13

Radical Solutions to the Ontological and Epistemological Problems of Consciousness

Javier Andrés García Castro

Explorations into consciousness have a remote history, which probably begins with the first mystical adventures thousands of years ago in the context of magical and religious practices. However, interest in this philosophical and scientific study is relatively more recent. We can date it to the seventeenth century thanks to the work of the French philosopher René Descartes (1596–1650) and to the end of the nineteenth century with the foundation of the first laboratory of experimental psychology in Leipzig by the German psychologist Wilhelm Wundt (1832–1920), respectively.

Problems in the study of consciousness have been a constant that has generated deep discouragement to those who have tried to approach its ontological and epistemological roots. Suffice it to cite as examples the gnoseological pessimism of behaviorism of the first half of the twentieth century, the currents of eliminative materialism, and *mysterianism* or catastrophic predictions of some sectors of neuroscience, impotent before the task of explaining the emergence of subjectivity as a product of a synchronized discharge of various populations of neurons. These and other predictions, arising from a debate that has been described as "dead end" ([1], p55), place us before a bleak panorama in which many researchers conclude their work with an air of frank resignation [2–4].

Now, what are the problems of consciousness? We assume that it is not a single problem, but several, and all of them have deep roots, from both a neuroscientific and a philosophical perspective. These problems have been stated in ontological and epistemological terms. Briefly, ontology means the study of the reality of the world, that is, what is in it, while epistemology refers to the ability to obtain an objective knowledge of that reality. While from the philosophical point of view consciousness is ontologically objective and undeniable, from the epistemological point of view, it is a subjective phenomenon, difficult to address scientifically [5]. However, the supposed ontological objectivity of consciousness could be denied since we still do not have an objective and universal criterion to determine the self-conscious capacity of an organism, entity, or object in the known universe, beyond the famous and limited Turing test [6]. Modern versions of this test propose that, to find out if an organism or entity is "self-aware," it must be tested by another organism that we know for sure is self-aware [7]. Note, however, the *regressus ad infinitum* of this proposal. Therefore, except each one privately and subjectively, no one can be sure that the other is self-aware [8], and, accordingly, we do not currently have a valid and reliable criterion to prove

J. A. García Castro (✉)
Centro Universitario Villanueva (Universidad Complutense de Madrid), Madrid, Spain
e-mail: jagcastro@villanueva.edu

P. Á. Gargiulo, H. L. Mesones Arroyo (eds.), *Psychiatry and Neuroscience Update*,
https://doi.org/10.1007/978-3-030-61721-9_13

the presence of self-awareness and/or phenomenal consciousness in other beings or devices.[1]

The objective of this chapter is to offer a recapitulation of the most groundbreaking solutions that have been proposed to try to solve the various problems posed by the study of consciousness. For this, the fundamental difficulties that this research field entails will be exposed, and each one of them will be answered from different theoretical approaches. Finally, a critical assessment of each of these contributions is proposed, and the possible lines of theoretical and empirical approach that are expected in the coming years are outlined.

The Problems of Consciousness

More than a few renowned philosophers have referred to the problem of consciousness in the singular [10, 11], when in reality the real problem of consciousness is that it is more than one problem, beginning with its conceptualization. Accordingly, there is currently no consensus on what could be the definition that best characterizes this elusive mental phenomenon [12]. In any case, this is not due to the lack of proposals, which have been numerous. However, none has been fully able to capture that which they aim to define; thus, the majority is inclined to delimit the concept by resorting to a mere list of obvious properties. Among them, its unity and continuity; its private, personal, and subjective nature; its coherence; and its ability to integrate multiple sensations and perceptions [13] should be highlighted. Indeed, and as William James [14] affirmed, private and subjective character, together with the sense of unity and continuity, are some of the problematic nuclear features of consciousness, though not the only ones.

The following section describes each of these problems. In this review, they have been reduced to three: the problem of reality, the problem of dualism, and the problem of the subjective quality of conscious experience (*qualia*).

[1] See however [9].

The Nature of Reality and Its Relation to Consciousness

The first difficulty that we must take into account when studying consciousness has to do with the correspondence that exists between the outside world or reality and the inner world of the subject or representation. Various philosophical currents have tried to address this issue, which remains immersed in deep debate. Thus, the problem of "double access" ([15], p291) raises the difficulty of verifying the fidelity of the "I-world" correspondence, precisely because we start from our own subjective representation of that reality and lack an external validity criterion that allows us to contrast the two. This and other evidences drawn from the research into perception, attention span, and certain hallucinatory phenomena [16, 17] question the possibility of a naive or radical realism. On the opposite extreme, *idealism* denies the existence of reality, which is reduced to a mere product of our thinking. Between the two, *constructivism* states that from information captured by the sensors, the cognitive system reconstructs a representation to some extent analogous to external reality.

