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The Causal Closure of the Physical Challenged in the Light of Causality

—The Case of Biological Mutations

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Abstract

The main challenge to mental causation arises from the causal exclusion argument proposed by Jaegwon Kim, which involves the principles of causal closure of the physical domain and non-overdetermination. The central aim of this article is to counter this argument with the idea that phenomena of essential chance—such as "absolute coincidences"—underlie intrinsic creations over the course of evolution. In the case of a mutation, given the symbolic nature of the genetic code, the potential functional effects resulting from an alteration in an organism's DNA sequence are not a necessary outcome of the preexisting state of the natural system, even defined probabilistically: The probabilistic chance underlying the alteration of the genotype is converted into an essential chance of the functional effects of mutations. This instance of causal intransitivity challenges the principle of causal closure and makes room for the appearance of entities and properties that are causally irreducible to those that preceded them.

Keywords

Mind-Body Problem, Causal Closure, Causality, Philosophy of Mind, Evolutionary Biology

1. Introduction: The Challenge to Mental Causation

The main challenge to the causal role of the mind, as developed within the framework of physicalism (which posits that everything is fundamentally physical)[1]

[1]This opens up a wide field of interpretations, starting with the simple monist position, which regards every entity in nature as physically constituted and implies the notion of (nomological) supervenience. According to this view, there is no change affecting any entity without a change affecting its physical constituents: "Supervenience is only a 'phenomenological' relation about patterns of property covariation." However, in mainstream physicalism, these patterns are interpreted as "manifestations of some deeper dependence relationships" (Kim, 1998, 13ff.), implying, as far as mental properties are concerned, their causal determination by their underlying physical basis (Papineau, 1990).

arises from the argument involving the principles of causal closure of the physical domain and of no-overdetermination, advanced by Jaegwon Kim, the philosopher who has most significantly stimulated and clarified debates on mental causation. The central aim of this article is to counter this argument with the idea that phenomena of essential chance—such as "absolute coincidences"—underlie intrinsic creations in evolutionary history. In the case of mutations, given the symbolic nature of the genetic code, the potential functional effect resulting from an alteration in an organism's DNA sequence is not a necessary outcome of the preexisting state of the natural system, even defined probabilistically: The probabilistic chance underlying the alteration of the genotype is converted into an essential chance of the phenotypic effects of mutations. I argue that this instance of causal intransitivity challenges the principle of causal closure and makes room for the appearance of entities and properties that are causally irreducible to those that preceded them.

My argument can be summarized through the following five points:

1. The principle of physical causal closure asserts that every physical effect has a sufficient physical cause.

2. Causal sufficiency entails a specific conception of causation: it establishes a necessary link between the states of a causal system, which can be characterized as either deterministic or probabilistic.[2]

3. The symbolic nature of the genetic code introduces essential chance into the functional effects of mutations.

4. Essential chance arises from the encounter of two entirely independent causal systems, meaning that there is no necessary connection between them.

5. Consequently, the essential chance of the functional effects of mutations challenges the principle of physical causal closure.

This argument is developed in the following discussion by examining the foundations of each point it raises and the debates they may generate in the literature. First, Kim's argument regarding the causal closure of the physical domain is presented (Section 2); then, the meaning of the causal sufficiency condition and its links to the theoretical states of a causal system are highlighted (Section 3). On this basis, problems posed by emergentist approaches within the framework of physicalism are revisited (Section 4) and, finally, the principle of causal closure is challenged by biological mutational events (Section 5). The implications for the issue of mental causation are drawn in conclusion.

2. Jaegwon Kim's Argument

2.1. The Causal Exclusion Argument

Kim's argument is based on the principle of the causal closure of the physical domain, which implies that every physical effect has a sufficient physical cause; and

[2]Unlike structural or counterfactual accounts, a sufficient cause imposes a relation of necessity between cause and effect. That relation entails theoretical closure: only relative to fixed background conditions can the cause be sufficient—guaranteeing the outcome (deterministic) or fixing the effect's probability distribution (stochastic/quantum).

a principle of no-overdetermination, which implies that no physical effect has two distinct, concurrent sufficient causes—one physical and one mental,[3] leading him to conclude that mental properties, qua mental, are not causally efficacious. Kim's argument can be stated more precisely as follows (Kim, 1989a: p. 44; Kim, 1992b: p. 135; Kim, 1998: p. 41; Kim, 2005: pp. 38-45):

1. Assume that an instance of mental property M (i.e., an event, state, or phenomenon) causes a physical effect P*. The causal closure of the physical (non-mental) domain implies that P* also has a physical (non-mental) cause P.

Therefore, [M (mental cause)] or [P (physical cause)] => P* (physical effect).

The physical cause being more fundamental, the mental cause is thus redundant and excluded (no-overdetermination).

2. Mental-to-mental (M-M*) causation is also ruled out. If we consider the respective physical supervenience bases P and P* of M and M*, then, by causing M*, M is presumed to cause the physical supervenience base of M*, that is, P*. However, the principle of causal closure ensures that P* has a sufficient physical cause, and the supervenience relationship between P and M ensures that if, ex hypothesis, M is a cause of P*, then P is nomologically sufficient to cause P*, therefore, P qualifies as a sufficient cause of P*. In this scenario, the mental cause M becomes redundant.

The only way out of these impasses, according to Kim (1998: pp. 28, 118-119), is to accept the reduction of the functional properties of the mind to physical ones, interpreting them as second-order functional properties derived from properties in the basal physical domain. These properties do not introduce any new causal powers beyond those of their physical base, and moreover, they are determined by the latter: It is the brain state correlated with the pain I mentally experience that causes me to withdraw my hand from the flame. Thus, the causal closure of the physical domain is respected. Conversely, if some phenomenal properties of conscious experience remain functionally irreducible, we cannot account for their hypothetical causal role within physicalism.

