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ORIGINAL RESEARCH

Near-death experiences: feasibility and advantages of the mechanistic explanation

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Abstract
The new mechanistic philosophy seeks to identify and explain the mechanisms of various phenomena, including their overall organization and the interactions between the individualized components. This paper argues that among the phenomena that can be approached within the new mechanistic framework are near-death experiences, which can be included within the vast range of experiences that are grouped under the category of religious experience. Such experiences involve a complex set of cognitive, affective, and behavioural processes. Since studying such experiences is far from methodologically simple, we try to show the feasibility of applying the mechanistic explanation to near-death experiences. While some scholars (such as Egil Asprem and Ann Taves) argue that mechanistic explanation can shed new light on the explanation of religion, we instead emphasize neglected limits of such an explanation, as well as its epistemic-methodological advantages in comparison with alternative explanatory models, especially the models proposed by Michael Marsh, Frederick S. Barrett and Roland R. Griffiths.

Keywords Near-death experience · Religious experience · Mechanistic explanation · Explanatory pluralism · New mechanism

1 Introduction

Near-death experiences (NDEs) are grouped within the wide range of phenomena that are broadly defined as religious experiences. They are associated with anomalous or non-ordinary states of consciousness and occur ‘during singular life-threatening

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episodes when the body is injured by a heart attack, shock, or blunt trauma such as an explosion or a fall' (Koch, 2020), to people of all social classes, cultures, and religions. The majority of reports include features associated with general anaesthesia and cardiac arrest (Kelly et al., 2010, pp. 415–421). Likewise, various studies show that only about 10% of individuals are susceptible to NDE-like experiences (Marsh, 2021, p. 66). The self-reported features that frequently recur during such experiences include: feelings of peace and joy; a sense of being outside of one's body; the absence of pain; a sense of motion or weightlessness; seeing an unusual, bright light as in a tunnel or void; a revival of memories or a full life review; sensing the border beyond which one cannot go; catching sight of some other realm like a place of beauty or heaven, etc. (Moody, 1976; Ring, 1980).

The beginning of scientific-phenomenological research in this field dates back to the end of the nineteenth century (Egger, 1896; Heim, 1891). However, thanks to new technologies, in recent decades research has experienced a substantial increase. The rigorous and systematic study of this kind of phenomenon is of singular importance for a variety of reasons, among which the following are worth mentioning: (1) they are relatively recurrent and present similar characteristics; (2) they pose new challenges to certain established theories about the mind-brain relationship, brain dynamics, and the nature of consciousness; (3) they offer potential answers to fundamental existential questions, for example, the possibility of an out-of-body, timeless, virtually indefinite and blissful life, and the role of the corporeal dimension in shaping personal identity, among others.

Having said this, the aim of the present article is to show the feasibility of mechanistic explanation (MEx) in relation to the study of NDEs. In the first section, to contextualize the subject, we will provide a general definition of religious experiences and describe the most important problems that hinder the objective study of these phenomena (which, as noted above, include NDEs). In the second section, we will further develop the notion of NDE and describe the explanatory models used for the study of this phenomenon. In the third section, we will focus on the resources and explanatory advantages offered by the new mechanistic approach, and we will justify our differences with the phenomenological model of Michael Marsh, as well as with the approach of other proponents of mechanistic explanation. Specifically, we refer to the application of the new mechanism postulated by Egil Asprem and Ann Taves. This section is the longest of the article and is divided into four subsections. Finally, we will conclude with a brief reflection on all that has been developed.

2 The meaning and problems of religious experience

The expression 'religious experience' is unequivocally vague. This is because it includes two terms, namely 'experience' and 'religion/religious', which are in themselves rather vague, meaning that when both terms are combined, this results in even greater vagueness. Nevertheless, we understand that it is possible to detect some common denominators in these experiences. The *Abingdon Dictionary of Living Religions*, written by H.N. Malony, sets out the parameters according to which an experience can be defined as 'religious'. Such experiences, according to the author, consist of 'an

encounter with what is seen as transcendent reality; varies among major religious traditions; can be theistic or nontheistic, individual or group, passive or active, novel or recurring, intense or mild, transitory or enduring, tradition-centred or not, initiatory or developmental, expected or spontaneous; types may include ascetic, mystical, or prophetic, either reviving, affirming or converting, either confirming, responsive, ecstatic or revelational' (Malony, 1981, p. 613). In short, the difference between religious and non-religious experience is that the former consists of an encounter with a transcendent entity. In this vein, William Alston defines religious experiences as that type of experience in which Being, Meaning, God, Divinity, Ground, Truth or Ultimate Reality appears or makes itself present to the subject of the experience, either cognitively, perceptually, or in the form of some kind of peak experience (Alston, 1991).

These experiences of encounter with a transcendent entity can range from explicit perceptions such as voices, visions, etc., to vague (numinous) perceptions that are often associated with emotions (Previc, 2006). Among all the characteristics to be highlighted, the sense of oneness seems to be decisive for any religious experience. However, other features can also be noted: (1) an awareness of an all-embracing presence; (2) a sense of the existence of a divine design in one's life; (3) an awareness of divine help received in answer to prayers; (4) an awareness of being cared for or guided by the divine; (5) an experience that the self and all other things are one with the divine being; (6) a sense of having reached the ultimate ground of reality; (7) a loss of the sense of space and time; (8) positive feelings of peace, deep joy, and unconditional love; (9) an experience of blissful absorption in the present moment (Fingelkurts & Fingelkurts, 2009). To these features the following could be added: (10) loss of a sense of causality; (11) feelings of vitality and physical and mental well-being; (12) ineffability of the experience—recognizing the limitations of language and thought to explain its content; and (13) positive changes in the subject's attitude and behaviour (Rubia, 2009).

