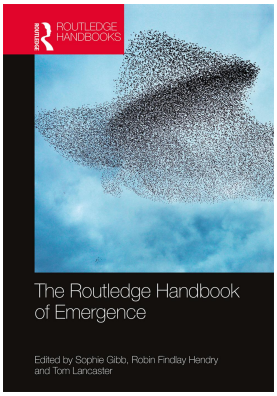


# The Routledge Handbook of Emergence

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## The Causal Closure Principle

Publication details
https://www.routledgehandbooks.com/doi/10.4324/9781315675213-9
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**Published online on: 22 Mar 2019**

# 8
# THE CAUSAL CLOSURE PRINCIPLE

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## The causal closure argument and emergentism

According to 'strong emergence' – which is the type of emergentism that I shall be concerned with throughout this chapter – certain properties emerge from, they arise out of, more fundamental physical properties, and yet emergent properties are not merely distinct from physical properties, but are novel, 'something over and above' the properties from which they arise. Hence, for example, those who are committed to the existence of emergent *mental* properties hold that mental properties emerge from more fundamental physical properties and yet are something over and above them. How *exactly* to understand 'strong emergence', beyond its negative characteristic of being incompatible with the physicalist claim that all non-physical properties are 'nothing over and above' physical properties is a much-disputed issue, which I do not have the space to explore here. That said, to capture a 'strong emergence' worthy of the name, emergent properties must exist in as robust a sense as the physical properties from which they emerge. Moreover, emergent entities must have full-blooded, independent causal powers that exist over and above the causal powers of the physical entities from which they emerge and which can, given a commitment to downward causation, affect physical entities. In virtue of the combination of its commitment to the claims that emergent properties are distinct from physical properties and that emergent properties are causally relevant in the physical domain, the principle of the causal closure of the physical domain presents a problem for emergence. Indeed, the causal closure argument – one essential premise of which is the causal closure principle – is the central argument against emergence in contemporary discussions of the ontological status of emergent entities.

Taking the existence of emergent mental properties as our example, the causal closure argument can be formulated as follows:

i *Relevance:* Some mental events are causally relevant to physical effects.
ii *Closure*: All physical effects have sufficient physical causes.
iii *Exclusion*: There is no systematic causal overdetermination.

Therefore, mental events (that are causally relevant to physical effects) are identical with physical events.[1]

Although I have here framed the causal closure argument as one concerning the ontological status of mental entities, the argument could equally have been presented as one concerning the ontological status of chemical, biological or economic entities. If chemical (biological, economic, etc.) events are causally relevant to physical effects, then, given *Closure* and *Exclusion*, the causal closure argument's conclusion is that those chemical (biological, economic, etc.) events must be identical with physical events.

Why is the combination of *Relevance*, *Closure* and *Exclusion* considered to entail the identity of mental events with physical events? Well, in accordance with *Relevance*, say that *M* is a mental event and that it is a sufficient cause of physical event *E*. From *Closure* it follows that *E* must have a sufficient physical cause, call it '*P*'. As *Closure* is consistent with the possibility of physical effects having *both* sufficient physical causes *and* sufficient non-physical causes, the mere combination of *Closure* with *Relevance* does not entail that *M* must be identical with a physical event. It is only the combination of *Closure* with *Exclusion* that entails that the cause of any physical effect must be physical – that there can be no downward causation from *sui generis* mental entities to physical entities. To give a standard example of causal overdetermination, say that two guns are independently fired and the bullets from both guns reach the victim at the same time. If each bullet striking was, on its own, causally sufficient for the victim's death, the death was causally overdetermined by the strikings. *Exclusion* permits *isolated* cases of causal overdetermination but rejects causal overdetermination that is systematic. That is, given *Exclusion*, events cannot be overdetermined as a general rule. More precisely, given *Exclusion*, it cannot be the case that *whenever M* causes *E*, *P* also causes *E*, where it is such that if one of the two events *M* and *P* had not existed, the other would have sufficed, in the circumstances, to cause *E*. But the causal overdetermination that the combination of *Relevance* and *Closure* gives rise to *is* precisely of this systematic kind. Whenever *M* causes *E*, given *Closure*, there will be a physical event that is causally sufficient for *E*. Consequently, the combination of *Relevance*, *Closure* and *Exclusion* entail that *M* is identical with *P*. More generally, it entails that mental events are not causally relevant to physical effects, unless they themselves are physical.