Let us note that, originally, the concept of reduction was conceptualized as a relationship between theories (one being reduced and the other one reducing). This has been extended, as Churchland (1989: p. 278) explains, to the relationships between phenomena with the understanding that these are captured by theories that are in a reduction relationship. Reduction is then interpreted as the idea that phenomena in domain X can be fully explained or reduced in terms of entities and properties from domain Y. Whereas theoretical reduction seeks a substitution of one theory by another, usually more fundamental or encompassing, Kim's functional reduction proposes a way of understanding mental properties in terms of their functional roles that can be realized by physical states, without eliminating their specificity. Functional reduction, therefore, emphasizes how functional properties associated with mental phenomena can be realized by physical pro-

[3]For example, Kim (2005: p. 17) states: "If an event e has a sufficient cause c at t, no event at t distinct from c can be a cause of e (unless this is a genuine case of causal overdetermination)."

cesses, without necessitating direct correspondence between the constructs of the theories, as is required in theoretical reduction. The causal exclusion argument thus allows Kim to identify the functional properties of the mental with those of its "physical realization," which he summarizes as the "causal inheritance principle": "[The Causal Inheritance Principle] If mental property M is realized in a system at t in virtue of physical realization base P, the causal powers of this instance of M are identical with the causal powers of P" (Kim, 1992a: p. 18). In other words, each instance of M has exactly the causal powers of its realizer on that occasion, so that all the "causal/explanatory work" is done by P (Kim, 1992b: p. 110).

Kim acknowledges that the idea that mental properties play a causal role that is only extrinsically realized and thus functionally reducible is an a priori conception, since: "it is prima facie a coherent position to think of mental properties as 'first-order properties' in their own right, characterized by their intrinsic nature (e.g., phenomenal feel) which, as it happens, turn out to have nomological correlates in neural properties." He rejects this position, which he believes would involve the hypothesis of the emergence of *sui generis* causal powers and the associated thorny problem of "downward causation" (which will be discussed below), as well as the violation of the causal closure of the physical domain (Kim, 1992a: p. 18).

Let us add that Kim (1998: pp. 83-86) proposes distinguishing between orders and levels to avoid the pitfall of reductionist regression to the ultimate physical constituents.[4] The notion of levels is reserved for the various entities and properties that characterize the micro-macro hierarchy and allows him to counter the fallacy of an entirely microphysical conception of causal sufficiency, since the physical constituents of the lower levels do not determine certain properties and forces of wholes at the higher physical levels. With the formation of new wholes, this micro-macro hierarchy naturally involves the appearance of new (macro) properties beyond those of their microconstituents. For example, the ten-kilogram mass of a given table is a property that represents a set of causal powers that no microconstituent of the table has, or H_2O molecules have causal powers that no oxygen or hydrogen atoms have.[5] Conversely, orders refer to properties of the same objects, meaning they involve a problem of intra-level causal exclusion. An example is given by the case of a sleeping pill: At the first order, we have the chemical property, and at the second order, we have its dormitive property. The same applies to the firing of C-fibers and the sensation of pain.

Kim's argument cannot be seriously challenged within the framework of physicalism if its premises lead to a priori equating the supervenience of the mental on the physical with the causal determination of the mental by the physical. However,

[4]This distinction itself is questionable (Gozzano (2009), on this subject), but only Kim's argument is of interest here.

[5]Roger Sperry's (Sperry, 1969: p. 532) evocative picture of the wheel rolling downhill and carrying its embedded molecules and atoms illustrates a simple form of (interlevel) physical downward causation.

such assimilation artificially separates mental from physical causation. One argument of this article is that this separation, supported by the argument of no-overdetermination, is ultimately a consequence of the evolutionary production of the mental by the non-mental, if the causal closure of the physical is assumed. In this context, the physicalist notion of the causal closure of the physical domain warrants closer examination.

2.2. The Physicalist Meaning of "Causal Closure" of the Physical

I have previously defined causal closure through what appears as the most widespread, precise, and unequivocal assertion that "every physical effect has a sufficient physical cause".[6] If the physical cause were not sufficient, it would open the door to the action of external causes, contradicting the notion of closure. Even when Kim (1989a: p. 43; 2005: pp. 15-16) explains that he roughly translates the principle of closure by the assumption that "any physical event that has a cause at time t has a physical cause at t", it seems to mean "any physical event that has a cause at time t has a 'sufficient' physical cause at t." From this, Kim derives the idea that "physics is causally and explanatory *self-sufficient*" (Kim, 2005: p. 16) or that "no causal chain will ever cross the boundary between the physical and the nonphysical" (Kim, 1998: p. 40). This statement highlights two key implications of the notion of a sufficient cause within the framework of the causal closure principle: first, the exclusion of external causal influences, and second, the exclusion of any exit from the physical domain. Due to the micro-macro hierarchy, Kim, as we have seen, includes the biological, the chemical, and so on. He thus rules out any exit from it through a functional effect that would be irreducible to the entities and properties within, as posited, for example, by strong emergentist hypotheses. In other words, every functional effect generated by a causal chain originating in the physical domain is, in principle, reducible within the physical, broadly conceived as the non-mental.

The principle of the causal closure of the physical (or the correlative notion of the completeness of physics)[7] is inspired by the conservation laws in physics.[8] These ideas underpin the physicalist foundations that dominate contemporary philosophy and have allowed the removal of ad hoc explanatory factors from science, such as, for instance, the so-called vital forces presumed to animate matter.

[6]This definition, which refers to a physical effect, assumes its causal production. However, for the sake of clarity, I prefer to keep it straightforward. The formulation of causal closure that explicitly restricts it to events having a cause aims to avoid conflict with quantum mechanics. As we will see below, quantum mechanics does not require abandoning the principle of causality but rather reformulating it in a more abstract manner. Another reason is to allow for the possibility of a physical "first" event, such as the "Big Bang" (Lowe, 2000: p. 575); however, this precaution is more likely to create confusion.