The experiences just described involve a complex set of cognitive, affective, and behavioural processes. Studying such experiences is far from methodologically simple. The risks of incurring biases of all kinds are high. Some of the problems we are interested in highlighting in this regard are the following:

1. The conclusions of research on this type of phenomena can be significantly influenced by the position previously adopted by the researchers on the mind-brain problem;
2. The process of selecting, collecting, and interpreting information could be affected by the researchers' existential commitment to a particular belief, be it religious, atheistic or agnostic;
3. The definition of the methodological limits of the different disciplines involved in the study of these phenomena could be made difficult by the conviction, which many researchers have, of being able to offer an exhaustive explanation from their own discipline.

In the first place, the conclusions of research on religious experiences may be, at least in part, the result of the thesis previously adopted by the researchers about the

mind-brain problem. Indeed, the same objective data obtained in the course of an investigation could receive widely divergent interpretations, for example, in the hands of a proponent of eliminative materialism and in those of a defender of the extended mind theory. On the mind-brain problem there is no unanimity in the scientific-philosophical community, as there seems to be no ultimate evidence in favour of any particular theory. As the psychologist Paul Cunningham (2011, p. 225) points out:

> A wealth of clinical and experimental evidence demonstrates a close connection between various aspects of religious experience and physiological processes in the brain. But does it necessarily demonstrate that such experiences are localized, generated, or even stored in the circuit of brain regions with which they are associated? The question is of sufficient theoretical and practical importance to a broad range of academic disciplines that it deserves further examination, especially in its bearing on what is traditionally called the mind–body problem.

Thus, depending on the answer given to the mind-brain problem, one can affirm, for example, that religious experience is a mere product of brain dynamics or the result of the interaction between brain, body, and world/culture, taking up only the theories mentioned above. Certainly, other theories of the mind-brain relationship may lead to the postulation that religious experience is the consequence of an encounter between the experiencing subject and a particular kind of extra-mental reality—which we might call God.

Friends of the 'production theory', who receive support from the research on correlation between brain states and mental changes, believe that mind and consciousness really are manufactured entirely by neurophysiological processes occurring in brains. However, the observed correlations may also be conceptualized in the alternative fashion of 'permission' or 'filter models', that is, that the brain may be a vehicle for the mind (Kelly, 2021, pp. 1–6).[1] That said, the fact that there is a diversity of theories and metaphysical perspectives on mind, far from detracting from the rigour and legitimacy of the study of religious experience by relativizing the value of the different explanations, obliges researchers to inspect and refine not only their experiments but also their metaphysical assumptions. In addition, such diversity calls on researchers to improve their methodological tools and to support their theses with a high level of theoretical and practical exigency. One would also hope that the study of religious experience will provide significant information for research into the mind-brain relationship. In this sense, the philosopher A.N. Whitehead can be seen to establish a basic premise that seems to confirm what has just been said: 'the rejection of any source of evidence is always treason to that ultimate rationalism which urges forward science and philosophy alike' (1929/1966, p. 61). Some scientists and philosophers, in fact, draw on research on religious experience to explain their position on the mind-brain problem (e.g., Kelly et al., 2010, 2015).

[1] The filter or transmission theory is not new. It has precursors in ancient philosophy and in the nineteenth and twentieth centuries it was advocated by F.W.H. Myers, William James, Henri Bergson, Aldous Huxley, and even the Polish philosopher Leszek Kołakowski. In recent years the research of Kelly et al. has given it a new impetus with a scientific perspective. One of the most important recent adherents of the theory was Harvard neurosurgeon Eben Alexander III, who abandoned the physicalist view and began to defend the plausibility of the filter theory on the basis of a near-death experience he had in 2008.

Secondly, the process of selecting, collecting, and interpreting information may be affected by the researchers' existential commitment to a particular belief, be it theistic, atheistic or agnostic. In practically all sciences it happens that when problems are taken to their ultimate consequences, limit questions arise, questions that can be decisively conditioned according to the particular beliefs of the researcher (Toulmin, 1950). The study of religious phenomena is not excluded from this situation. But this does not undermine sciences; on the contrary, we think it is wise to ask whether a scientific discipline, that is, an authentically human knowledge, can do without history, tacit presuppositions (values, beliefs, habits, culture, imaginary, experiences), and even the psychological characteristics of those who practise it.

Thirdly, certain empirical methods may be very limited when it comes to studying religious experience (especially in its most sublime manifestations), due to the unpredictability of such events and the content of such experiences. On the one hand, it seems that one cannot voluntarily produce a religious mystical experience in a laboratory. Although some core dimensions of mystical experience (such as extrovertive unity, introvertive unity, sacredness, noetic quality, deeply felt positive mood, ineffability, paradoxicality, transcendence of time and space) have been identified, at the same time these experiences are deeply bounded by characteristic lifestyles, teachings, and traditions that instruct the individual and provide an unrepeatable context for them. On the other hand, R. Griffiths and colleagues (2006, 2008, and 2011) demonstrated a fairly high frequency of 'complete mystical experiences' during psilocybin sessions. Their studies reveal that under double-blind conditions, certain drugs can not only occasion complete mystical experiences in the majority of people studied, but also have an enduring impact on the moods, attitudes, and behaviors of participants. However, F. Barrett and R. Griffiths (2018) note that whether mystical experience itself 'is wholly reducible to neural processes is an open question' (p. 413). In fact, some psychological processes, such as the experience of sacredness, unity, positive mood or alterations in the perception of time and space, are elements of mystical experiences which can be associated with primary neural processes, it is unclear whether they provide a complete account of a mystical experience.[2] In reality, in the case of disciplines such as neuroscience, researchers have to be satisfied with studying phenomena associated with religious experience, but of a secondary nature. For example, they study (as in the work of Griffiths and his colleagues) the neural correlates of different forms of meditation, of prayer, or they may be content to study religious experience by urging the subject of the experience to evoke the event at another time in their life. Although the study of