The different positions that are held regarding the ontological status of emergent entities can, to a large extent, be distinguished by their response to the causal closure argument. Once again, focusing on the mental causation debate, first take the physicalist stance, which holds that all mental entities are, in some sense, physical. Its proponents can be divided into three main groups. Reductive physicalists identify mental properties with physical properties. Eliminativists reject the existence of mental properties. Non-reductive physicalists hold that mental properties are distinct from, although dependent on (and, hence, 'nothing over and above'), physical properties. Each of these versions of physicalism provides a different response to the causal closure argument. The reductive physicalist accepts its conclusion. According to it, mental properties are identical with physical properties and, hence, mental events are identical with physical events.[2] The eliminativist rejects *Relevance* – according to the eliminativist, there are no mental properties, and, hence, there are no mental causes. The non-reductive physicalist standardly attempts to reject or disambiguate *Exclusion*. Hence, one popular account of non-reductive physicalism argues that although psychophysical causation always involves two distinct, sufficient causes – a mental and a physical one – given non-reductive physicalism, this does not give rise to a worrying systematic causal overdetermination because of the dependence relationship that they posit between the mental and the physical cause.

The response to the causal closure argument that is not available to any physicalist – for this would be to abandon physicalism – is to reject *Closure*. And it is precisely this response that strong emergentism – along with all other forms of dualism that are committed to *Relevance* (that is, all forms of *interactive* dualism) – typically offers to the causal closure argument. In this chapter, I shall consider why this response to the causal closure argument is arguably a plausible one.

## Formulating the causal closure principle

In the earlier outline of the causal closure argument, I have formulated the causal closure principle as the principle that 'All physical effects have sufficient physical causes'. This is but one of the many different formulations of the principle presented in the literature on the causal closure argument. Here, I provide examples of some of the different ways in which the principle has been formulated:

1 All physical effects have sufficient physical causes.

*(Papineau 1998, p. 375)*

2 Every physical event has a physical cause which is enough to bring it about, given the laws of physics.

*(Crane 2001, p. 45)*

3 All physical effects have complete physical causes ('complete' in the sense that those causes on their own suffice by physical law to fix the chances of those effects).

*(Papineau 1993, p. 22)*

4 All physical effects are fully determined by law by prior physical events.

*(Papineau 2000)*

5 If a physical event has a cause at *t*, then it has a physical cause at *t*.

*(Kim 2005, p. 15)*

6 No physical effect has a non-physical cause.

*(Smith and Jones 1986, p. 66)*[3]

As I observe elsewhere, clearly these formulations are not all equivalent (Gibb 2015b). Some appeal to the notion of a 'sufficient cause', some appeal to the laws of physics, some are probabilistic in nature. Most importantly, not all of these formulations are of the same strength. Indeed, upon closer scrutiny, not all of these formulations are of the *required* strength. Some are too weak to do their job, whereas others are too strong.

Hence, take formulation (1), the formulation of the causal closure principle that I assumed when outlining the causal closure argument. It is too weak. That is, when (1) is combined with *Relevance* and *Exclusion* it does not entail that mental events (or any other types of emergent events) are identical with physical events. This objection to (1) rests upon the plausible assumption that causation is transitive. If causation is transitive, a physical event *would* have a sufficient physical cause if it had a sufficient mental cause which in turn had a sufficient physical cause. Hence, if physical event *P* caused mental event *M* which in turn caused physical event *E*, this would not be a violation of (1). Consequently, far from entailing that mental events are identical with physical events, given the transitivity of causation, the combination of (1) with *Relevance* and *Exclusion* is compatible with an emergent model of psychophysical causal relevance which holds that neural events cause bodily movement via mental causal intermediaries.