In relation to consciousness, neuroscience postulates a materialistic directionality by stating that the brain creates consciousness [18]. This directionality is not new at all [19] but has been accentuated in recent decades. Faced with this point of view, authors who reduce all possible knowledge to subjectivity have not been lacking in the philosophical tradition [20] nor have those who consider that consciousness uses the brain as an instrument to self-manifest in the course of an evolutionary process [21]. A third way to resolve this directionality is that defended by Francisco Varela through the existence of a mutual overlap between mind, brain, and world, based on the concept of "embodied" mind, that is, one inextricably linked to a body [22].

To further complicate matters, the findings of quantum mechanics in the early twentieth century introduced notable difficulties in articulating the micro-phenomena of physics with macro-phenomena, extending their implications to the very study of consciousness. Among the propos-

als that have been made, Roger Penrose and Stuart Hameroff stand out. They suggested, through their *model of orchestrated objective reduction*, that consciousness could be explained from quantum computing processes [23]. For Penrose, consciousness, such as thought or creativity, is a non-computable mental phenomenon, since algorithmic computing contains a deterministic element that is incompatible with freedom and creativity. These authors, therefore, state in their hypothesis that consciousness arises as a result of quantum coherence in auspicious structures that make up the cytoskeleton of all cells of the human body: the microtubules. Microtubules are essential for a wide variety of biological functions that include cell displacement, mitosis, and maintenance of cellular form and functions. In addition, in neurons, they contribute to "maintain and regulate synaptic plasticity related to learning and other cognitive functions" ([24], p1872). The proteins that make up the microtubules are called tubulins and can adopt two possible configurations, α and β, which could be made equivalent to the binary computing system "0 and 1." The quantum computation developed in the microtubules in an isolated and superimposed way could be generalized to the whole brain, giving rise to a large-scale physical activity in accordance with the quantum nonlocality. This state of quantum overlap would suffer an objective reduction orchestrated by the molecular structures of the microtubule (tubulin) proteins to move to a conscious state thanks to a quantum gravitation mechanism, which would generate self-collapse by latent nonlocal variables [25]. All this would lead to the irreversible transition from a state of preconscious overlap to a reduced one that would coincide with the state of conscious experience in the phenomenal world of macrophysics (Fig. 13.1).

The efforts undertaken to try to explain consciousness from microphysics are abundant, and recent proposals have been made that attempt to overcome some of the intrinsic difficulties identified in the previous theory and other similar hypotheses [26].

Faced with the enigma of the ontological status of reality and its relation to the mind-body problem, Donald Hoffman has constructed a mathematical theory which he calls *conscious realism* [27]. For this author, consciousness is composed of three processes that he assumes as true in an axiomatic way by intuition: perception, decision, and action. From here, he defines the key concept of his hypothesis: the conscious agent. A conscious agent, when interacting with the world (W), has a conscious experience (X) that triggers a decision process (D), which consists of a deliberation on what courses of action to take. The possible course of action translates into an effective action (G) that transforms the world (W_i), which in turn will alter the subject's conscious experience (X_i). These processes are developed in spaces of probability, and the messages that are transmitted between the components (W, X, G) can be counted by a number N measuring the flow of information through stochastic channels that connect each node of the conscious agent (P, D, A) (Fig. 13.2).

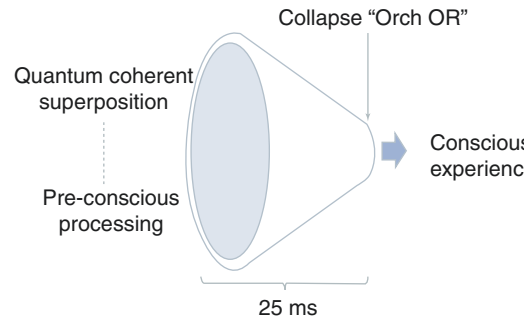

Fig. 13.1 An orchestrated objective reduction event that produces a conscious experience