[2] The question of whether the ingestion of substances can lead to mystical experiences has received a variety of answers and does not yet seem to have a definitive one. For example, already in the 1950s and 1960s, the British writer Aldous Huxley (who studied the effects of so-called 'entheogens' and personally experienced the effects of mescaline, psilocybin and LSD) distinguished between mystical experiences and visionary experiences. The ingestion of substances, according to the author, produces visionary experiences, not mystical experiences. Visionary experiences are lived in a situation of total passivity and individuality, since they inhibit action, and even the will to act, and place the experimenting subject at the margin of the human world, seriously limiting the communitarian dimension (a distinctive quality of the human being) (Huxley, 1994). Thus, substance use leads to a state of quiescence and isolation incompatible with the effects of mystical experiences. Huxley recalls the Gospel passage of the sisters Mary and Martha and affirms that mystical experiences (which are identified with Mary's way) include Martha's way and elevate it, while visionary experiences open Mary's way but close the door to Martha's way.

the neural correlates of religious experiences may lead to a better understanding of the possible brain mechanisms, it is not sufficient to conclude that religious or mystical experience is nothing but neurophysiological processes occurring in brain. Hence the need to recognize that each science has its own methods and resources for research, and that these methods and resources cannot offer an ultimate and total explanation of these experiences because they are limited. The formulation of 'scientific' judgements that go beyond the scope of the method, that is, scientific expansionism, always leads to sterile reductionism. However, though surprising, reductionism 'is still a very prevalent attitude among scientists' (Holder, 2008, p. 4). In the case of religious experience, these forms of reductionism are expressed in statements such as: religious experience is *nothing but* limbic activity, or *nothing but* a *by-product* emerged of adaptations, and so on. In order to avoid *nothing-buttery*, it is important that researchers who apply themselves to the task of explaining a phenomenon as complex as religious experience become aware of the possibilities and limits of the methods and resources of their own discipline, avoiding the temptation of expansionism.

3 Near-death experience: definition and explanatory models

We have noted that it is not a straightforward task to characterize the religious experience as such, since it makes itself present to the subject of the experience, either cognitively, perceptually, or in the form of some kind of peak experience, that can exhibit many and varied features. Having made this general characterization, we now wish to analyse the near-death experience, a particular subclass of such experiences. NDEs describe a spectrum of subjective perceptions involving dissociation between mind and body. Then, an analysis of these experiences directly exemplifies that there can be the epistemology to metaphysics influence by the explanatory position previously adopted by researchers on the mind-brain problem.

As mentioned in the Introduction, there is no universally accepted definition of the phenomenon of the NDE, but it is generally understood as an unusual, vivid, life-changing experience resulting from various life-threatening events, such as being physiologically (e.g., in the case of cardiac arrest) or psychologically (e.g., in the case of accidents or illness) close to death. Following Michael Marsh (2020, pp. 128–30), we agree that four features are the most influential components of NDEs which highly resemble the character of religious experience: (1) fictive movement (e.g. a feeling of coming away from one's body, floating away); (2) seeing divine figures (e.g. encountering godlike figures, a feeling of being in Heaven or seeing Jesus); (3) seeing deceased persons (whom the experiencer recognizes or whom the experiencer had never known but has met in the other realm); (4) distinctive changes in the post-experiential attitudes and values of people who have undergone NDEs (e.g. a permanent altering of one's beliefs or values, an increase in spirituality, an appreciation of life and others, a heightened sense of purpose in life, etc.). These features are of great relevance for our topic since, on the one hand, they strongly suggest that NDEs are manifestations of a large class of experiences in which we deal with the alteration of the ordinary experience of the mind to body or to the external environment; on the other hand, the encounters with a transcendent entity, places of peace and self-reports of feelings that

frequently accompany NDEs strongly resemble the repertoire of features typical of religious experience. Moreover, a noteworthy feature of NDEs is a changed sense of being and personality or a shift in one's beliefs and values, which exemplifies the form of religious experience with a long-lasting impact on one's moral life as a transformative experience (McNamara, 2022, pp. 159–177). In light of the aforementioned recent studies, it seems that all these features are commonly experienced during psychedelic-induced religious experiences. Although these studies allow for controlled exploration of such experiences and are necessary in order to 'provide a degree of neurobiological specificity and mechanistic understanding that is not possible in correlational or descriptive studies, or in reviews of present-day or historical case reports' (Barrett & Griffiths, 2018, p. 395), we do not consider these experimental results as sufficient in offering an explanation of the *explanandum*. In other words, in the same manner that various percepts do not wholly constitute consciousness itself, the mechanistic explanation of individual neural elements of religious experience does not provide a complete account of a mystical experience or NDE. Let us now analyze in more detail the main assumptions of the explanatory models proposed so far and their limits.

3.1 Nomothetic models

Since NDEs can occur in a wide variety of circumstances and include a variety of features, many explanatory models of NDEs have been proposed. These models, envisaged from the perspective of the mind–body relation, can be placed on a continuum from reductive to non-reductive. By the former we intend those models that are primarily committed to bottom-up explanations. They can be characterized, using the new mechanistic terms, by two main features: (1) part-whole explanations (i.e., entities or features of complex systems are provided in terms of the entities or activities of its parts); (2) nothing-but explanations [i.e. an explanation of *A* in terms of *B* is nothing-but just in case the conceptual content of *B* is sufficiently rich to generate that of *A* without the addition of anything fundamentally new (Horst, 1996, p. 267)].

Such characterized models lead to two distinct sets of claims. While some of these claims are about reduction as a form of explanation, others are claims about the domain of metaphysics (Horst, 2007, pp. 31–6). In case of claims about explanation, reductive models embrace the following:

1. Vertical reductive explanation (vREx): given a complete—physical, neurochemical, neurophysiological, etc.—description of the brain at a particular moment, one could in principle derive all other facts about the mind at that moment;
2. Horizontal reductive explanation (hREx): given a complete—physical, neurochemical, neurophysiological, etc.—description of the brain at a particular moment, one could in principle predict all subsequent events about the mind.

In case of claims about metaphysics, reductive models embrace the following:

1. Vertical metaphysical determination (vMDet): given a complete set of basic—physical, neurochemical, neurophysiological, etc.—facts about the brain at a particular moment, these determine a unique possible mental state at that moment;
2. Horizontal metaphysical determination (hMDet): given a complete set of basic—physical, neurochemical, neurophysiological, etc.—facts about the brain at a

particular moment, these determine unique possible mental states that will take place at all subsequent moments.