While, on the one hand, a causal closure principle must not be so weak that it renders the causal closure argument invalid, on the other hand, a causal closure principle must not be too strong. Causal closure principles that are so strong that they lack empirical support should clearly be rejected. Equally, causal closure principles that are so strong that they require one to make

physicalist assumptions in their defence, and, hence, beg the question against emergentism and other forms of interactive dualism should be rejected. With this in mind, consider formulation (6). Formulations of the causal closure principle such as (1), (2) and (3) rest upon the idea that non-physical causes are never *needed* to account for physical effects. That is, one can tell the complete causal story about any physical effect, purely in terms of physical events. This is not to suggest that non-physical causes could not have physical effects. Rather, the point is that the physical effect would also have a sufficient physical cause, and hence the non-physical cause would be redundant. Unlike these formulations of the causal closure principle, (6) rules out the very possibility of non-physical causes having physical effects. Because of this, given (6), *Exclusion* becomes redundant within the causal closure argument – the following two-premise argument is arguably all that is required to reject interactive dualism:

1 *Relevance:* Some mental events are causally relevant to physical effects.
2 *Closure*: No physical effect has a non-physical cause.

Therefore, mental events (that are causally relevant to physical effects) are identical with physical events.[4]

Lowe (2000, p. 572) argues that any causal closure principle that renders *Exclusion* redundant within the causal closure argument must be too strong. This is because a two-premise argument is being offered, which includes a premise that interactive dualism accepts (*Relevance)* but a conclusion that they reject. Consequently, one can plausibly infer that this formulation of *Closure* is merely an assertion of what the interactive dualist is denying and, hence, that any argument that is presented for *Closure* will inevitably beg the question against the interactive dualist's position.

Ultimately, the goal is to advance a formulation of the causal closure principle which is neither too weak nor too strong. That is, a causal closure principle that is not so weak that it renders the causal closure argument invalid, but not so strong that the causal closure principle is itself untenable. Consequently, when assessing arguments for the causal closure principle – which I will go on to do in the following section – three of the crucial questions to consider are:

1 What strength of causal closure principle does this argument entail?
2 Is this causal closure principle, in combination with *Relevance* and *Exclusion*, strong enough to rule out all plausible forms of interactive dualism, or does it instead render the causal closure argument invalid?
3 Does the argument for the causal closure principle smuggle in assumptions that certain forms of interactive dualism would deny?

In the next two sections I shall briefly consider the two most popular arguments for the causal closure principle and consider why, given certain accounts of emergentism, they fail.

## Arguments for the causal closure principle

Despite the central role that the causal closure principle plays in attacks on interactive dualism in contemporary philosophical debates, rigorous arguments for this principle are hard to find. This is presumably because it is assumed that the causal closure principle is an uncontroversial claim that is supported by, and finds its evidence from within, current science. Consequently, it is a principle that requires little further defence from those who make use of it to reject interactive dualism. But how, exactly, does current science provide support for the causal closure principle?

If the principle is a working hypothesis of current science, then as Papineau (a central proponent of the causal closure principle) observes, it is one that is left implicit within current science – it is not written down in any science textbook (Papineau 2000). An argument is therefore needed in defence of the claim that the causal closure principle actually can be inferred from facts of current science.

## *The no-gap-argument*

Within debates about interactive dualism in the philosophy of mind, those that do attempt to defend the causal closure principle most commonly appeal to the 'no-gap argument' to do so (Kim 2010, pp. 112–113; McLaughlin 1998, pp. 278–282; Melnyk 2003, pp. 288–290; Papineau 1993, pp. 31–32). Note, as the no-gap argument is usually specifically targeted against interactive dualist accounts of *psychophysical* causal relevance, in this section my discussion will focus on the mental causation debate and the question of the existence of emergent mental entities. Whether or not the no-gap argument is as persuasive if applied to the existence of other kinds of emergent entities (i.e. chemical, biological, economical, etc.) is a question for another paper.