However, the theory thus formulated would fall into dualism; on the one hand, we have the world (W) that is described in classical physics and, on the other, conscious (X, G), private, subjective, and ineffable experience. But, the hypothesis of conscious realism aims to be a monism in which consciousness is ontologically fundamental and thus overcomes the difficulties posed by the mind-body problem from materialism and its relation to reality. Therefore, Hoffman proposes replacing the world (W) with the dynamic interaction of conscious agents. Thus, the decisions and actions of a conscious agent would constitute the experiences of another conscious agent and

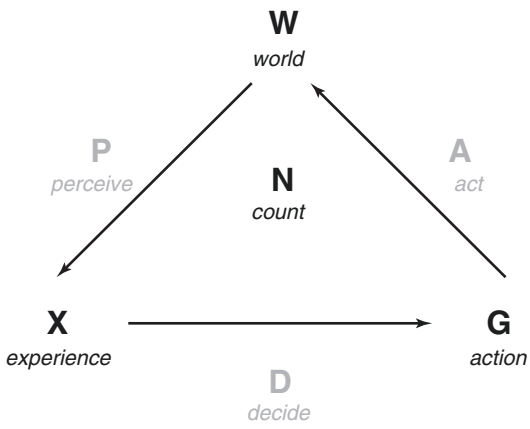

Fig. 13.2 Diagram of a conscious agent [27]. (Adapted with permission from the original author. Orignally published under a CC-BY license)

vice versa. The world, consciousness, would be composed only of conscious agents in reciprocal interaction.

To illustrate this idea, Hoffman uses the split-brain analogy, which consists of an interhemispheric communication difficulty secondary to a surgical intervention that cuts the corpus callosum. According to this author, this phenomenon reveals the existence of two conscious agents who interacted before generating the impression of a unified consciousness. In short, for Hoffman, the "subject-world" correspondence arises because consciousness creates brain activity and not vice versa, as neuroscience defends.

If consciousness, in addition to self-awareness, is also of the objects and entities of the outside world, it seems obvious that any research on consciousness must deal with the supposed objectivity of reality. Both physics and psychology have provided convincing evidence that, for the moment, we must not literally interpret the stimuli of external reality. In addition, studies on perception have shown that organisms have not been evolutionarily selected to perceive reality as it is but to optimally record those stimulus configurations that are most advantageous for their adaptation to the environment and survival [28]. A multidisciplinary approach, therefore, is necessary to continue moving forward on this issue.

The Problem of Dualism

Another of the great and traditional problems that have arisen to explain consciousness is dualism. Although it is a metaphysical interpretation already present in other cultures and eras, Descartes [29] establishes the modern distinction between res cogitans and res extensa, two independent but interacting substances, subject to different laws and principles and with different properties. The other possibility, monism, tries to explain and reduce all the phenomena that exist to matter, and therefore, subject to deterministic physicochemical laws. While dualism cannot satisfactorily explain the interaction between two substances of different nature, monism has not been able to complete successfully its reductionist project.

Cartesian dualism was harshly criticized by the philosopher Gilbert Ryle in the mid-twentieth century [30], leading to a current of animosity that would extend to the entire neuroscience research program. However, if monism cannot account for the main problem when studying consciousness – that is, the emergence of subjective experience from a physical process – many authors consider that the most reasonable alternative we have left is the dualism. So much so, neurosurgeon Wilder Penfield [31] goes on to state that dualism, perhaps, is the lesser evil of the existing solutions:

Taken either way, the nature of the mind presents the fundamental problem, perhaps the most difficult and most important of all problems. For myself, after a professional lifetime spent in trying to discover how the brain accounts for the mind, it comes as a surprise now to discover, during this final examination of the evidence, that the dualist hypothesis seems the more reasonable of the two possible explanations. (p123)

To resolve this controversy, numerous proposals have been formulated. Attempts to reconcile dualism with the contemporary scientific method have led to the interactionist dualism of John Eccles [32], who proposes interaction between the mind and the brain as two independent and autonomous substances. The soul (mind) would

act on the brain through a mechano-quantum field altering the probability of release of presynaptic vesicles. In turn, the body (the brain) would influence the mind through the process of exocytosis of presynaptic terminations on receptive fields of cortical neurons, which would be detected by the quantum field of probability producing a mental and conscious event.

For his part, Nicholas Humphrey [33], in his attempt to solve the mind-body problem, states that consciousness is actually an emergent property that arose as a result of the natural selection process and, therefore, with an adaptive function. This function is fundamentally social, although it later evolved by providing an internal model of itself. This process, presumably, would occur through the "internal monitoring of the body's external reactions to the outside world" (p19).