[7]The two principles are often not distinguished. However, there are different formulations of causal closure. Completeness is often viewed as a principle that emphasizes the sufficiency of physical explanations for all physical effects, though it may be compatible with overdetermination by non-physical causes in specific formulations (for discussions, see especially Lowe (2000); Papineau & Spurrett (1999)).

[8]Physical philosopher Brian Pitts (Pitts, 2019) offers an overview of criticisms of the justification of causal closure by conservation laws and concludes that, in this context, energy conservation is "question-begging" and "has little to recommend it."

However, the physicalist stance in this context is a problematic issue. There are two main options involving two versions of the argument, one weak and, in a sense, trivial (Crane, 1991), the other strong and, in a sense, tautological. The weak version establishes a minimal physicalism, which holds that everything supervenes on the physical, so that the presumed causal closure would have no implication regarding the causal efficacy of the mental, qua mental. Conversely, the strong, standard version utilized in Kim's argument pits the "physical" against the "mental" in matters of causality (Kim, 1989b; Papineau & Spurrett, 1999), such that the closure of the non-mental tends to become tautological in that it:

1. Assumes the existence of a sufficient physical cause for any physical effect;
2. Excludes the mental from the physical causes by definition.[9]

However, adopting minimal physicalism is not sufficient to reject Kim's reductionist argument, since the ontological precedence of a physical world devoid of mental properties can justify the assumption that the mental is causally determined by the non-mental and can therefore be reduced by it in terms of causal functions. This has been supported by Oppenheim and Putnam:

"Let us, as is customary in science, assume causal determination as a guiding principle; i.e., let us assume that things that appear later in time can be accounted for in terms of things and processes at earlier times. Then, if we find that there was a time when a certain whole did not exist, and that things on a lower level came together to form that whole, it is very natural to suppose that the characteristics of the whole can be causally explained by reference to these earlier events and parts; and that the theory of these characteristics can be micro-reduced by a theory involving only characteristics of the parts" (Oppenheim & Putnam, 1958: p. 15).

In what follows, I argue that the reduction of entities and causal properties that have appeared over the course of evolution to preexisting entities and causal properties depends on the condition of causal sufficiency, a cornerstone of causal closure, and that this condition is not satisfied in the case of a mutational event (or a sequence of mutational events) that underlies the appearance of new functional properties. Consequently, the appearance of a mental property over the course of evolution constitutes a case of causal opening of the physical. Causality, according to the argument developed here, lies at the core of this conundrum. Although the debate about mental causation does not depend on any particular theory of causation (Crane & Brewer, 1995: p. 225), it is by taking a closer look at the scientific concept of causality that the flaws of mainstream physicalism will be highlighted.

3. The Issue of Causality

3.1. Causality and Consistency of Nature

In discussing the notion of cause, I will first refer to the insights of Henry Margenau, which particularly shed light on the question of sufficient cause (Margenau, 1950: Ch. 19). Margenau notes that even in science, causality takes on multiple mean-

[9]Bishop (2006) emphasizes this point.

ings, and that when scientists refer to it, it is not in the same univocal way as that of force, energy, or mutations. In essence, this concept reflects our expectation of consistency in nature. This is encapsulated in the causal relationship "same cause, same effect" that manifests in the various approaches to causality. In Humean phenomenalism, causality is expressed as the habitual perception of a regular sequence of events. Causality also reflects our expectation of consistency in given circumstances ("ceteris paribus") through the regularities or invariance upheld by counterfactuals or partial causes (Woodward, 2000; Kim, 2010). However, the counterfactual inference—"if no cause A, then no effect B"; for instance, "if the patient had not contracted pneumonia, he would not have died"—does not establish a necessary relationship between A and B, such that if A occurs, then B occurs (A => B). Not all patients with pneumonia die from it. The notion of a sufficient cause, on the other hand, requires the establishment of a necessary relation (though it does not preclude the occurrence of the effect in its absence). However, just as with the uniqueness of the causal relation, its necessity is never guaranteed when the cause is an object (or a class of objects) or an event. For instance, in the case of a broken glass, why attribute the cause to the impact of a balloon rather than to the inherent fragility of the glass? This is because alternative objects or events could equally be invoked to explain the effect in question. But referring to the state of the entire universe would render the notion of cause trivial. A cause becomes necessary only when we can isolate within the universe a limited, well-defined system whose sequential states account for the causal connection, that is, when it refers to a stage in a process involving the whole system under consideration. It should be noted that this does not preclude the consideration of a partial or counterfactual cause which, under 'ceteris paribus' conditions, may be considered a sufficient cause for a particular effect. However, in such cases, the lack of specificity with respect to other factors or partial causes, that may collectively constitute a sufficient cause for an effect, not only introduces imprecision but also cannot support the principle of causal closure, since the latter requires all contributing factors and partial causes to be identified as being of a physical nature.

Therefore, only the speculative isolation of a causal system within the universe, defined by theoretical constructs and laws, underpins a deterministic sequence from one state, A, to another, B (involving a specific effect, B*), thus supporting the notion of a sufficient physical cause. However, such isolated theoretical systems—shielded from any external disruptive forces and any loss or gain of energy—only approximate and idealize certain targeted natural systems, given that these are never completely isolated in nature. We will also see below that the states of a causal system can be defined probabilistically. In brief, the concept of a sufficient cause, as implicated in the principle of causal closure, refers to a physical system wherein the causal relationship reflects the necessary link between its successive states.