The no-gap argument begins with the observation that physicists have been incredibly successful in identifying the complete and immediate causes of different kinds of physical events. (A 'complete cause' is the sum of all of the contributory – that is, partial – causes of an event in a particular instance of causation. One event is an 'immediate cause' of another event, if the former does not cause the latter by causing some further event.) To identify the cause of a physical event, physicists have never needed to appeal to *sui generis* mental causes. They have only needed to appeal to physical causes. There is no doubt that there are physical events that are yet to be discovered and, hence, which await a causal explanation. Equally, there are physical events that have been examined but are still to be causally explained. Hence, physics cannot claim to provide the complete and immediate cause of *every* physical event – the causal account that physics provides of physical events contains gaps. But the crucial point is that it is highly implausible that physics will ever need to appeal to *sui generis* mental causes to fill these gaps, or so proponents of the no-gap argument claim. Hence, for example, Kim argues that:

> If a physicist encounters a physical event for which there is no ready physical explanation, or physical cause, she would consider that as indicating a need for further research; perhaps there are as-yet undiscovered physical forces. At no point would she consider the possibility that some nonphysical force outside the space-time world was the cause of this unexplained physical occurrence.
>
> *(Kim 2010, p. 113)*

Furthermore, a more specific no-gap argument can be presented at the level of neurophysiology (Kim 2010, p. 113; McLaughlin 1998, p. 278; Melnyk 2003, p. 187). Interactive dualists in the mental causation debate hold that some bodily events have *sui generis* mental causes. But, the proponent of the no-gap argument reasons, this does not fit with the neurophysiological evidence. In their examination of the causal chains of neural events that bring about bodily movements, neurophysiologists have never needed to appeal to *sui generis* mental causes to provide the complete and immediate cause of any neural event within such a chain. This is not to suggest that for every neural event, current neurophysiology can provide a complete and immediate neural cause. Rather, as with the more general no-gap argument, the crucial point of the neurophysiological no-gap argument is that it is highly implausible that neurophysiology will ever need to

appeal to *sui generis* mental causes to fill gaps in the causal chains of neural events that give rise to bodily movement. Quoting from Kim again:

> If a brain scientist finds a neural event that is not explainable by currently known facts in neural science, what is the chance that she would say to herself, 'Maybe this is a case of a Cartesian immaterial mind interfering with neural processes, messing up my experiment. I should look into that possibility!' We can be sure that would never happen.
>
> *(Kim 2010, p. 113)*

I do not wish to assess whether the no-gap argument is plausible here. Instead, my aim is briefly to consider whether, insofar as it is plausible, it generates a successful causal closure argument against emergentism. Does the no-gap argument entail a causal closure principle that is strong enough, when combined with *Relevance* and *Exclusion*, to entail the rejection of emergentism? This question can be broken into two parts: 1) What is the strongest version of the causal closure principle that the no-gap argument entails? and 2) Is this causal closure principle strong enough to defeat emergentism?

What is the strongest version of the causal closure principle that the no-gap argument entails? In the previous section it was observed that if the causal closure principle is taken to be the principle that 'All physical effects have sufficient physical causes', then it is too weak. This principle in combination with *Relevance* and *Exclusion* is consistent with an emergent dualism according to which neural events cause bodily movement via mental causal intermediaries. The no-gap argument, if correct, appears to rule out the existence of such mental causal intermediaries. According to the no-gap argument the discoveries of science and, more specifically, neurophysiology suggest that with regard to any instance of bodily movement, if we trace the causal chain of events leading up to this bodily movement back, we will be faced with a gapless causal chain of purely physical events, with no mental causal intermediaries.