Another way to address the overlap between mind and brain is the so-called emergentism. For example, for Charlie D. Broad, phenomena can be explained mechanically or emergently. In the first case, observed phenomena can be explained from the complete knowledge of the properties of the components of that which is intended to be studied, while in the case of emergentism, this is not possible [34]. Although the classic example usually used to illustrate this idea is to obtain the liquid state of water from the covalent bonds of hydrogen and oxygen atoms, in a sense, it should be expected that the properties of these elements, when combined, produce that effect. This, however, does not occur in the case of the mind, since the same laws that govern the behavior of neurons do not have the status they should to justify the onset of mental states. Therefore, it is proposed that certain systems have associated new – emergent – properties, although the mechanisms that produce them are not explained.

From neuroscience, on the other hand, we work around the concept of neural correlate of consciousness (NCC), which currently accepts at least three different possibilities: (1) identity, a mental state is equal to a brain state; (2) causality, a brain state causes a mental state or vice versa; and (3) correlation, both mental and cerebral states are related. Each of these possibilities is supported by a concrete theoretical-conceptual framework. The first two start from physicalism, while the last one implies, in one way or another, some form of dualism (interactionist, substance, property, etc.) or even the possible existence of a psychophysical parallelism. However, we must bear in mind that "correlation," as a condition of possibility, does not imply causation but is only limited to indicating the co-occurrence of two or more events that could be related [35]. In addition, if the concept of NCC is far from being clarified, much less will be the explanatory implications on consciousness around that concept [36].

All these difficulties seem to demand a change of epistemological paradigm. The dominant scientific method currently tries to explain the phenomena from the principle of causality. Thus, consciousness would be the result of certain neuronal operations [37]. Neuroscience, in general terms, seems to be limited to the correlational study of mental and brain events, without examining in depth the theoretical implications of its findings. If we could formulate the problem as follows:

(a) $\Phi = \psi$
(b) $\Phi \rightarrow \psi$
(c) $\Phi \leftarrow \psi$

being Φ = physical events and ψ = mental events, we could establish a discussion about the directionality of causality or even the possible identity of both phenomena, an issue that remains open. When talking about correlation, we thought, in principle, "of a linear measure of the association between two variables" ([38], p890). Therefore, it does not seem legitimate, at the moment, to speak of causal directionality.

Faced with the sequential view that prevails in Western epistemology, the principle of synchronicity implies that there is a correspondence between two simultaneous states of two different phenomenal systems [39]. This connection is not of cause-effect but of homology of two events that concur in the same instant. These approaches would open the possibility to currents similar to psychophysical parallelism, according to which the physical and psychic processes are indepen-

dent, although they occur in a coordinated manner [40]. In this sense, synchronicity, understood as the "temporal coincidence of two or more causally unrelated events" ([41], p35), could be extrapolated to overcome the difficulties imposed by the concept of NCC. It would be interesting to investigate the necessary and sufficient physiological, spatial, and temporal conditions of this synchronicity. In fact, various investigations in cognitive neuroscience point to the need for a minimum time for the emergence of a correlation between neural and cognitive events [42, 43]. At the same time, neurophysiology has revealed the existence of synchronized discharges in certain neuronal groups with oscillations in the gamma band at 40 hertz when a moving object is perceived [44]. Whether these neuronal synchronies are causally decisive to generate awareness or not, or that they may have some link with the synchronicity between mental states and neuronal states, is something that has not yet been explored.

Following the line of what might be called neodualism, David Chalmers had already raised through his naturalistic dualism the possibility of investigating the mechanisms of interaction between subjective experience and the physical world [45]. Specifically, he proposed three psychophysical principles that could establish links between both dimensions: the *principle of structural coherence*, the *principle of organizational invariance*, and, finally, the *double aspect of information theory*. This last principle, of fundamental character, implies that certain types of information have a double structure in which there is a correspondence between the physical states and the phenomenal states. One of the corollaries of this principle is that wherever there is some kind of information, there could be some kind of equivalent consciousness, although this would be as rudimentary as that corresponding, for example, to a thermostat.