On these bases, it should be noted that the causal relationship, that is, the dependency relationship between one entity, situation, or state A and another B, always transcends experience. This is implied by the Humean insight that causality is not a necessary truth derived from empirical experience. What makes the causal relationship more fundamental is, as Born (1948: pp. 6-9) explains, not the simple connection between two successive events (as in the sequence of day and night), but a general relationship that this connection illustrates. This has been widely acknowledged by post-positivist epistemology, which conceives that in any field of science or common-sense knowledge, a causal narrative must be constructed through speculative means: A theory formulated deductively is tested indirectly via its empirical outcomes. In this very framework, the causal relationship does not merely involve the empirical and the theoretical; it also tends to assume an ontological realm that guides the development of science. A view widely shared in the philosophy of science is that the inherent order in nature, which fuels our expectation of consistency, is based on an objective relational order among the things we experience phenomenally. In this regard, Planck (1933: p. 99) observes that the endeavor of theoretical science cannot be conceived without reference to an ontological reality which, although it is not directly attainable, guides the progress of our understanding. This explains why the current philosophy of science seeks to elucidate observable regularities by invoking entities and properties that suggest an ontological reality, which is the target of the theoretical realm. Examples include Machamer, Darden, and Craver's (2000) activities approach; Cartwright's (1989) capacities approach; and numerous approaches in terms of causal powers (see especially Chakravartty, 2008; Ellis, 2002). Scientific causality operationalizes these causal powers through theoretical systems because, from an ontological standpoint, we have no means of comprehending how things ultimately interact with one another. In line with contemporary philosophy of science's active epistemologies, Kim believes that causal relationships must be analyzed in terms of more fundamental dependencies relationships, and makes extensive use of the notion of causal power, knowing, however, that the "nomological/causal relationships" among events, states or processes, are the objective correlates of explanatory relations, and assure "causal realism" (Kim, 1981).

In summary, based on the foregoing, it can be inferred that in science, a sufficient cause is understood as the necessary connection between the states of a theoretical system at different points in time, where the inputs and outputs correspond to empirical regularities. The causal explanation unfolds by drawing closer to a postulated ontological reality, in which, for example, the entities and properties within the system are thought to possess trans-situational causal powers or capacities. These relationships between the phenomenal, the theoretical, and the ontological, anchored in the issue of causality, are assumed in the subsequent discussion. However, it is recognized that the ontological serves only as an asymptotic goal of scientific explanation; thus, the argument developed in the following sections does not require a specific hypothesis about it.

3.2. Causal Relationships

Different types of causal systems can be distinguished based on the definition of their states, which specify the entities, properties, and conditions at a given time that determine the system's behavior. In particular, the concept of a deterministic mechanism has been challenged by quantum mechanics, leading to a reevaluation of causality on more abstract grounds. The classical notion of cause, implying a necessary connection between the states of a physical system at different moments in time, has been retained in quantum mechanics, with the understanding that these states are defined in terms of probability distributions (see, on this subject, Northrop, 1958).

The idea that the states of a causal system can be defined probabilistically is captured by the Popperian notion of propensity, which extends the notion of cause to situations involving random or indeterministic phenomena. In this framework, deterministic causality is considered a limit case where the probabilities of the effects equal 1. The concept of propensity invites us to move from an observational plane, potentially involving observable frequencies (for example, the frequency of occurrence of a certain result in a game of dice over time), to a theoretical plane, and at the same time underpins the reference to an unobservable primary reality. Propensity is a tendency that a physical system has to produce a certain result, given the contextual conditions of the system. Comparable to the resulting forces in a physical system that are a property of the whole system, propensity is a relational concept, according to which: "every experimental arrangement (and therefore every state of a system) generates physical propensities which can be tested by frequencies […] both ideas [force and propensity] draw attention to unobservable dispositional properties of the physical world" (Popper, 1959: p. 38, see also Popper, 1990). The Popperian notion of propensity thus helps to extend the study of causal systems to situations where the concept of probability is needed to describe their states, that is, assuming their persistence over time.

3.3. Back to the Causal Closure Condition

In the preceding discussion, the exclusion of approaches that do not support causal closure—namely, partial or counterfactual causes—has fostered a conception of causation as involving a complete causal system, theoretically conceived. It has been argued that the condition of closure is precisely satisfied in relation to the states of such a system, since each given state determines its subsequent states, whether these are defined deterministically or probabilistically.

On this basis, it can be noted that if causality were to be considered solely as a metaphysical principle—essential for guiding scientific thought yet entirely a priori—then causal closure would also be considered a metaphysical principle, thereby resolving the debate. Acknowledging a primary reality that genuinely guides scientific progress is a fundamental assumption that lends meaning to it.

Using the Popperian notion of propensity, it can be posited that the physical domain is causally closed if, for any physical effect, there exists in principle (even if not always identifiable) a physical causal system which, given the initial conditions, has a certain propensity to produce that effect as part of one of its subsequent states. The physical effect and its sufficient cause, referring to successive states of the same causal system, are thus explained by the same entities and properties. Consequently, if the effect is functional, it can be functionally reduced to these entities and properties, ensuring that there is no departure from the preexisting physical domain. Otherwise, there is nothing to support the idea that the physical effect can be functionally reduced to preexisting entities and properties, except for a metaphysical hypothesis that forbids any functional creation. The notion of sufficient cause is the cornerstone of causal closure.

From this point forward, our interest will lie in the possibility of falsifying the principle of causal closure by demonstrating the absence of a sufficient cause for certain effects originating in the physical domain—namely, the functional effects of mutations and, especially, the evolutionary appearance of the mental and its physical supervenience basis.

4. Causality, Mental Causation, and Emergentist Assumptions

4.1. Logical Issues of Emergence and Downward Causation in Physicalism

As seen above, if a physical causal system, given initial conditions, has a certain propensity to produce a given effect as part of one of its subsequent states—for example, a functional property—then this functional property should be fully explainable by the entities and causal properties of the physical system. This situation leads to the impasse of emergence and downward causation within the physicalist framework.

