Our Phenomenal Universe
How Physical Brains Create Phenomenal Consciousness

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Abstract

Theories of emergence explain the creation of most aspects of consciousness as emergent properties of physical systems. However, an 'explanatory gap' remains regarding an explanation for phenomenal consciousness. Many argue that this gap will never be resolved, asserting that physical systems simply do not contain the prerequisites for phenomenal consciousness. This paper challenges that assertion by identifying an extraordinary quality of phenomenal consciousness, a quality that offers an explanation for how its prerequisites could give rise to physical systems, mathematics and logic. Therefore suggesting that its prerequisites could be the building blocks of reality. This idea is shown to be consistent with a philosophy of mathematics and an interpretation of quantum physics. Furthermore, this paper argues how this resolves the 'explanatory gap' while remaining otherwise consistent with theories of emergence.

Keywords: Emergence, Explanatory Gap, Phenomenal Consciousness, Philosophy of Mathematics

1. Introduction

Phenomenal consciousness, put simply, relates to the conscious mind and how it experiences the physical brain's state (e.g. the feeling of pain) (Van Gulick 2021). This aspect of consciousness remains the one aspect unexplained by theories of emergence (Feinberg and Mallatt 2020). Levine (1983) highlighted the significance of this missing explanation by referring to it as the 'explanatory gap'. Views that this 'explanatory gap' will never be resolved are based on the assertion that physical systems do not contain the prerequisites for phenomenal consciousness (Revonsuo 2010). To challenge this assertion, this paper identifies these prerequisites and an extraordinary quality they possess, a quality that explains how these prerequisites could give rise to, and consequently be contained throughout, physical systems.

This explanation for giving rise to physical systems relates to Gödel's incompleteness theorem, which asserts that no sufficiently complex axiomatic system can be based on itself (Raatikainen 2022). Though first debated in the philosophies of mathematics and logic this assertion also

applies to the physical systems of modern physics (Jaki 2004). In simple terms, these systems have a set of fundamental axioms which define the system itself and which cannot be established by the system (Wormell 1958). For quantum systems these could be the definition and rules of the Standard Model or those of quantum information. Although theories of modern physics propose what these axioms are, they do not explain how these axioms are established. The problem of how fundamental axioms are established has resulted in several schools of thought within the philosophy of mathematics and logic (Hilbert 1983, Hirsch 1996). This paper's explanation for the existence of physical systems builds on one of these schools of thought. Specifically, the extraordinary quality, which was mentioned earlier, is used to extend this school of thought beyond mathematics and logic to cover physical systems as well. This results in an explanation for the existence of *reality*, where reality refers collectively to physical systems, mathematics and logic. This explanation, it is argued, is sufficient to resolve the 'explanatory gap' while remaining otherwise consistent with theories of emergence.

2. Before reality

Theories of emergence presuppose physical systems but philosophies that reality (including physical systems, mathematics and logic) arises from something more fundamental are not new. One such philosophy was inspired by the Copenhagen interpretation of quantum mechanics, which asserts that observers influence physical reality (Neumann et al. 1955). This observer-influence idea was extended by Wheeler (1983) resulting in a philosophy called participatory realism (Fuchs 2017).

> Useful as it is under everyday circumstances to say that the world exists "out there" independent of us, that view can no longer be upheld. There is a strange sense in which this is a "participatory universe."
> (Wheeler 1983, 194)

Participatory realism is the philosophy that observers create reality (Wheeler 1983, 1989, Fuchs 2017). This philosophy accounts for reality, including physical systems, by presupposing observers and therefore, consciousness. However, presupposing consciousness is incompatible with theories of emergence. To be compatible, only aspects of consciousness not accounted for by emergence can be presupposed. Furthermore, presupposing phenomenal consciousness would not achieve compatibility because emergence does explain what is experienced by phenomenal consciousness, just not how it is experienced (Feinberg and Mallatt 2020). Therefore, a compatible presupposition is limited to the elements of phenomenal consciousness (P-elements), which relate only to how things are experienced (Tye 2021, Van Gulick 2021). There is no consensus for the set of all P-elements (Tye 2021), however, it is sufficient to understand that these include qualia (e.g. pain, taste, redness) and elements for the other aspects of phenomenal consciousness, such as space, time and self (Tye 2021, Van Gulick 2021). P-elements are, by

definition, prerequisites for phenomenal consciousness. This paper argues that presupposing them is compatible with a philosophy of mathematics, explains the existence of physical systems and resolves the 'explanatory gap'.