The no-gap argument seems to point to a causal closure principle that is far stronger – something like the following:

> *Closure**: Every physical event that has a cause has an immediate and complete wholly physical cause.

(As noted before, a 'complete cause' is the sum of all of the contributory causes of an event in a particular instance of causation. If each contributory cause of an event is physical, then that event has a complete, wholly physical cause.) *Closure** entails that there will be a seamless causal chain of purely physical events leading up to any bodily movement. And that there will be a seamless causal chain of purely physical events leading up to any bodily movement is precisely the conclusion of the no-gap argument.

Is this causal closure principle, when combined with *Relevance* and *Exclusion*, strong enough to rule out interactive dualism? My view is that it rules out some, but not all, dualist models of psychophysical causal relevance. I shall very briefly summarize the reason why here. (For a detailed defence of these claims, see Gibb 2015a.) The kinds of dualist models of psychophysical causal relevance that are ruled out by this version of the causal closure principle and, hence, which are threatened by the no-gap argument are what I refer to as 'standard' dualist models. According to these models of psychophysical causal relevance, the causal role of a mental event in the physical domain is to cause (either by itself or in conjunction with some other physical event) some neural event or set of neural events, thereby initiating a causal chain of physical events that results in some bodily movement. Descartes' model of psychophysical causal relevance provides an obvious example of a standard dualist model of psychophysical causal relevance. According to Descartes,

(simplifying his model greatly) mental events alter the direction of the motion of particles in the brain. These motions initiate a causal chain of physical events which result in bodily movement. This model of psychophysical causal relevance attempts to find a causal role for mental events in the physical domain by suggesting that there is a gap in the causal chain of neural events that result in intentional bodily movement – a gap which is filled by mental events. This claim is in direct opposition to the no-gap argument and *Closure**.

However, not all interactive dualist models of psychophysical causal relevance take the causal role of mental events in the physical domain to be that of causing some neural event which ultimately gives rise to some bodily movement – that is, to fill in gaps in causal chains of neural events. I here have in mind E. J. Lowe's emergent model of psychophysical causal relevance and also my own. (See, for example, Lowe 2000; Gibb 2013.) According to Lowe, the causal role of mental events in the physical domain is not to cause neural *events* but to cause neural *facts*. More specifically, according to Lowe, a mental event is causally responsible for the *fact* that a causal chain of neural events converges upon a particular bodily movement non-coincidentally. According to my own emergent model of psychophysical causal relevance, the causal role of mental events in the physical domain is not to cause neural events, but to *enable* neural events to cause bodily movements. I shall not explore these positions here, but shall simply note that both models depart from standard dualist models of psychophysical causal relevance by denying that the causal role of mental events in the physical domain is to cause some neural event or set of neural events which give rise to some bodily movement. Consequently, both accounts can accept *Closure**, for neither is committed to the claim that any physical event lacks an immediate, complete, wholly physical cause. And as these accounts are not relying on the assumption that there are any gaps in the causal chains of neural events that give rise to bodily movement, neither account would seem to be threatened by the no-gap argument. (For a detailed account of both of these models and why they are not threatened by the no-gap argument, see Gibb 2015a.)

In summary, insofar as the no-gap argument is plausible, it is only a threat to some emergent models of psychophysical causal relevance, not all.

## *An appeal to the conservation laws*

A further argument for the causal closure principle is one that appeals to the conservation laws. Like the no-gap argument, it is most commonly found in the mental causation debate.

According to Harbecke, the causal closure principle is a fact of contemporary physics, because the principle 'draws its main force' from the conservation laws, a cornerstone of contemporary physics (Harbecke 2008, p. 24). Similarly, in Papineau's 'The Rise of Physicalism', which provides one of the most thorough defences of the causal closure principle in the literature, Papineau explains that his original thought was that the principle 'follows from the fact that physics can be formulated in terms of conservation laws' (Papineau 2000, p. 185).