These schemes fit very well within the nomothetic sciences which are mainly focused on formulating laws (e.g., physics). Although in neuroscience or medicine one can find laws, universal, deterministic laws rarely occur in these sciences. The above view on explanation is the logical empiricist one, a version of the deductive-nomological model based on descriptions and deduction. Although the problems of such a model of explanation (i.e., well-known paradoxes of Hempelian models) have led to new insights on the nature of scientific explanation (Salmon, 1989), such a nomothetic view on explanatory demands within neuroscience is still present. Both reductive and non-reductive philosophers may reason according to the above schemes. Where the two positions will differ is that reductive approaches are committed to nothing-but explanations conceived of as the compositional reduction (i.e., microphysical entities are determined solely by other microphysical entities).

3.2 Mechanistic explanation and mechanistic models

The concept of mechanism has recently received significant attention in the philosophy of science, especially in the domain of the life sciences (biology, medicine, cognitive science, and neuroscience) (Glennan & Illari, 2018; Nicholson, 2012). New mechanists have been struggling to move beyond the aforementioned picture of explanation, particularly by referring to the MEx of biological phenomena. Four basic features of mechanisms should be envisaged when we think about providing explanatory models: a phenomenon; entities and activities; causation; and organization (Bechtel & Abrahamsen, 2005; Craver & Tabery, 2019; Glennan, 1996; Machamer et al., 2000). The phenomenon is understood as the behaviour of a mechanism as a whole. Mechanisms are to be classified by the kinds of entities and activities. According to mechanists, the knowledge of causation is possible and basically it is acquired through experimental manipulations. This means that 'on the one hand, our knowledge of underlying mechanisms guides our causal ascriptions, while on the other, evidence of causal relationships helps us to discover mechanisms' (Williamson, 2011, p. 421). What a mechanism does (phenomenon) depends not only on the entities and activities, and its causal relations, but also on how mechanisms are organized. The overall mechanistic organization comes in many forms (e.g., spatial, temporal), but fundamentally it is conceived of as the causal structure of the mechanism composed of multiple entities and activities that, as a whole, manifest certain patterns of action.

Since causality is basically taken by new mechanists to be a productive relation (Glennan, 2017, pp. 153–156, 170–184; Machamer et al., 2000, p. 3), they do not provide a reductive account of causation but focus on systemic thinking about mechanisms (Wimsatt, 2007). In aggregates, the property of the whole is simply a sum of the properties of their parts, which change linearly with the addition or removal of the parts. However, in contrast to aggregates, mechanisms 'are literally more than the sum of their parts: they change non-linearly with the addition and removal of parts, their behaviour is disrupted if parts are switched out, and this is because their spatial, temporal, and causal organization make a difference to how the whole behaves'

(Povich & Craver, 2018, p. 188). The mechanistic model can be defined in the following terms: it 'consists of (i) a description of the mechanism's behavior (the behavioral description); and (ii) a description of the mechanism that accounts for that behavior (the mechanical description)' (Glennan, 2005, p. 446). The mechanistic model has to represent the mechanism's parts, activities, and overall organization; it is not just the deduction of the *explanandum* based on the description of certain initial conditions and general regularities.

Bearing in mind the differences between the logical empiricist view on explanation and the new mechanistic one, we consider mechanistic models as non-reductive. Although they are part-whole explanations, they do not embrace the aforementioned claims in terms of explanation (vREx, hREx) or in terms of metaphysics (vMDet, hMDet). Non-reductive models are not mere nothing-but explanations (Silberstein, 2002), since they integrate multiple levels of life complexity. Although we will come back to the issue of levels in the third section, now we emphasize that some philosophers or scientists have come to the view that we keep the language of higher-level theories or descriptions merely as a kind of shorthand way of talking about the lower-level stuff (Gillett, 2016, pp. 103–139). The latter view is not the one stemming from the mechanistic explanation as such.

3.3 NDE and variety of models

There have been various attempts to explain NDEs in reductive terms of biochemical or neurobiological mechanisms: lowered levels of oxygen accompanied by increased levels of carbon dioxide (Blackmore, 1993; Lempert, 1994), release of endorphins or other endogenous opioids in stressful conditions (Carr, 1981, 1982); abnormal functioning of the limbic system (Saavedra-Aguilar & Gómez-Jeria, 1989), of the temporal lobes (Britton & Bootzin, 2004), or recently of brain-derived dream states (Marsh, 2021, pp. 97–115). Other models concern wider genetic or neurological backgrounds affecting behaviour within the religious domain, wherein the latter may be pertinent to the propensity to undergo NDEs. Such models focus on, for example: the genetic changes associated with one's predisposition toward religiosity in case of the polymorphism of the 5HT-2A—serotonin—receptor (Borg et al., 2003; Urgesi et al., 2010); patients affected with Guillain-Barré syndrome who report NDEs (Buzzi, 2002; Marsh, 2018), or abnormal perception of body shape and appearance (Murray & Fox, 2005). All these models suggest that the brain produces NDE and the brains of those undergoing NDEs are univocally determining these phenomena or at least are predisposed to do so. As a consequence, these models do not consider other factors (ethnicity, gender, age, profession, social class, religious denomination, personal history, etc.) as precipitants of NDE; nor has the interdependence of genetic or neurobiological predisposition with the environment been well explored.

Although there is disagreement on how to understand the mind-brain relation in the case of NDE, we think that in the context of recent studies there are three main candidates of 'mechanisms' to explain NDE: (1) the electrical spikes in the temporal lobes; (2) the demodulation of serotonergic transmission; (3) the intrusion of REM sleep into wakefulness. With respect to the first case, Blanke and Dieguez (2009) have

argued that there are two types of NDEs on the basis of corresponding temporal lobes alterations: one type characterized by out-of-body experiences (right temporoparietal junction dysfunction) and another type characterized by the feeling of a presence of supernatural agents (left temporoparietal junction dysfunction). With respect to the second case, Timmermann et al. (2018) have noted that there is a significant overlap between psychedelic experiences (induced by administering the serotonergic psychedelic DMT) and NDEs.