3. Mathematics and logic

There are a few different schools of thought relating to the establishment of mathematics' axioms. Platonism, named in honor of the Greek philosopher, views mathematical objects as existing within their own realm, suggesting a transcendent nature for mathematics' axioms (Hirsch 1996). Formalism, for which Hilbert is the chief architect, denies any meaning to logical symbols (Hilbert 1983), suggesting that the axioms are arbitrary. And intuitionism views mathematics as a product of one's mind, a completely subjective interpretation of physical reality (Tasi 2001). As Hirsch (1996) describes, all of these schools of thought suffer from a common failing.

> All of these views deny a link between the meaning of mathematics and the objective properties of the universe we inhabit. So the problem facing all these approaches is to explain why mathematics is such a useful subject - why highly abstract theories often lead to powerful applications in the rest of science.
> (Hisch 1996, 68)

Engels (1976) put forth an argument that addresses this failing and laid the foundation for a new understanding of mathematics, called materialism.

> The concepts of number and form have been derived from no source other than the world of reality. The ten fingers on which men learnt to count, that is, to carry out the first arithmetic operation, are anything but a free creation of the mind. Counting requires not only objects that can be counted, but also the ability to abstract from all properties of the objects being considered except their number - and this ability is the product of a long historical development based on experience.
> (Engels 1976, 47)

The materialist understanding of mathematics explains the usefulness of mathematics by asserting that elementary mathematics and logic arise from experience (Hirsch 1996). This implies that the axioms of mathematics and logic are contained within experience. This paper puts forth a hypothesis that builds on the materialist philosophy by identifying the specific aspect of experience that is the source of axioms, not just for mathematics and logic but for physical systems as well. The rationale for this hypothesis is covered in section 4, here the hypothesis is

introduced to highlight the consistency between this paper's presupposition and materialism. The hypothesis is called the Critical Role of Phenomenal Consciousness hypothesis (CRP) and states:

> **The elements of phenomenal consciousness establish the fundamental axioms of reality.**

This suggests, for example, that the axioms for the vector space R^3 come from the P-element space. Experience exposes elementary mathematics and logic, as described by Engels (1976), because it is composed of P-elements, which are the source of their fundamental axioms. Mathematics is discovered through experience but with the CRP, mathematics itself is not seen as derived from physical reality, instead they are fundamentally linked. This fundamental link is their shared source for their fundamental axioms (P-elements). Wigner's (1967) question about the 'unreasonable effectiveness' of mathematics to predict the natural world is explained by them having this shared source. The CRP fits with materialism and this paper's presupposition of P-elements but the true rationale for it relates to the defining quality of P-elements. A quality that explains the establishment of axioms not just for mathematics and logic but for physical systems as well.

4. Physical systems

The key to establishing axioms is the P-element's quality of being self-evident. This defining quality of P-elements is the source of common expressions like 'seeing is believing' and has been reflected upon by such influential philosophers as Descartes (1955) and Levine (1983).

> One might say, it makes the way pain feels into merely brute fact.
> (Levine 1983, 357)

In being self-evident, the creation of a P-element is the establishment of it as a self-evident axiom. If a P-element can be expressed as a set of more fundamental propositions then those become implied axioms. For example, the existence of the P-element space implies the eight axioms of vector spaces. Other P-elements, such as redness and pain, establish axioms related to vision, touch and even axioms necessary for concepts like bad and worse. A P-element cannot exist without implying its axioms and, based on Gödel's incompleteness theorem, reality's fundamental axioms cannot exist without being self-evident or implied by a self-evident axiom. Therefore, the existence of a fundamental axiom of reality and that of its P-element are intrinsically linked.