Although various notions of emergence have been developed in the literature, a strong (non-epistemic) conception pervades the emergentist tradition.[10] The latter began in the mid-nineteenth century with John Stuart Mill's *System of Logic*, and was developed in particular by British emergentists in the early twentieth century. Emergentists typically assume that the specific connections between the components and properties Xs [or Xs'], of physical systems (Xs) [or (Xs')], underlie their new causal properties in the emergent wholes Ys, from a sufficient level of complexity of structural arrangements. If we support physicalism, and therefore the existence in principle of a sufficient cause at t1 for any physical effect at t2, we have $(Xs)t_1 \Rightarrow Ys = (Xs)t_2$. However, the relation of (strong) emergence implies the appearance of irreducible new causal properties. This can be translated into $(Xs)t_1 \xrightarrow{emergence} Ys = (Xs')t_2$ and $(Xs')t_2 \neq (Xs)t_2$, which is in contradiction with the previous equation. As Kim (1992b: p. 123) observes on this subject, "it is crucial to see that", in classical conceptions of emergence, "the conditions at the underlying, 'basal' level are by themselves sufficient for the appearance of the higher-level properties, there is no need to add anything from anywhere else", so that (strong) emergence involves downward causation. The reason is that complexity or organization alone is not sufficient to exclude reducibility in principle,

[10]See Mclaughlin (1992); see also especially Russell, Morris, & Mackenzie (1926) and, on the notion of emergence, especially Van Gulick (2001), 16ff.

so that true irreducibility presupposes a form of action of the new causal powers on their physical basis, and thus downward causation (Kim, 1999: p. 21). This is why Kim argues that we must either accept that emergent properties have no causal powers of their own or abandon physicalism. The logical problem involved underpins the idea that emergence simply reflects our inability to offer a causal explanation of the phenomenon and, ultimately, exposes us to the suspicion that it is merely epistemic.

These weaknesses lend support to the confidence that reductionism has not been affected by emergentism. At best, the forms of downward causation in which higher-level entities act as constraining conditions for the emergent activity of lower levels are reminiscent of Aristotle's formal cause, but cannot account for efficient causation (for a discussion, see Emmeche, Koppe, & Stjernfelt, 2000; Tabaczek, 2013). The problem with emergentist conceptions is that they place all the weight of creation on the organization and relations of the components of the preexisting physical systems,[11] so that the new causal properties appear without any explanation other than the descriptive principle of emergence. Non-reductive physicalism, for its part, insofar as it endorses the causal closure of the physical, entails the same limitations: In its standard version, it opposes reduction only at the epistemic level.

4.2. New Avenues for the Emergence of Causal Powers and Departure from Physicalism

Given these issues, the idea of emergence is undergoing a renewal in a non-physicalist framework, based on the notion of "contextual emergence" (for a recent advocacy, see Bishop, Silberstein, & Pexton, 2022 and for its specific application to philosophy of mind, see Filozoficzne, 2018). To explain that the characteristics of the parts of a whole from a lower organizational level or from another domain provide necessary but not sufficient conditions for explaining their causal properties in the whole, contextual emergentists reject the principle of closure of the physical. They argue that it is merely a physicalist axiom, not necessitated by physical knowledge and conflicting with human experience. The consequence is the departure from physicalism, but not from monism. The emergence of new, irreducible causal properties is justified by the idea that relations are constitutive of new entity properties. These relations suggest that the properties of entities acting in the world are fundamentally relational, intertwined, and interwoven across multiple scales, awaiting the appropriate "stabilizing" conditions to manifest. Such powers emerge in specific ways, depending on the stability conditions set by the exogenous context. However, even when moving beyond physicalism, it remains hypothetical to claim that the causal properties of a given system (Xs') in nature are emergent in the strong sense rather than merely epistemic, since such claims

[11]"British Emergentism maintains that some special science kinds from each special science can be wholly composed of types of structures of material particles that endow the kinds in question with fundamental causal powers. Subtleties aside, the powers in question 'emerge' from the types of structures in question" (Mclaughlin, 1992: p. 50).

could only reflect the limits of our knowledge.

In the following discussion, in line with emergentism, I defend the claim that suitably novel organizations of physical entities and properties can yield genuinely new, irreducible entities and causal powers. This view rejects strong causal closure as a substantive metaphysical thesis, treating closure instead as a methodological idealization in physics. Moreover, it complements contextual-emergentist accounts by grounding intrinsic creations, thereby avoiding the requirement of ontological parsimony typically built into emergentist views. If it can be demonstrated that, given a certain mental property that appeared over the course of evolution, no preexisting physical causal system has the propensity to produce it and, consequently, its physical supervenience base, this would not only invalidate the causal sufficiency condition of the causal closure principle but could also suggest that the entities and potential functional properties in question are intrinsically new. Thus, the concept of essential chance to be discussed can maintain only a metaphorical relationship with the notion of emergence.

5. Biological Evolution as the Causal Opening of Physical Systems

5.1. The Probabilistic Nature of Mutation Phenomena

The process of transcribing the genetic code, essential to the molecular conservation of living organisms, is subject to rare but unavoidable imperfections. These imperfections lead to mutations, which randomly alter the genetic information stored in DNA molecules and can have functional effects at the macroscopic level of the organism. The occurrence of these mutations leads us to understand the states of the microphysical systems responsible for replication mechanisms in probabilistic terms. The fundamentally random nature of the phenomenon of alteration of genetic information conveyed in DNA molecules is discussed on various grounds, either in terms of internal processes at the microphysical scale or in terms of its relation to the macrophysical scale. For example, the existence of macrolevel factors that impact the mutation rate, such as environmental pressures, is assumed. However, as Stamos (2001: p. 180) states, this question does not allow us to "jump to determinism." In other words, advances in molecular genetics do not lead us to question the basic premise of the modern synthesis, namely that all genetic mutations occur by chance in relation to adaptation (Merlin, 2010). But the openness of the microphysical systems that underlies the random alteration of the DNA sequence of an organism does not tell the whole story of this chance. Due to the symbolic nature of the genetic code, the potentially functional effects resulting from an alteration in an organism's DNA sequence are entirely independent of the cause of that alteration. This converts the probabilistic chance underpinning the DNA sequence alteration into the essential chance of its functional consequences. This point is developed below.