With respect to the third possible mechanism, it seems that the intrusion of REM phenomenology into waking consciousness and our neurocognitive functions is the strongest explanation we have now for NDE. Nelson (2015) has provided evidence that there is the prevalence of REM sleep intrusion within people undergoing NDE. Although this shows that people with evidence of waking REM intrusion are more susceptible to experiencing NDEs, it does not mean that we have already individuated the how-actual mechanism of NDE. One of the recent models on the origin of NDEs proposed by Marsh suggests that some areas of the brain involved in dreaming modalities may be identified as the possible mechanisms of NDE. On the one hand, Marsh offers a list of critical features pointing to the neurophysiological origins of NDE as a re-awakening phenomenon (i.e., its abrupt termination, dream-like reminiscence up to the point at which full consciousness dawns, personally idiosyncratic, culturally influenced, etc.); on the other hand, he refers to an innovative suggestion to understand dreaming as controlled by forebrain mechanisms (Solms, 2000). Such empirical arguments, according to Marsh, clearly suggest that NDEs consist of waking phenomena (Marsh, 2021, p. 86), could be regarded as epiphenomenal (Marsh, 2021, p. 86), and have hallucinatory, dream-analogous content (Marsh, 2021, p. 112). However, Greyson (2021, p. 33) refers to studies showing that the current data speak against the contribution of REM intrusion to NDEs. For instance: fear is typical in the sleep paralysis seen in REM intrusion but rare in NDEs; NDEs typically occur under general anesthesia that inhibits REM activity; REM brain activity of people undergoing NDEs shows that they actually have less REM activity than do other people; and finally NDE experiencers did not have brain wave patterns typical of recalling dreams but rather typical of memories of real events.

Apart from the fact that current data counter the thesis that REM intrusion is the strongest explanation for NDE, in what follows we will argue that not only are authors like Marsh jumping to conclusions on the basis of empirical data too quickly, but also that they are labouring under too rough an assumption that referring to, e.g., narrowly defined brain mechanisms of dreaming leads one to regard the whole phenomenology of NDEs as epiphenomenal. In other words, we argue that invoking possible mechanisms of certain processes does not necessarily lead to the nothing-but stance, that is, a compositional relation that enables one to explain higher-level properties in terms of lower-level properties does not entail that higher-level entities are nothing-but lower-level ones.

On the very opposite side to reductive models, we find non-reductive ones. Proponents of the latter call into question the acquiescence that the mind is nothing-but the brain. According to proponents of such models, the incompatibility of NDE with the mind is nothing-but the brain stance is particularly evident in connection with the following conditions of NDE: general anesthesia, cardiac arrest, the occurrence

of enhanced mental activity (e.g., rapid revival of memories that extend over one's entire life), a firm belief among NDE experiencers of postmortem survival, and finally an out-of-body experience linked with perceiving events that normally one could not perceive (Kelly et al., 1999–2000; Greyson, 2021, pp. 34–45). Although we will not consider these challenges in a detailed way in our paper, we emphasize that a lot of joint theoretical and empirical work needs to be done if one wants to find a proper explanation of NDE. According to proponents of such models, the lack of an adequate explanation of NDEs should not lead to the suggestion that these occurrences, as often self-reported in cases of NDE, should be ruled out. Between reductive and non-reductive models, there are psychological models. The need to expand the search for psychological factors inducing NDEs stems from the fact that the occurrence of NDEs is not yet univocally associated with well-defined psychological causes (Van Lommel, 2001).

4 Thinking about mechanisms of near-death experience

In contrast to Marsh (2021), we wish to show that applying the mechanistic framework to explain religious experiences, or the particular subclass of such experiences like NDEs, does not lead to the nothing-but compositional reduction of such explananda. We choose MEx since it can be regarded as a successor of the reductionist explanations, while at the same time it evidences how different is the contemporary philosophy of science from the normative agenda of the positivist and logical empiricist approaches. Moreover, recently some prominent authors have emphasized the potential for successfully applying MEx to religious phenomena.[3] In fact, Asprem and Taves (2018) argue that since the MEx is focused on the causal mechanisms of explananda, it can shed new light on the explanation of religion. Basically, we agree that using the models of causal mechanisms to map out and constitutively explain religious experience holds potential for successful explanations, but we cannot neglect some limits of MEx in this case. Moreover, in our view, the potential of MEx lay not so much in the faithful, mechanistic mapping of synchronic and diachronic causal chains, but rather in the mechanistic approach being interpreted as a case of interactive pluralism.

4.1 Explanatory vs metaphysical mechanisms

It is not our aim to discuss here all details of the new mechanistic wave. Instead, we want to focus on the fact that scientific models, including mechanistic ones, are models of particular aspects of the world. Modelling thus involves bracketing off some features of the world in order to grasp others. In the case of mechanistic models, boundaries, levels or causal mechanisms, they constitute idealized representations of processes. In the case of causal mechanisms, as Nicholson rightly argues, 'explanations always presuppose a context that specifies what is to be explained and how much detail will

[3] In order to situate the reader historically, we mention that the project of non-reductive explanations in science has been ongoing since the works of Putnam (1988) and Fodor (1980). We have not delved into it from a metaphysical point of view because we do not consider it relevant for the purposes of the article and the logic of explanations that it demands.

suffice for a satisfying answer, […] it is this very epistemic context that determines how causal mechanisms are individuated and what details are featured in them' (2012, p. 160). If this is so, it seems that the term 'mechanism' does not necessarily refer to metaphysical causal mechanisms. What does it refer to, then?