In a new proposal, Chalmers raises this relationship founded on the principles of quantum mechanics, based on the pioneering works of Eugene P. Wigner on the possibility that consciousness caused the wave function determined by the Schrödinger equation. According to its new model [46], in the universe, there would be a special property, called m-property, whose effect would be to respond with the collapse of the wave function every time it encounters an overlap state. Thus, for example, if a photon is in two overlapping positions (P1; P2), when it comes into contact with an m-particle, the photon would collapse into a defined state (i.e., M1-P1). The m-properties would be similar to the physical correlates of consciousness, which in turn should find neurobiological candidates that establish their relationship with brain mechanisms. One of them could be the phi (Φ) measure of the *integrated information theory* of Giulio Tononi [47], which provides a dimension of the amount of consciousness generated by a system. Here consciousness, as a phenomenal state, is taken as an intrinsic property of physical systems, being the result of the degree of integration of information into that system. Therefore, according to this model, consciousness is understood as a higher order function of physical systems, such as the brain, determined by its functional ability to exhibit the collapse of the wave function thanks to the existence of the m-property.

In sum, there are currently as many difficulties as arguments in favor of dualism as of monism. Adopting the attitude of denial as a solution, as proposed by eliminative materialism, is not convincing in the face of Cartesian evidence of self-consciousness. The inconsistencies of the concept of neural correlate to conform to the linear causality scheme imposed by the methodological framework of Western science should not be an obstacle to persist in neuroscientific research but rather an incentive to reform a possibly inappropriate epistemological paradigm which must be expanded and reformulated. Thus, the progressive conceptual enrichment derived from the convergence between apparently distant theories could be a crucial starting point to unlock an atavistic antinomy [48].

Qualia: The Subjective Quality of Conscious Experience

No less thorny than the other two is the problem of the subjective quality of conscious experience, what philosophers have called *qualia*. Indeed, the explanatory leap between the aseptic functioning

of neuronal computing and the intimate and private sensation of perceiving inwardly the quality of a color, a taste, or a pain is one of the greatest difficulties that physicalism has encountered in all its aspects [49]. From this perspective, the most thorough investigation of the neural intricacies of the perceptual pathways in the brain can tell us nothing about *qualia* [50]. Beyond the axon tracts, the exchange of neurotransmitters and the feedback and feedforward mechanisms, the mysterious sensation of *what it is to feel like* will always remain in the air; it seems to escape, for the moment, the methods of modern science.

At this point, many authors conclude in a logically impeccable way a reasoning that starts from questionable premises: consciousness does not exist; it is a mere epiphenomenon; it is not relevant [51–53]. However, at least since Descartes, the subjective experience of the world and of oneself is something clear and evident. Some contemporary authors have even hinted at the possibility that consciousness is a fundamental property of the universe, such as mass, electric charge, or space-time continuum in physics, thus approaching panpsychism [54].

A possible solution to this dilemma could be the intersubjective agreement reached through a neurophenomenological approach to the problem, a well-known philosophical tradition that has recently been revitalized in the field of cognitive neuroscience and the philosophy of the mind. Indeed, at the beginning of the twentieth century, the German philosopher Edmund Husserl founded the phenomenological movement in response to the epistemological limitations of positivism, materialism, and psychology [55]. Phenomenology questions the validity of everyday metaphysical and epistemological statements and tries to go to things themselves as presented to consciousness. By suspending the trial (*ἐποχή*), the belief that sustains the natural attitude about the objective existence of the world is in doubt. The goal is to obtain sufficient knowledge in itself, an absolute fact on which to build the immediate experience. This process is called *phenomenological reduction*.

More recently, the philosopher Thomas Nagel [56] has suggested the possibility of developing an objective phenomenology that allows a description of the subjective nature of the experiences in such a way that it is understandable to other beings lacking such experiences. Perhaps collecting the witness, neurophenomenology proposes a research program capable of articulating the relationships and mutual restrictions between the phenomenological experience and the findings of cognitive neuroscience [57]. Thus, one of the fundamental attitudes of the neurophenomenological method is that it does not persist in the "objective-subjective" opposition, but rather seeks to go further and cover the explanatory gap between the two from its fundamental correlation.

The working hypothesis of neurophenomenology would be to explore the structure of experience and its equivalents in cognitive neuroscience in order to "formulate relational principles and laws between the two to resolve apparent contradictions" (p343). The novelty of this proposal would be that the explanations of "first person" should be included as fundamental elements of validation of the neurobiological findings of "third person" and not as mere accidents in the course of experimentation. The aspiration to find a way to reconcile objective and subjective data in a unified epistemological framework is common in various authors and fields of knowledge and, therefore, is an ideal working field to search for convergent theoretical spaces. All this suggests a stereoscopic perspective in which both conscious experience and cognitive science must become active partners in a new way of understanding the relationships between the mind and the brain.