5.2. The Creativity of Mutational Events

As Monod (1970: Ch. 6) explains, the meaning of the genetic code, which is universal in the biosphere (and therefore fixed), is chemically largely arbitrary (i.e., conventional). Therein lies a major point raised by the biologist: The genetic code is the logical equivalent of an alphabet in which the structure and thus the specific associative functions of proteins are written. It represents the rule that associates the sequences of nucleotides in a segment of DNA with the sequences of amino acids used for protein synthesis. In fact, translation from DNA to protein does not occur directly. Instead, one of the DNA strands is transcribed into "messenger ribonucleic acid" (messenger RNA), which serves as a copy of the gene and acts as a template for protein synthesis. The nucleotide sequences (containing genetic information) in RNA do not directly correspond to those of the amino acids used by proteins because they are not the same types of molecules. Consequently, the translation of RNA nucleotide sequences into amino acids relies on a translation code, which is a rule of an arbitrary nature. Like the alphabetic signs of human languages, the conventional nature of the genetic code explains its creative power by the richness of the combinations it allows. This power is well illustrated in the diversity of entities and properties contained in the biosphere, knowing that the universality of the genetic code suggests their common origin. In the evolutionary process, the conventional nature of the genetic code entails a specific form of chance resulting from the total independence between the processes responsible for the replication error of the genetic message and its potentially functional meaning. The radical nature of this independence suggests to Monod the idea of "essential" chance, which he characterizes by the meeting of two totally independent causal chains:

"There is also complete independence between the events that can cause or allow an error in the replication of the genetic message and its functional consequences. The functional effect depends on the structure, the current role of the modified protein, the interactions it ensures, and the reactions it catalyzes. These are all things that have nothing to do with the mutation event itself, nor with its immediate or remote causes." (Monod, 1970: pp. 149-150)

This particular concept of essential chance was introduced by the mathematician Cournot (1843), who, among other examples, proposed that of a man who could not read and who randomly selected printed characters from a pile. Cournot explains that if the man in question managed to form a meaningful word, such as the first name Alexander, it would be a totally fortuitous result, because there would be absolutely no connection between the causes directing his hand and the meaningful result obtained. More precisely, the random selection of the printed characters at play responds to a probabilistic problem, but the specific meaning that results, if any, involves a chance of another nature, and can be compared to the meeting of two entirely independent causal chains (or, we may say, two entirely independent causal systems). The concept of essential chance, illustrated by the encounter of two entirely independent causal chains, implies the absence, even in principle, of an integrative causal system capable of linking the two causal chains and thus accounting for their meeting point. This is not merely a matter of epistemic unpredictability, but of incommensurability. This illustrates a case of non-transitivity in the causal relationship, to which we will return.

The distinction between the simple probabilistic chance involved in the random selection of elements of a symbolic code and the essential chance of its possible meaning is evocatively illustrated in Kurd Lasswitz's short story, *The Universal Library*, which inspired another famous short story by the writer Jorge Luis Borges, *The Library of Babel*. In essence, *The Universal Library* contrasts the nearly infinite creative potential of the human mind, linked to its ability to manipulate language symbols, with that of random mechanisms, which can combine the same symbols but lack intentionality. Specifically, the finite nature of the number of printed characters necessary to create a text, or to craft any synthesis that could be transmitted to humanity, whether in the form of historical events, scientific knowledge, literary or philosophical creations, etc., is opposed to the number of volumes resulting from blind printing needed to write the same meaningful texts, a number that is also finite but would require a library large enough to occupy numerous universes.

The great inefficiency of the mechanistic processes that create novelty by blindly altering the genetic message carried by the DNA molecule is countered by the processes of natural selection, which can be likened to a scrutiny of its meaning, so that only meaningful results remain, namely, organisms that can reproduce. As Jacob (1970: p. 287) explains, what is recorded in the genetic program is the result of all past reproductions, that is, the accumulation of successes, since any trace of failure has vanished. The genetic message presents itself as a text without an author, which a corrector would have revised during "more than a billion years, continually improving, refining, and completing it, gradually eliminating all imperfections. What is recopied and transmitted today to ensure the stability of species is this text, ceaselessly modified by time."

Criticisms targeting Monod's emphasis on the role of chance tend to diminish the dichotomy between chance and necessity. They point to the long-term processes of natural selection, which gradually imbue direction and meaning through adaptively coherent patterns into the randomness of mutations, which may initially lack functional consequences (Jacob, 1977; Mayr, 1981; de Duve, 2007).[12] However, these criticisms do not challenge the fundamental thesis regarding the essential chance of mutations, as implied by the symbolic nature of the genetic code (Merlin, 2015). It is this essential chance that is of interest to us here, insofar as it has permitted the appearance of intrinsic novelties, such as the various phenomena of life, the initial forms of consciousness, and their evolution across the different species. The essential nature of the chance involved is the touchstone of a fundamental challenge to the causal closure of the physical. This is the point to be established.

[12]For recent discussions on this subject see, for instance, Stoltzfus (2021) and references therein.

5.3. The Mutation Phenomena and the Causal Opening of the Physical

In the ensuing discussion, it is assumed that the randomness of mutation events reflects the inherent openness of the genetic subsystem involved in DNA replication. It is then argued that, due to the essential chance of any functional effect arising from a mutation, such an effect lacks a sufficient cause within the preexisting physical domain. While a sufficient cause would support functional reducibility, its absence opens the possibility of irreducibility, given the assumption that new arrangements of physical entities and properties could give rise to novel, irreducible entities and causal powers.

The process involved in a genetic mutation is well known. It can be succinctly described as follows. Under certain conditions, the S1 state of a biological system with one genetic subsystem can evolve into a new S2 state of this biological system, now with a randomly altered genetic subsystem. This could lead to the S3 state of a new biological system, which exhibits a new functional property and contains the modified genetic subsystem from the previous state. The critical point is the non-transitivity[13] of the causal relationship resulting from the absence of a unique causal system that would underpin the transition from state S1 before the mutation to state S3 after the mutation (**Figure 1**). In this scenario, the symbolic nature of the genetic code introduces a discontinuity in the causal relationship between the biological system before and after a mutation. This causal discontinuity can be metaphorically represented as the meeting of two completely independent causal systems: the natural system prior to the mutation and the system that underpins the functional effects of the mutation.