When speaking, e.g., about the mechanisms of NDEs, it is quite intuitive to think about mechanisms 'out there in the world' and MExs or models that depict them. However, as Nathan (2021, pp. 171–172) notes, the root of the problem is simple: the term 'mechanism' is ambiguous and may refer to both aspects, that is, to things in the world and to their representations. Since MExs represent entities and activities in the world, it may seem obvious that claims about representations are claims about the mechanisms in the world. In fact, such a melding of two distinct claims is the core of the reductive strategy, i.e., given the vREx we infer the vMDet, or given the hREx we infer the hMDet, but it cannot be the case when we deal with MEx. As the strategy of MEx shows, asking whether we are talking about explanations or things that are explained is not foolhardy, since explanations are not 'magic devices' capable of faithfully mirroring reality. This caveat may seem simplistic insofar as it is just pointing out that the *explanans-explanandum* relation is much more complex than deductive entailment. However, it should not be neglected that our representations of mechanisms out in the world are inaccurate, abstracted, idealized, and context-sensitive. The ambiguity of the term 'mechanism' stems from the widely shared presupposition that MExs take care of two endeavours at once, providing descriptions and explanations that are melded into individual mechanistic models. However, the description and explanation are different functions that should be kept distinct (Cartwright, 1980). If these functions are not distinguished, then the notion of explanatory reduction becomes closely connected with some sort of metaphysical necessity, i.e., if you have a part-whole and nothing-but explanation of E in terms of C, you have then guaranteed that C is sufficient and necessary for the occurrence of E. Friends of the new mechanism probably would expect us here to enter into the debate on ontic versus epistemic explanation; however, we leave these problems for another paper.

4.2 Methodological pluralism

What different pluralisms share is not just an acknowledgement of the plurality of languages, objects, methods, theories, and representations in scientific research and practice, but an explicit endorsement of the multiplicity of epistemic tools. This endorsement is not like the by-product of the epistemic practices, but an added value, strongly preferred over attempts to reduce or overcome plurality and implying positive evaluation of pluralities (Campaner, 2019). Now we will pursue mechanistic pluralism, addressing more specifically its two guises: the methodological and the causal (the latter will be explained in the next section).

The methodological pluralism emerging from the mechanistic project consists of explanatory and experimental plurality. By the explanatory plurality, we understand that science essentially involves explanations of different kinds at different epistemic levels, and that interdisciplinary connections have a fundamental role in the advancement of science. Explanatory plurality is then an alternative to the above-mentioned

compositional reductionism. In more detail, we can disentangle the explanatory plurality following Eronen's (2012, p. 220) overview adapted for our aims:

1. Explanations of different kinds are necessary in many cases;
2. Explanations at different levels are necessary in many cases;
3. Successful higher-level explanations remain explanatory even when corresponding lower-level explanations are complete;
4. Interlevel connections and explanatory integration across disciplines are crucial for the explanatory endeavour.

A brief comment on these points. Thesis (1) expresses the fact that there is no single structure to which all scientific explanations necessarily conform (Aizawa & Gillett, 2019). In fact, mechanistic explanation employs and integrates different types of explanations: causal (activity-based, manipulationist, processual, Glennan's view; non-productive causation dealing with omission, prevention, disconnection); non-causal (mathematical: probabilistic, statistical; topological dealing with graphs, networks); mixed causal and non-causal (systemic, evolutionary, functional), or modelling view of science. The point of thesis (2) is to emphasize that focusing on just one level of explanation is in most cases insufficient for a satisfactory theoretical account of the *explanandum*. Thesis (3) is related to the previous one, since it states that higher-level explanations are no less necessary than lower-level ones. Thesis (4) reflects the fact that the explanations of different scientific domains and levels are not independent from each other.

It is beyond the aim of this paper to study in more detail how these four principles of explanatory pluralism actually apply to specific models of NDE. We hope to treat this problem in future research. For now, it suffices to emphasize that in the case of MEx that was explicitly proposed in the literature by Asprem and Taves and implicitly by F. Barrett and R. Griffiths in their overview of induced mystical experiences, these methodological principles when dealing with *explananda* such as NDEs work in the following way:

1. Explanations of different kinds, e.g., systematic perturbation of brain functioning, causal processual approach to working of receptors, psychometrically validated retrospective measures of experiences (questionnaires), evolutionary approach to cognitive capacities;
2. Explanations at different levels such as neurochemical, neuroanatomical, pharmacological, clinical, emotional, mental;
3. Successful higher-level explanations remain explanatory and are not replaced by corresponding lower-level explanations, i.e., higher-level explanations of complex emotions such as reverence or sacredness are no less necessary than lower-level ones;
4. The explanations of different scientific domains and levels are not independent from each other, e.g., as the explanatory challenge remains the fact that psychological processes such as the experience of positive life-changing events or alterations in the perception of time and space are to be associated with neural processes.

In the case of experimental plurality, mechanists are in favour of using different experimental and intervention techniques (inhibitory/bottom-up or stimulatory/top-down experiments) to investigate various components of the *explanandum*. For

instance, in the case of brain studies, crucial interventions and manipulations can be made at (at least) three levels (i.e., a macrolevel of both environmental and genetic factors; a microlevel, focused on molecular pathways and electrochemical activity; clinical conditions of each single patient). In the case of neuroscience, mechanists also focus on several kinds of interventions (e.g., activation strategies—functional PET or MRI techniques; interference experiments; additive experimental strategies—intervening to stimulate, intensify, or multiply some component in a mechanism).

4.3 The causal pluralism

Certainly, there are different ways of being a causal pluralist. Looking at mechanistic talk about causation and causal explanations, it is clear that mechanists generally do not embrace what Psillos has called the 'straightjacket view' (2009, pp. 131–151). Mechanists do not assume just the monist view on causation, but instead combine different concepts describing what kind of relation causation is. They willingly attribute some platitudes to causation, such as: the productive (i.e. causes are the means to produce or prevent certain effects); the processual (i.e. the causal processes propagate causal influences); the difference-making (i.e. causes make a difference); the explanatory import (i.e. causes explain their effects); the grounding (i.e. mechanisms ground causal relations); the evidential import (i.e. knowing that *c* occurred and that *c* causes *e* gives us reason to expect that *e* will occur).