On the other hand, if we accept the existence of a phenomenal level of organization, within a stratification of increasing complexity between different ontological levels, new and original approaches are necessary to capture the essential properties of consciousness. According to Antti Revonsuo, the exploration of dream activity during sleep, particularly during the REM phase, which is when narrative dreams occur, could constitute an adequate model of the proposed phenomenal level of organization [58]. This is so because the dreaming brain doesn't need neither sensory input nor motor output to produce phenomenal consciousness. This could provide us

with the more accurate possibility of identifying the processes that are sufficient to produce subjective experience. In this line, new technologies such as virtual reality could offer us methodological opportunities to open unexpected fields in the study of consciousness. For example, Jeremy Bailenson's group has carried out interesting experiments in which, through a conscious change of perspective using virtual reality, they managed to increase the prosocial behavior of the participants [59]. In this sense, the development of technology can contribute to exploring aspects of consciousness hitherto inaccessible to experimentation.

Discussion and Conclusions

In this brief review of the different alternatives offered to problems in the study of consciousness, we have focused on three fundamental difficulties and some of the most radical solutions that have been proposed. However, other problems have not been considered here, although in one way or another they could be understood as precursors, related to or derived from those presented here (i.e., binding problem, free will, or self-consciousness, among others).

Faced with the problem of interaction between reality and consciousness, various authors have proposed solutions from the peculiar properties of particles at the subatomic level of quantum mechanics. Perhaps their biggest problem, as mentioned in various places [60], is that these theories try to explain a mystery through something even more mysterious, such as quantum mechanics, based on future advances that do not currently exist. In addition, they rely heavily on physical explanations, neglecting their link with the data that neuroscience research continues to generate [61]. However, a comprehensive explanation of consciousness will have to rely, eventually, on the ultimate foundations of the universe's matter or, at least, be in some way consistent with them.

The dualism-monism debate has been entrenched for centuries. It does not seem that new data or proposals generated from the same epistemological context can produce a satisfactory solution to this perennial problem. Although outlawed in the field of neuroscience, dualism remains in force due to the inadequacies of physicalism [62]. Therefore, a reformulation of the epistemological framework that allows us to overcome what has also been described as false debate is necessary. This would open new possibilities to other explanatory frameworks in which events do not follow a linear logic of causality but a spatiotemporal coincidence of transversality. The possible mechanisms of this synchronicity and the ontological nature of the two states, mental and physical, are issues that need even more radical proposals.

In relation to subjective experience, the acceptance of the privacy and subjectivity of conscious states does not imply that we cannot investigate the necessary and sufficient conditions to generate consciousness. It means that describing these conditions is not the same as producing those experiences [63]. Moreover, a phenomenological approach to the states of conscious experience may allow us, over time, to generate intersubjective communication codes that make possible the transfer of interspecies experiential qualities. Each level of organization requires levels of analysis, methods, and particular theoretical developments that should not become antagonistic and incompatible rivals but, rather, allies capable of building bridges that enable a global and articulated understanding for a complex problem.

On the other hand, emergentism has been repeatedly proposed as a panacea for the various problems of consciousness and, more specifically, to circumvent the explanatory gap. However, the difficulties of this formulation are notable. Among them and like most materialistic proposals, they merely expose the magical appearance of consciousness as an emergent property of the interaction between the different parts of a system, without really explaining how it arises or why [64].

In short, both the diversity of problems listed and the proliferation of theories to address them suggest that the science of consciousness is in a still immature stage of development [65]. The progressive integration between different epistemological frameworks, such as the case of neuroscience and cognitive psychology or the fusion between some metaphysical theories with the principles of quantum mechanics, indicates the

possible existence of a convergent movement that could result in new approaches that we do not contemplate today. At this time, creative and groundbreaking proposals that challenge conventional practices in both the philosophy of science and empirical research are more necessary than ever. The proliferation of new technological tools opens up unknown horizons for experimentation, whose data should enrich and improve the theoretical discussion. Such proposals should stimulate and generate exciting lines of research in the not too distant future, in order to overcome the difficulties posed by the different and numerous problems of consciousness.