According to these laws:

> *Conservation*: Every physical system is conservative or is part of a larger system that is conservative (where a system is conservative if its total amount of energy and linear momentum can be redistributed, but not altered in amount, by changes that happen within it).[5]

Why is the causal closure principle thought to follow from *Conservation*? Well, as Papineau explains '(i)f the laws of mechanics tell us that important physical quantities are conserved regardless of what happens, then doesn't it follow that the later states of physical systems are always fully determined by their earlier physical states' (Papineau 2000, p. 185)? If, for example, *sui generis*

mental events did have neural effects, this would presumably alter the total amount of energy and/or momentum of the brain and, hence, violate the law of the conservation of energy and/or the law of the conservation of momentum.

As Papineau observes, there is an immediate problem with this claim, but it is one which he considers contemporary science to address. This argument for the causal closure principle is threatened if *sui generis* mental energy exists. If *sui generis* mental energy did exist, then provided that it operated conservatively, this would be entirely consistent with the conservation laws – the conservation laws do not regulate what kinds of energy exist, only demanding that all kinds of energy must operate conservatively. If there is *sui generis* mental energy, then the move from *Conservation* to the causal closure principle is brought into question. Indeed, the claim that *sui generis* mental energy does exist and that the occurrence of some physical effects requires the transfer of such energy is precisely the model of psychophysical causal relevance adopted by the interactive dualist, Hart (1988). In light of these considerations, one of Papineau's central concerns in 'The Rise of Physicalism' is to demonstrate that '*sui generis* mental or vital forces should be rejected and physics declared complete' (Papineau 2000, p. 196). Papineau considers that contemporary science gives us very good grounds to conclude that the existence of *sui generis* mental energy is highly improbable. The two arguments that Papineau provides for this conclusion – the 'Argument from Fundamental Forces' and the 'Argument from Physiology' – are not ones that we need to consider here. For the sake of argument, let us assume that Papineau is correct that there is no *sui generis* mental energy. Papineau considers that, from this, it follows that all physical effects are fully determined by law by prior physical events. Hence, we have the following argument for a causal closure principle:

1 Every physical system is conservative or is part of a larger system that is conservative (*Conservation*).
2 There is no non-physical energy (*Energy).*

Therefore:

All physical effects are fully determined by law by prior physical events (*Closure* **).

*Closure***, unlike *Closure**, is strong enough to rule out most dualist models of psychophysical causal relevance, including the non-standard dualist models of psychophysical causation that I referred to in the previous section. But does the combination of *Conservation* and *Energy* really entail *Closure*** or even *Closure**? My response is 'No'. Here, I only have the space to briefly indicate why. I consider that to move from the combination of *Conservation* and *Energy*, one must also (at the very least) accept two causal claims without which neither *Conservation* nor *Energy*, nor their combination, could be used to defend *Closure***. First, the causal claim that the redistribution of energy and momentum cannot be brought about without supplying energy or momentum. Second, the causal claim that the only way that something non-physical could contribute to determining an effect in a physical system is by i) affecting the amount of energy or momentum in it or ii) redistributing the energy or momentum in it. Moreover, these causal claims are *denied* by certain dualist models of psychophysical causal relevance. Hence, C. D. Broad's model of psychophysical causal relevance, according to which mental events prompt transfers of energy between physical events without themselves transferring energy, appears to hinge upon the denial of the first causal claim (Broad 1925, p. 109). And the two dualist models of psychophysical causal relevance that I referred to in the discussion of the no-gap argument – that of Lowe's and my own – both reject the second causal claim. (For a detailed discussion and defence of these points see Gibb 2010; Gibb 2015c.)