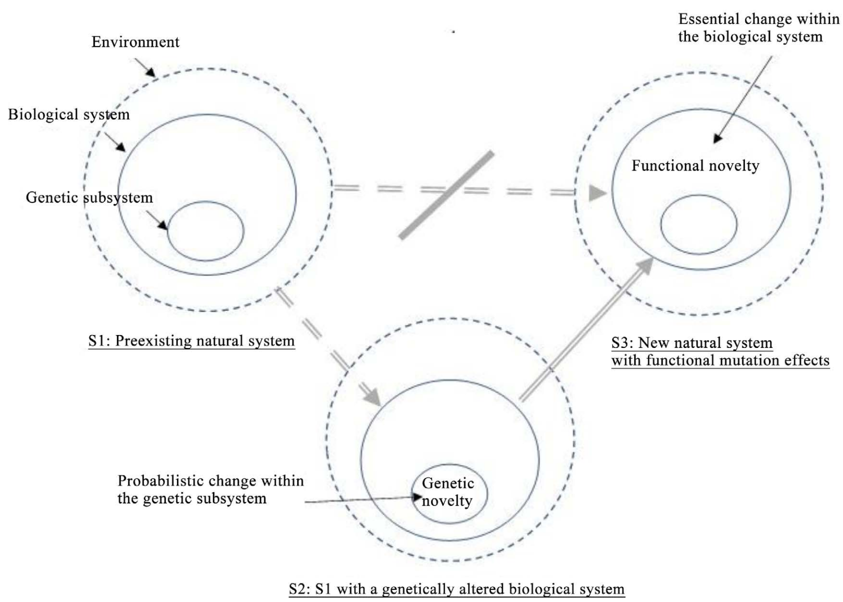

Figure 1. Causal chain in case of mutation with a functional effect.

[13]Cases of non-transitivity of the causal relationship have been emphasized based on various approaches to causality. See for example Eells & Sober (1983), Hitchcock (2001), McDermott (1995), Owens (1989).

In other words, a natural system (consisting of a biological system and its environment), as probabilistically defined before a mutation event, does not necessitate the functional effect of a given mutation; it has no inherent propensity to cause it. It would be a misuse of language to speak of "propensity" in this context if referring only to the purely statistical meaning of the term. A causal relationship may probabilistically link the state of the biological system before the random mutation to the set of possible alterations in the genetic message. But the state of the natural system before the mutation is not a sufficient cause of a given functional consequence, if any. The fact that functional creations generally require multiple mutations, and that the paths of selection themselves depend on the biological systems involved and their environment, does not change the theoretical case at hand. The latter can be simplified by assuming that each functional creation is associated with a single mutation event. Furthermore, the problem is not that the indeterminate or probabilistic situation is followed by a singular process. If the probabilistically defined initial state of the natural system was a sufficient cause of the functional effect of the mutational event, it would necessitate this effect at least in a tendential way. As we have seen, the causal link requires a raison d'être that justifies the idea of propensity other than as a simple frequency observation. For example, the chance of a throw of the dice, possibly biased, to which Popper (1959) refers to illustrate the notion of propensity, brings into play a very large number of small causes that are composed and whose propensity to produce a given result is explicable by the states of a physical system, so that in principle, by getting sufficiently close to a defined initial state, we could hope to increase the probability of obtaining a given result. In the quantum realm, causality is preserved despite the probabilistic nature of quantum states, since their evolution is governed by Schrödinger's equation. However, here, there is no inherent directionality or tendency in the initial system toward the singular event of the functional outcome. Despite all the factors that potentially favor a certain direction of functional evolution for a given biological system within a specific environment, the key point is that there remains an irreducible essential chance. This chance stems from the random modification of the purely conventional genetic code underlying this evolution. Consequently, no sufficient cause necessarily links the state of the natural system prior to the mutations with the functional effects of those mutations.

The same reasoning can be repeated as many times as mutational processes occur and are inherited to explain the functional effects resulting from multiple mutational events and selection processes in various environmental conditions. The conjunction of two processes whose meeting point is totally fortuitous, that relating to the random alteration of the genetic information conveyed in the DNA sequence of an organism, and that relating to the potentially functional creation caused by this alteration, can produce an effect comparable to the activity of a genius who conceives new causal powers for living beings, based on new arrangements of physical entities and properties, and implements them genetically. While the intentional reorganization of entities and properties could account for the new causal powers involved, there would be no causal system that includes the genius, which could play the role of a sufficient cause to account for them.

This holds true unless, contrary to the conditions above, the previous state of the natural system is a sufficient cause for the physical outcome of a mutation event, assuming that this natural system conforms to the deterministic model of a Laplacean system (for instance, at a sub-quantum level). Such a hypothesis, however, would conflict with widely accepted principles of contemporary physics. In such a scenario, nature's creativity would then be merely an epiphenomenon of the relentless determinism that would otherwise govern it. Such determinism would preclude any questioning of the causal closure of the physical domain. This is because, even if the functional meaning of the mutation event remained entirely independent of the cause of the event itself, it would still be logically implied by the state of the natural system underpinning the mutation event. Consequently, this state would be identified as the sufficient cause of any functional effect. This account, which assumes an underlying Laplacean deterministic framework that Kim did not support, may pose the ultimate challenge to the perspective adopted here. Consequently, the argument of this article is predicated on its rejection.