References

1. Dennett D. Contenido y conciencia. Barcelona: Gedisa; 1996. p. 55.
2. Crick F. La búsqueda científica del alma: una revolucionaria hipótesis para el siglo XXI. Madrid: Debate; 1994. p. XI.
3. Llinás R. El cerebro y el mito del yo. El papel de las neuronas en el pensamiento y el comportamiento humano. Barcelona: Belacqua; 2003. p. 131.
4. McGinn C. The mysterious flame: conscious minds in a material world. New York: Oxford Books; 1999.
5. Chalmers D. How can we construct a science of consciousness? Ann N Y Acad Sci. 2013;1303:25–35. https://doi.org/10.1111/nyas.12166.
6. Turing A. Computing machinery and intelligence. Mind. 1950;59(236):433–60.
7. Arana J. La conciencia inexplicada. Ensayo sobre los límites de la comprensión naturalista de la mente. Madrid: Biblioteca Nueva; 2015. p. 151.
8. Wittgenstein L. Investigaciones filosóficas. Barcelona: Crítica; 2008. p. 245.
9. Cowey A, Stoerig P. Blindsight in monkeys. Nature. 1995;373:247–9.
10. Chalmers D. The conscious mind: in search of a fundamental theory. Oxford: Oxford University Press; 1996.
11. Searle J. El misterio de la conciencia. Paidós: Barcelona; 2000.
12. Dietrich A. Introduction to consciousness. New York: Palgrave Macmillan; 2007. p. 1–61.
13. Searle J. The rediscovery of the mind. Massachusetts: MIT Press; 1992. p. 127–31.
14. James W. The principles of psychology. New York: Henry Holt & Co; 1890. p. 224–5.
15. Aznar-Casanova J. La consciencia: la interfaz polinómica de la subjetividad. Madrid: Pirámide; 2017. p. 291.
16. Simons D, Chabris CF. Gorillas in our midst: sustained inattentional blindness for dynamic events. Perception. 1999;28(9):1059–74.
17. Ramachandran V. Lo que el cerebro nos dice: los misterios de la mente humana al descubierto. Barcelona: Paidós; 2012. p. 62–80.
18. Churchland PM. Eliminative materialism and the propositional attitudes. J Philos. 1981;LXXVIII:67–90.
19. La Mettrie JO. Histoire naturelle de l'ame. Oxford: aux dépends de l'auteur; 1747.
20. Berkeley G. Principios del conocimiento humano. Madrid: Aguilar; 1980.
21. Bergson H. La evolución creadora. Madrid: Espasa-Calpe; 1973.
22. Varela F. De cuerpo presente: las licencias cognitivas y la experiencia humana. Gedisa: Barcelona; 1992.
23. Hameroff S, Penrose R. Consciousness in the universe. A review of the 'Orch OR' theory. Phys Life Rev. 2014;11(1):39–78. https://doi.org/10.1016/j.plrev.2013.08.002.
24. Hameroff S. Quantum computation in brain microtubules? The Penrose-Hameroff 'Orch OR' model of consciousness. Phil Trans R Soc Lond A. 1998;356:1869–96.
25. Penrose R. Shadows of the mind. Oxford: Oxford University Press; 1994. p. 367.
26. Kodukula SP. New hypothesis on consciousness-brain as quantum processor-synchronization of quantum mechanics and relativity. Int J Theor Phys. 2019;7(2):31–43.
27. Hoffman D, Prakash C. Objects of consciousness. Front Psychol. 2014;577(5):1–22. https://doi.org/10.3389/fpsyg.2014.00577.
28. Hoffman D. The interface theory of perception: natural selection drives true perception to swift extinction. In: Tarr M, Leonardis A, Schiele B, editors. Object categorization: computer and human vision perspectives. Cambridge: Cambridge University Press; 2009. p. 48–165.
29. Descartes R. Meditaciones metafísicas. Madrid: Espasa-Calpe; 1990.
30. Ryle G. The concept of mind. Hutchison: Londres; 1949.
31. Penfield W. El misterio de la mente. Estudio crítico de la consciencia y del cerebro humano. Madrid: Pirámide; 1977. p. 123.
32. Eccles J. A unitary hypothesis of mind-brain interactions in the cerebral cortex. Proc R Soc Lond B. 1990;240:433–51.
33. Humphrey N. How to solve the mind-body problem. J Conscious Stud. 2000;7(4):5–20.
34. Broad CD. The mind and its place in nature. London: Routledge and Kegan Paul; 1925. p. 61.
35. Martínez PC. What is understood by "neural correlate" in mind-brain relations. In: Gargiulo PA, Mesones-Arroyo HL, editors. Psychiatry and Neuroscience Update update: from translational research to a humanistic approach, vol. 3. Switzerland: Springer; 2019. p. 73–81.