Once the P-elements have established sufficient axioms to define the most fundamental physical system, physical reality can emerge. By satisfying the requirements of the most fundamental system those of higher-level systems are also realized, for axioms of higher-level systems are

simply abstractions of those of the most fundamental system. In mathematics this relationship is made explicit by mathematical proofs, which show how higher-level mathematics can be expressed with a set of lower-level mathematical statements. In the case of physical systems, the equivalent to mathematical proofs are the theories which link modern physics to atomic physics to chemistry to biology, etc. This accounts for the establishment of the physical systems themselves but not for the universe's state. The universe's state is defined by non-fundamental axioms (see section 5) but its establishment is beyond the scope of this paper. The important point is that physical reality is modeled as an axiomatic system with all non-fundamental axioms, associated with any level of physical reality, ultimately based on reality's fundamental axioms.

These fundamental axioms, and the P-elements they are intrinsically linked to, are the basic building blocks of reality. For the emergence of physical systems, the CRP simply defines a layer below modern physics. This layer, composed of P-elements, suggests a function for the P-elements' defining quality (to establish axioms). More importantly, this explanation links physical systems to the elements of phenomenal consciousness.

5. Phenomenal consciousness

When someone looks around and sees four walls, a floor and a ceiling, they believe that they are in a room. Although this belief is based on P-elements, it is not representative of a fundamental axiom of reality. Higher-level beliefs, and higher-levels of consciousness in general, emerge from complex physical systems.

The process of emergence has been debated for over a century (Lewes 1877, Broad 1925, Feigl 1958, Popper and Eccles 1977, Searle 1992, Scott 1995, Bedau 1997, Kim 1998, 2006, Andersen et al. 2000, Feinberg 2001, 2012, Van Gulick 2001, Chalmers 2006, Clayton and Davies 2006, Thompson 2007, Bedau and Humphreys 2008, Beckermann et al. 2011, Deacon 2011, Nunez 2016, Mallatt and Feinberg 2017, Feinberg and Mallatt 2020). These theories explain nearly all aspects of consciousness as emergent properties of complex physical systems (Feinberg and Mallatt 2020). However, there exists what Levine (1983) refers to as an 'explanatory gap' in trying to explain the emergence of phenomenal consciousness.

Theories that this gap will eventually be closed are called weak emergence (Bedau, 1997) or emergence1 (Searle 1992, Feinberg 2001, 2012). Contrary theories, that the gap will never be fully resolved are called strong emergence (Bedau 1997, Chalmers 2006, Clayton and Davies 2006, Revonsuo 2010), emergence2 (Searle 1992) or radical emergence (Feinberg 2001, Van Gulick 2001). Revonsuo summarizes the view of those who believe this gap will never be resolved:

> Supporters of strong emergent materialism point to the fundamental differences between the subjective psychological reality and the objective physical (or neural) reality. The former includes qualitative experiences that feel like something and exist only from the first-person point of view; the latter consists of physical entities and causal mechanisms that involve nothing subjective or qualitative about them and exist from the third-person point of view or objectively. Nothing we can think about or imagine could make an objective physical process turn into or "secrete" subjective, qualitative "feels." It is like trying to squeeze wine out of pure water: it is just not there, and there can be no natural mechanism (short of magic) that could ever turn the former into the latter.
> (Revonsuo 2010, 30)