Hence, while the combination of *Conservation* and *Energy* allows one to rule out certain dualist models of psychophysical causal relevance, such as Hart's model which claims that psychophysical causation consists in the transfer of *sui generis* mental energy, it does not allow one to rule out *all* dualist models of psychophysical causal relevance. More generally, the combination of *Conservation* and *Energy* does not entail *Closure***. To move from *Conservation* and *Energy* to *Closure***, one must make a number of causal assumptions, and whether these causal assumptions are actually correct is the very issue for several dualist models of psychophysical causal relevance.

## Concluding remarks

I have suggested that two of the most popular arguments presented in the mental causation debate for the causal closure principle fail. Although they do threaten certain interactive dualist models of psychophysical causal relevance, they certainly do not threaten *all* interactive dualist models of psychophysical causal relevance. Consequently, if these are the best arguments for the causal closure principle, one can conclude that the causal closure argument does not provide a general argument against interactive dualism, or – more specifically – a general argument against emergentism.

And the problems with the causal closure principle do not end here. It has been argued that investigation into what current science itself has to say about the causal structure of the physical domain reveals that the causal closure principle is not a fact of current science – that, far from supporting the principle, current science actually calls it into question. Hence, Hendry (2006) argues that current *chemistry* challenges the causal closure principle. And it has been argued that current *physics* also challenges the principle. It is widely accepted by proponents of the causal closure principle that, given the indeterministic nature of quantum mechanics, causes cannot always be sufficient for their effects. Consequently, formulations of the causal closure principle such as the formulation that 'All physical effects have sufficient physical causes' should be abandoned on the basis of current physics. To attempt to avoid any conflict with quantum mechanics, probabilistic versions of the causal closure principle have been advanced. Formulation (3) of the causal closure principle – 'All physical effects have complete physical causes ('complete' in the sense that those causes on their own suffice by physical law to fix the chances of those effects)' – provides just one example of a probabilistic version of the principle. But the deeper problem that current physics raises for the causal closure principle is that quantum systems are arguably holistic, and the holistic nature of quantum systems appears to conflict with the causal closure principle. For discussions of this particular issue and also other defences of emergence in physics, see Barrett (2006), McGivern and Reuger (2010), Stapp (2005), and Teller (1986).

Consideration of how strong a causal closure principle must be for the causal closure argument to provide a general argument against emergentism and the fact that the arguments presented for the causal closure principle in contemporary philosophical debate fail to support a causal closure principle of this strength, coupled with the questionable status that the causal closure principle has in current science, point to the conclusion that if the causal closure argument is the best argument against emergentism, then emergentism is one of the serious contenders in the debate about the ontological status of certain higher-level entities.

## Notes

1 I am understanding causes and effects to be Kimean events. A Kimean event is the exemplification of a property by a substance at a time. Hence, a mental event is the exemplification of a mental property by a substance at a time. A physical event is the exemplification of a physical property by a substance at a time. Given this account of events, two events are identical if and only if they involve the same property, substance and time. It follows that a dualism, not only with regard to mental and physical *substances*, but

also with regard to mental and physical *properties*, entails a dualism with regard to mental and physical events. However, the assumption that the causal relata are Kimean events is not essential to the causal closure argument. (See, for example, Heil and Mele (1993) for further defence of this claim.) Nor is it essential to the arguments that this chapter presents.

2 Note, however, that despite the fact that the causal closure argument entails reductive physicalism, reductive physicalism is an unpopular position in contemporary debate largely as a result of the argument from multiple realizability – the argument that mental properties are multiply realized by, and hence, cannot be identical with, physical properties.

3 For a more extensive list and a thorough examination of the various formulations of the causal closure principle, see (Gibb 2015b).

4 Note, I myself would dispute the validity of this argument, regardless of whether or not *Exclusion* is included as a third premise in it. This is because, according to my own emergent theory of psychophysical causal relevance, a non-physical event does not have to be a cause of a physical event to be causally relevant to it. (See, for example, Gibb 2015b.)

5 See the *Oxford Dictionary of Physics* (Daintith 2005) for a formulation of the conservation laws along these lines.

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