necessary for a set of behavior, this makes consciousness itself necessary given our current human capacities and the operations we have identified above. Without subjective experience, the operations we have defined could not be computed.

Any alternative would not be possible. An intermediary recursive state of another type would not be possible, and a lack of recursion neither. Subconscious recursion within our neurons would fail for the specific types of processes we identified. Any other alternative than consciousness would end up either leaving the explanation of process unexplained, computational incoherence, or introducing new objects and pushing the project further. Consciousness is the only mechanism which works under the constraints we have set. In other terms, consciousness is necessary to explain a large part of behavior because it has a functional role. Nothing apart from consciousness could fulfill the role. Remove consciousness and recursive processes of the type described above are not possible

Let us consider the opposite hypothesis: consciousness vanishes. Philosophical zombies are often said to be conceivable, but only in the weak sense in which any alternative metaphysical structure can be abstractedly imagined. Once we endow such a zombie with a concrete computational apparatus, the hypothesis collapses. To sustain cognition without consciousness, the system would require unbounded internal resources; it would have to be cognitively infinite, which would make the zombie incoherent given necessarily bounded resources.

Within this framework, the explanatory resources used to address the *how* and *why* of the so-called easy problems can be extended to consciousness itself, precisely because consciousness is assigned a functional role. It is neither contingent nor eliminable. This necessity closes the explanatory gap by integrating consciousness into the economy of mental processes, thereby securing explanatory sufficiency. The constraints established above eliminate the relevant space of possible worlds. Consciousness is therefore a necessary component of cognition: any alternative account would require abandoning one or more of the assumptions established in the preceding analysis.

4.2 Necessity and Deductive Process

Our argument proceeded through a deductive chain. The preceding sections established that, given a specific set of intermediary constraints on cognitive processing, phenomenal consciousness is not optional but necessary. A final step is therefore required: to assess the necessity of the assumptions themselves and of the deductive path we have taken. Only if this entire structure is necessary, conditional on current human capacities and behavior, can the hard *why* be answered and the explanatory gap closed.

The argument rests on three components. First, we identify a class of directly observable mental processes behaviors. Second, we adopt computational theory as the formal framework within which these processes

are conducted. Third, we establish a mapping between mental processes and structures and the computational structures required for their implementation. All three must be necessary for our argument to hold.

The first component is fixed by observation: the existence of the relevant cognitive processes is an empirical fact and therefore non-negotiable. The second components follow from the explanatory framework within which the hard problem and the explanatory gap are formulated. Our reasoning relies on results from computational theory, not as a contingent modeling choice, but as the formal architecture presupposed by the problem itself. Mental processes are computational within the very framing of the problem. If computational theory were rejected as an appropriate framework for explaining mental processes, the hard problem of consciousness as traditionally formulated would dissolve rather than be solved. Computational theory is thereby necessary for the problem itself to be solved.

The third component of the argument consists in the mapping itself: the reconstruction of mental processes from computational theory. Our approach has been to begin with the formal constraints imposed by computation and to determine how mental processes must instantiate those constraints in order to be possible at all. In carrying out this mapping, we focused on core computational features such as input, output, recursion, and intermediate state preservation. We treated both input and output as perception-like, insofar as mental processes are oriented toward modeling and regulating interactions with the environment, which also follows from the non-negotiable existence of the mental processes we have identified. Therefore, our approach makes minimal claims on the input and output. The mapping proceeds independently of any particular physical implementation. What matters are the therefore functional and formal constraints which exclude any counterfactuals *by design*. This gave us a set of primitives from which we deduced the necessity of consciousness from perception-like structure.

This completes the modal closure required to bridge the explanatory gap. The persistence of the gap does not reflect an ontological discontinuity, but the internal complexity of the processes involved. Simple perceptual processing can often be described as a relatively straightforward input–output mapping. By contrast, the recursive generation and compounding of perception-like states that underlies conscious experience is high-dimensional and individual-specific. This complexity makes the mapping difficult to trace in practice. The problem thus shifts from a conceptual to an empirical one. Within this framework, consciousness is not introduced as a separate ontological category. The explanatory gap therefore persists as an epistemic challenge, not as an ontological divide.

V. Conclusion:

This article has argued that phenomenal consciousness is not an optional accompaniment to cognition, but a necessary component of a specific class of mental processes. It has identified a class of computational processes observable in human cognition and shown that their implementation imposes strict structural requirements. From these requirements, we derived the necessity of consciousness. In doing so, the article offered a unified response to the two-pronged problem of consciousness. It specified constitutive structures under which subjective experience emerges and acquires determinate form, and it demonstrated why consciousness is required for the realization of the target mental processes. Finally, by showing that no alternative implementation can satisfy these constraints without either collapsing into functional equivalence or incoherence, the argument excluded the relevant counterfactuals and secured modal closure. This work therefore aims to provide, in finding a function for consciousness, a potential start for a foundation for a scientific study of consciousness. To refute the argument, one would need to provide a genuine counterexample: a case in which recursive reasoning with intermediate state preservation is realized without phenomenal consciousness. The challenge is therefore to explain how such processes could be made tractable in the absence of consciousness, while still satisfying the constraints identified above.

This article will also end by saying how such an account is compatible with modern science. Naturally, a large part of bridging the explanatory gap is an empirical matter, we will only demonstrate the necessity of such a structure. Not the empirical validation, which can only be left to empirical matter. We will only, in this conclusion, suggest that such a theory also has empirical validity, as it would make mental processes not only possible, but also more efficient. Thus, the above theory has the advantage of scientific coherence and fits in well with the current scientific paradigm. From a broader evolutionary perspective, the tradeoff between computation and storage is a key driver in biological processes and directly observed in mammals. Earlier animals, for instance, had larger storage capacities, but much less flexible compute. Evolutionary drive to tendentially improve population fitness. In fitting with our conception of mental processes as optimizing towards a goal, evolution aims to design better and stronger algorithmic processes for information processing. *A similar storage versus compute issue has been observed in cognitive science.* It is better in humans to perform the computations in context compared to unconsciously (Griffiths, Tenenbaum). We offload the storage so the computations can be performed in-context in consciousness. Consciousness allows humans to produce flexible and adaptable computing.