The mechanistic focus on scientific practice, by attending to the methods of discovery, reasoning, and representation of causal mechanisms, has provided good reasons for adopting a pluralist position on causation. One of the biggest contributions of the new mechanism is that close attention to the explanatory practice of various sciences shows that causes play important and distinct roles within the sciences. On the one hand, they work as metaphysical posits, and, on the other, as explanatory postulates (Nathan, 2020). In the first case, the objectivity of causation is what grounds the objectivity of explanation, and sound causal explanations require identifying the appropriate causal factors. In the case of their being explanatory postulates, causes play a specific role restricted to the context of a particular theoretical framework or model. In this case, causal relations are essentially preliminary hypotheses awaiting replacement by more perspicuous explanatory elements. This distinction between causation *de re* and causal explanations provides the conceptual resources to revisit the reductionist acquiescence of equating explanatory claims within certain models of neurocognitive functions with the metaphysical ones about the mind (Nagel, 2012).

4.4 The interactive pluralism

Always focusing on integration, irrespective of precise explanatory aims in a given context, would both unnecessarily complicate matters and subject the plurality to the imperative of integration (Bouwel et al., 2014). To some degree, integrative pluralism correctly describes the character of methodological and causal plurality and may be useful in explaining religious phenomena. However, the mechanistic debate over pluralism reveals that what makes pluralism so useful and efficacious is that it might help

refine the respective approaches by articulating their strengths and limitations due to interaction and engagement (Oviedo, 2020). The interactive pluralism seems to be more suitable for the interdisciplinary approach to dealing with religious experience. This interactive pluralism can be further articulated. On the one hand, interactive pluralism claims that satisfactory explanations can also be obtained without regard to the integration imperative, and, on the other, it does not disregard the fact that interaction and integration may lead to better explanations. How, then, can we generalize the main features of such interactive pluralism?

In the case of causal explanations, different approaches to causation may compete in parsing the causal space. It therefore remains an open question which of the accounts should be advocated and whether different accounts can be integrated in order to obtain the causal history of an *explanandum*. In respect of religious experience, the causal account should not be limited only to the causal accounts of brain processes, but at the same time should refer to mental processes (as evolving in terms of one's beliefs, attitudes, moral actions) and to the brain-culture nexus understood within an overall life history. This wider perspective on the causation of religious experience clearly shows that at the outset there is a problem of deciding the *explanandum*: do we tend to explain religion in the abstract, e.g., the cerebral processes underlying certain religious phenomena, or are we studying the people who engage in certain processes, practices, experiences deemed 'religious'? If we opt for the latter, then different causal approaches should start on an equal footing. The interaction between approaches may respond to aims (explanatory interests) posited by the knower, when the explanation-seeking questions are the channels of interaction between competing explanatory projects, rather than vehicles for formulating nothing-but explanations from the outset. Moreover, the interaction of different causal accounts does not have to do with some provisional feature of our construction of knowledge that is to be overcome by capturing an all-encompassing theory of religious experience or NDE. In other words, the fact that our best-confirmed scientific accounts struggle with 'the explanatory gap of the mind' or, in a distorted manner, represent the *explanandum* may reveal something not only about the reality beyond our cognitive capacities, but also in larger measure about our limited cognitive architecture.

In their recent paper, Asprem and Taves (2018) have expressed confidence in the MEx since it has the capacity to explain the complexity of religious phenomena. We agree that interactive pluralism holds the potential to the diachronic and synchronic explanation of individualized components constituting higher-level processes contributing to the production of such phenomena. Yet, we do not share these authors' conviction that grounding certain phenomena in lower-level mechanisms is all that is needed. Asprem and Taves argue that our religious experiences are well-suited for mechanistic causal explanations since the latter are grounded within the adapted cognitive features that account for the repertoire of religious experience. In fact, in their MEx of belief formation, they argue that while the interaction in terms of abilities, beliefs, and motivations provides an explanation of the social interactions, it is rather the evolutionary perspective on intentionality that provides a mechanism that explains how certain people came to believe religious phenomena (Asprem & Taves, 2018, pp. 150–152). For them the mechanistic causal explanation of the religious phenomenon is grounded in the evolutionary theory of certain cognitive features.

Although Barrett and Griffiths (2018), while exploring the literature on experiences with classic hallucinogens, do not refer explicitly to MEx, nevertheless, it seems that they have it implicitly assumed. First of all, in the introduction they claim that classic hallucinogens 'provide a degree of neurobiological specificity and *mechanistic understanding*' (2018, p. 395; italics added) of such experiences. Secondly, in the section 'Are Mystical Experiences Reducible to Neural Processes?', they claim that 'the study of the neural correlates of mystical experiences may lead to a better understanding of the *possible brain mechanisms underlying* self-referential, spatial, and temporal processing, as well as complex emotions such as reverence or sacredness' (p. 414; italics added).

Let us see their proposal in the grid of our analysis of the causal pluralism. After that we will emphasize some methodological challenges not mentioned before. These authors treat causes of such experiences from various perspectives: the productive (i.e., classic hallucinogens are the means to occasion mystical effects); the processual (i.e., since classic hallucinogens are compounds that bind at 5-HT_{2A} serotonin receptors, they influence a unique profile of changes in thoughts, emotions, and perceptions); the difference-making (i.e., systematic perturbations of a neural system make a difference; PET, SPECT, fMRI, BOLD brain imaging methods have been used to show that different brain parts are modulated by classic hallucinogens); the explanatory import (i.e., the study of the neural activities may lead to a better understanding of the possible brain mechanisms of mystical experiences); the grounding (i.e., the intriguing overlap in neural findings on classic hallucinogens and neural findings on meditative practices that may occasion mystical experiences); the evidential import (i.e., administering classic hallucinogens can occasion mystical experiences with high probability). Although the study of the neurochemical and neuroanatomical aspects may lead to a better understanding of the possible brain mechanisms of *explananda*, the authors are aware that it is not clear whether and how mystical experiences are to be reduced to neural processes. In other words, it means that such causal explanations are working in fact as explanatory postulates, playing a specific role restricted to the context of a particular theoretical framework or model.