36. Chalmers D. What is a neural correlate of consciousness? In: Metzinger T, editor. Neural correlates of consciousness. Massachusetts: MIT Press; 2000. p. 17–40.
37. Miller G. What is the biological basis of consciousness? Science. 2005;309:79.
38. Binder MD. Correlation. In: Binder MD, Hirokawa N, Windhorst U, editors. Encyclopedia of neuroscience. Berlin: Springer; 2009. p. 890.
39. Racionero L. Oriente y Occidente. Barcelona: Anagrama; 1993. p. 64.
40. Leibniz GW. Monadología. Madrid: Alhambra; 1986.
41. Jung CG. La interpretación de la naturaleza y la psique. Barcelona: Paidós; 2003. p. 35.
42. Dennett D, Kinsbourne M. Time and the observer: the where and when of consciousness in the brain. Behav Brain Sci. 1992;15:183–247.
43. Pöppel E. Lost in time: a historical frame, elementary processing units and the 3-second window. Acta Neurobiol Exp. 2004;64:295–301.
44. Gray C, Singer W. Stimulus-specific neuronal oscillations in orientation columns of cat visual cortex. Proc Natl Acad Sci U S A. 1989;86:1698–702.
45. Chalmers D. Facing up to the problem of consciousness. J Conscious Stud. 1995a;2(3):200–19.
46. Chalmers D, McQueen K. Consciousness and the collapse of the wave function. A lecture given by David Chalmers at Göttingen University: Göttingen; 2014.
47. Tononi G, Koch C. Consciousness: here, there and everywhere? Phil Trans R Soc B. 2015;370:1–18. https://doi.org/10.1098/rstb.2014.0167.
48. Rorty R. Contemporary philosophy of mind. Synthese. 1982;53:323–48.
49. Levine J. Materialism and qualia: the explanatory gap. Pac Philos Q. 1983;64(4):354–61.
50. Pinker S. How the mind works. New York: W.W. Norton & Co; 1997. p. 546.
51. Dennett D. Consciousness explained. Boston: MIT Press; 1991.
52. Flanagan O. Consciousness reconsidered. Cambridge, MA: MIT Press; 1992.
53. Jackendoff R. Consciousness and the computational mind. Cambridge: MIT Press; 1987.
54. Goswami A. Creative evolution: a physicist resolution between Darwin and intelligent design. Wheaton: Quest Books; 2008.
55. Husserl E. Investigaciones lógicas. Madrid: Alianza Editorial; 1985.
56. Nagel T. What is it like to be a bat? Philos Rev. 1974;83(4):435–50.
57. Varela F. Neurophenomenology: a methodological approach remedy for the hard problem. J Conscious Stud. 1996;3(4):330–49.
58. Revonsuo A. Consciousness, dreams and virtual realities. Philos Psychol. 1995;8:35–58.
59. Van Loon A, Bailenson J, Zaki J, Bostick J, Willer R. Virtual reality perspective-taking increases cognitive empathy for specific others. PLoS One. 2018;13(8):1–19. https://doi.org/10.1371/journal.pone.0202442.
60. Glattfelder JB. Subjective consciousness: what am I? In: Glattfelder JB, editor. Information – consciousness – reality: how a new understanding of the universe can help answer age-old questions of existence. Switzerland: Springer; 2019. p. 395–449.
61. Pastor-Gómez J. Mecánica cuántica y cerebro: una revisión crítica. Rev Neurol. 2002;35(1):87–94.
62. Davidson D. Ensayos sobre acciones y sucesos. Barcelona: Crítica; 1995. p. 265.
63. Edelman G, Tononi G. Reentry and the dynamic core: neural correlates of conscious experience In: Metzinger T, editor. Neural correlates of consciousness. Massachusetts: MIT Press; 2000. pp. 139–52.
64. Goñi-Sáez F, Tirapu-Ustárroz J. El problema mente-cerebro (I): fundamentos ontoepistemológicos. Rev Neurol. 2016;63(3):130–9.
65. García-Castro J. Nuevas teorías sobre la consciencia. eNeurobiologia. 2019;10(24):1–12. doi:www.uv.mx/eneurobiologia/vols/2019/24/24.html.