A physicalist might ultimately object that the "symbolic" character of the genetic code is itself a highly complex physical property, and that its outcomes—although stochastic—remain fully within the physical domain. Against this line of microreductive reasoning, Simmel (1977: p. 114) offers an illuminating reply: the drive toward analysis "all the way down" to an "absolute atom"—supposed to represent what is most fundamentally real—rests on a category mistake, since that atom is itself a scientific construct. Unity and compositeness are relative, epistemic categories variably ascribed to phenomena; it is therefore fallacious to oppose allegedly real elements to derivative composites. Moreover, if causal power grounds ontological status, nothing prevents composites from possessing it. On this view, the reductionist reading mislocates the explanandum: it conflates the causal determinants of a mutational event with its functional significance at the organismic level. This aligns with Hitchcock's (2012) criticism of explanations that fixate on a purely microphysical notion of causal sufficiency—such accounts cannot, on their own, capture higher-level meanings.

In summary, on the assumption of the widely accepted principles of contemporary physics, the state of the system prior to a mutational event is not a sufficient cause of any specific functional outcome. This potentially allows the functional effects of these mutations to transcend the physical domain, thus making them functionally irreducible to it. Such a case challenges the principle of the causal closure of the physical.

6. Conclusion: Mind in a Creative World

The above simply derives the consequences for physicalism from one of the main sources of nature's creativity. Entities and properties that preexist certain evolutionary creations cannot give a causal account, in the sense of causal sufficiency, for given new entities and properties in nature, that is, via a single causal system that would support the causal inheritance of the entities and properties it generates. The effects of mutation events are comparable to the result of the action of factors irremediably exogenous to any encompassing causal system involved. Just as a random selection of printed characters is not a sufficient cause for the meaning of any word they may form, the entities and functional properties that appear during evolution are not "caused"—in the sense of causal sufficiency—by the physical systems that preexist the mutational events they represent. The consequence is that there is no guarantee that they inherit only the entities and functional properties that make them up. When these properties are mental, they can involve the crossing of the boundary from the physical (broadly defined, but excluding the mental) to the mental.

Therefore, merely arguing that the non-mental was sufficient to produce the mental during evolution would not adequately support the principled reducibility of the mental to prior physical entities and their properties, as suggested in the argument by Oppenheim and Putnam cited above. The difficulty in understanding how nature can generate sui generis causal powers seems to stem from shifts in the notion of causality, in this case, the confusion between the idea of production or explanation and that of sufficient cause, a confusion that feeds the idea that production authorizes reduction, however we conceive it, or runs up against the problem of downward causation. The secret of nature's creativity lies precisely in its ability to produce in a non-causally sufficient manner, thanks to this "conservatory of chance", as Monod calls DNA. DNA orchestrates a reorganization of entities and properties that can potentially create new functional, irreducible properties for organisms.

The conundrum posed by the mind-body problem—how the mind can be produced by, and at the same time affect, physical processes—arises from the implicit physicalist premise that the mental and the physical must be causally separate. However, as we have seen, no causal system within the physical domain represents a sufficient cause for the transition from a pre-mental to a mental state (involving its supervenience basis), and thus ensures the functional reducibility of the mental to the physical. The consequence is that the mental properties of the body, qua mental, may represent intrinsic causal powers. Such causal powers can be exercised by brain processes that, for the most part, have no mental counterpart. The point here is that while mental properties and brain processes are components of the same natural experience, neural activity may be driven by conscious mental states (Bulle, 2021; Bulle, 2022). On this basis, the brain causally explains the mind's functioning through neural organizations that are constitutive of mentality; it is via these organizations that mental states and changes are explained. The new causal systems to be considered in the case of human consciousness do not distinguish between mental and physical causes per se. Mentality appears in them as a constitutive factor of the functioning of the brain. Thus, we can assume that the activity of the mind and the activity of the brain are not parallel, identical, interacting, or merely covariant, but codependent.

The overdetermination relation [M (mental cause)] or [P (physical cause)] => P* (physical effect) is misleading, since there is no distinction between mental and physical causal powers that would justify the claim that P is the true cause of P*. In fact, the (nomological) relation of supervenience is not guaranteed by an independent causal power. P and M are not different representations of properties of the same objects, as Kim argued, but representations of one and the same cause P_M, which is the physical cause under mental condition. No physical cause understood as non-mental can simply preempt the genuine mental role in the name of the causal closure of the physical domain.[14]

The aim of the present analysis was to counter Kim's physicalist argument advocating the causal inefficiency of the mental, qua mental, and it appears to have achieved its objective. In addition to all the arguments already developed against the causal closure of the physical, whatever its meaning, but excluding the mental, it has been demonstrated that this principle is challenged by evolutionary processes. This applies to all creations of life based on the genetic information encoded in the DNA of an organism, and thus extends to all living beings, with the understanding that the crossing of the causal boundary of the physical domain by potential functional effects of mutational processes refers to the appearance of the mental. Consequently, the physical domain is open to all new causal powers developed over the course of evolution, with non-mental causal powers having no preemptive priority over mental causal powers.

The appearance of radically new entities and properties finds its most extreme and perplexing expression in the mind. Natural selection for functionally efficacious traits does not exclude either that consciousness is an epiphenomenon or a mind–brain identity view. However, the hypothesis that mental properties acquired irreducible causal powers over the course of evolution remains, following Lindahl (1997), more plausible and more fruitful for explaining the maintenance and further evolution of consciousness. Moreover, the development of the mind's irreducible causal powers can be seen as a higher-order continuation of the logic that Schrödinger (1944) describes: living systems, as open systems, maintain local order by exporting entropy ("feeding on negative entropy") and succeed against disorder and death by exercising functional control over their own physical processes. In contrast to the action of non-mental causal powers, the causal power of the mind is likely to involve a pure power of action with no biological equivalent. The problem of self-determination is beyond the scope of this analysis, but accepting the causal codependence of the mental and the non-mental allows the functional role of the mind to be considered on new grounds.

[14]The co-implication of the brain and consciousness in understanding their relationship in human action and thought has been proposed from various epistemological and ontological perspectives. These proposals will be discussed in a forthcoming article.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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