As it comes to methodological aspects, it should be added that Griffiths and colleagues provided the four-factor psychometrically validated questionnaire (MEQ30) to measure the mystical experience. Among its limits is the fact that it assesses phenomena occurring not over a lifetime but during a single discrete experience and it has only been used in studies of classic hallucinogens. The authors themselves emphasize that 'future research is needed to validate the MEQ30 in assessing mystical experiences that occur in experimental and nonexperimental contexts in absence of drug administration' (Barrett & Griffiths, 2018, p. 409). Moreover, Griffiths and colleagues argue that in light of the recent studies both psilocybin and LSD were shown to increase global brain entropy. These findings all support a breakdown of long-distance communication in brain regions involved in the medial default mode network (DMN) of the brain (Barrett & Griffiths, 2018, p. 418). Although Barrett and Griffiths claim that 'alteration of the efficiency or fidelity of long-distance communication between nodes of the DMN after classic hallucinogens may be a *neural mechanism underlying changes* in activity in the DMN, and it may be a *mechanistic change* that is crucial to supporting mystical experiences' (p. 422; italics added), such 'mechanistic evidence'

may be drawn too hastily. In the light of recent studies, intense experiences brought on by psychedelic drugs are correlated with decreased brain activity. This rather runs counter to models of consciousness that require greater integration of activity across the brain. 'It is difficult to understand how greater fragmentation or random signal fluctuations in the brain can produce the highly structured and experientially rich experiences that are typically described as the most meaningful in life' (Greyson, 2021, p. 42).

We think that postulating causal mechanisms, as in the Asprem and Taves' case study by evoking evolved cognitive capacities or in Barrett and Griffiths' mechanistic understanding of psychedelic-induced religious experiences, is not sufficient to 'do justice to a whole swath of cultural, psychological, material and social elements' (Asprem & Taves, 2018, p. 153) present in such experiences. Presenting an empirically informed defence of the claim that religious experience is univocally determined or caused by certain cognitive abilities, evolutionary traits or neural mechanisms fails to take into account that: (1) first of all, it is not obvious that synchronous relations are to be treated as causal ones, i.e. such relations comprise not wholly distinct entities and do not necessarily involve any transfer of measurable quantity; (2) properties within the religious experience are qualitatively distinct; (3) lower-level components of religious experience together compose the qualitatively different entities of higher-level experience. These three conditions show that we may get the multiple realization of religious phenomena, instead of locating their univocal empirical underpinning (Aizawa & Gillett, 2009). Seeking out empirical evidence for religious experience in terms of compositional reductionism, e.g., taken from the evolutionary accounts of cognitive abilities or neural models of such experience, turns out to be explanatorily insufficient.

In our view, the potential of MEx stems not just from the mechanistic mapping of synchronic and diachronic causal chains; rather, if its potential is to be realized, then the mechanistic approach has to be interpreted as a form of interactive pluralism. The latter acknowledges more than just a range of different possible epistemological tools and metaphysical commitments, as any pluralism does. What is at stake is the fact that the pluralism discussed above is an explicit endorsement of the multiplicity of epistemological and metaphysical approaches, e.g., to religious experience that offers 'an added value, and should be strongly preferred over monistic attempts to reduce, neglect, or overcome plurality' (Campaner, 2009, p. 30). Interactive pluralism preserves the richness of plurality, since it does not necessarily commit us to the progressively pursued integration towards some sort of most comprehensive understanding, triumphant super-explanation, or single correct theory of religious phenomena. Such interactive pluralism is mainly motivated by the fact that scientific theories dealing with complex phenomena are underdetermined by the available data.

5 Conclusions

We have noted that the identification and decomposition of mechanisms of NDEs, treated as a case of religious experience, is inherently perspectival (i.e., idiosyncratic, based on self-reports and non-repeatable events), and yet at the same time this does not

imply that the brain parts or functions are not engaged in providing conditions of such experiences. The differences between the strategies adopted by various models do not impose that the epistemic perspective is necessarily arbitrary. Such a perspective is theoretically and experimentally elaborated since the real reference to the investigated phenomenon is at stake. Nevertheless, 'NDE pushes at the limits of medical ideas about the range of human consciousness and the mind-brain relation' (Van Lommel, 2001, p. 2044). In other words, the central challenge for explanatory models of NDE is how complex consciousness can occur under conditions in which current neurophysiological models deem it impossible. In fact, there is the set of phenomena occurring in strict connection with NDEs that turn out to be incompatible with the explanatory models so far proposed. These theoretical challenges have not been adequately addressed by the mechanistic understanding of NDE. Moreover, an open question remains as to whether they could be treated properly within such an explanatory framework. Thus, from a more general point of view, the other salient aspects demanding further exploration are: how to account for complex phenomena associated with NDEs when most areas of the brain are not working properly and how to relate what we already know about NDEs to the rest of our knowledge on the brain and religious experience.

Secondly, the mechanistic literature shows that strategies of abstraction or idealization are used abundantly in life sciences, especially to elucidate system-level patterns of organization that cannot be predicted from or derived ab initio from the features of the system. The presence of abstractions and idealizations in the models often makes the causal relations among parts and activities misrepresented in MEx (Love & Nathan, 2015). The idealization and abstraction remain essential and irreducible features of scientific explanation. On the one hand, this is because explanation involves a necessary trade-off between explanatory power and descriptive accuracy; on the other, the goal of explanation is not an all-encompassing model of the target phenomenon, but rather a series of many complementary and partial descriptions similar, to a certain degree, to what is being investigated. Moreover, since NDE pushes at the limits of proposed neurobiological explanatory models, we should probably rethink our metaphysical implications about the mind–body relation drawn from our explanatory models of religious experience or NDE.

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Declarations

Conflict of interest The authors declare no conflict of interest.

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