If phenomenal consciousness is emergent then Revonsuo's argument would suggest that physical reality must contain the ingredients for phenomenal consciousness (i.e. P-elements). With the CRP, physical systems are composed of P-elements and the emergence of phenomenal consciousness is explainable by the relationship between these P-elements and states of physical systems. A system's state is a set of truths which are based on the system's fundamental axioms, such as the locations of particles in a particle system. As described by quantum information theory, such truths can be modeled as a set of relationships (Wheeler 1989). In this case, what is being related are the fundamental axioms of the particular system. Specifically, each truth represents a set of relationships between the axioms on which it is dependent. Since the system's axioms are abstractions of reality's fundamental axioms, the relationships are actually between reality's fundamental axioms and consequently between the P-elements they are intrinsically linked to (see section 4). This means that, ultimately, the state of a physical system represents a set of relationships between P-elements. Phenomenal consciousness emerges from physical systems because of what they contain, P-element networks. P-elements are the building blocks of reality and physical reality is where realty's structures, which are simultaneously physical and phenomenal, are formed. The universe, at its essence, is a phenomenal universe. The 'explanatory gap' is resolved with the CRP because P-elements lay at the base of emergence, so it is not like trying to 'squeeze wine out of pure water' (Revonsuo 2010, 30).

When a physical system's state represents a P-element network that includes the P-elements required for phenomenal consciousness (e.g. self, time and space) then it becomes the very definition of phenomenal consciousness. For example, the state of someone being in a room is a set of truths, such as the color of the walls, floor and ceiling and their relative locations to the person. As Immanuel Kant asserted, such a set of truths is contingent on the axioms of time and space (Tasi 2001). Kant claimed that 'the intuitions of time and space are a priori given to the mind' (Tasi 2001, 25) and that these intuitions are subjective (Hirsch 1996, Tasi 2001). The CRP, instead, suggests that the required axioms are established by P-elements, the same P-elements that form the phenomenal consciousness of the mind. In this example, the P-elements of self,

time, space and various qualia provide the axioms and form a P-element network. This P-element network results from the establishment of the set of truths and results in the associated experience of phenomenal consciousness (a phenomenal experience).

As mentioned, the establishment of the universe's state is beyond the scope of this paper. However, given that time is a P-element, the dynamic nature of phenomenal experiences might not come from mutating P-element neworks. Instead, there could exist a single, fixed, P-element network that defines reality across all of space and time, similar to the idea of eternalism. However, within the P-element network, space and time are nodes not dimensions. So, the P-element network itself need not take the form of 4D spacetime, as described by relativity (Everett 1957). The space in which the P-element network exists could be of unlimited dimensionality, similar to the spaces described by variants of string theory (Naschie 2000). Phenomenal experiences of dynamic 3D environments would evolve within P-element subnets that included self, space and time. This emergent nature of experience might be what led Einstein to refer to the experience of time as an illusion (Neffe 2007). An emergent nature for space and time has been proposed by Cowen (2015) and is the basis for theories of quantum gravity (Becker 2022).

6. Summary

The explanation offered here for the emergence of consciousness relies heavily on existing theories of emergence. These existing theories explain how higher-levels of consciousness can be realized by physical systems. The proposed resolution for the 'explanatory gap' is the idea that physical systems are built of P-elements which form P-element networks, resulting in phenomenal consciousness. This idea, it was argued, is a consequence of presupposing P-elements and their defining quality of being self-evident. Therefore, a justification for phenomenal consciousness may be that its elements, with their self-evident nature, are necessary for the existence of reality.

The ultimate model of reality, suggested by the CRP, would be an axiomatic system with all and only the axioms implied by P-elements. This aligns with the scientific method's reliance on observation. However, p-elements are not limited to those measurable by calipers, thermocouples or other scientific instruments. To uncover all of reality's fundamental axioms, all P-elements, including those of emotion, thought and morality, should be philosophically and, to the degree that they can, scientifically analyzed to determine what fundamental axioms they imply.

Beyond offering a resolution for the 'explanatory gap' the CRP's true value may be in its consistencies with quantum physics. These consistencies could lead to knowledge sharing between the philosophical disciplines of consciousness and modern physics, potentially resulting in valuable insights within both domains.

Statements and Declarations

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