Hume's Temporal Priority Thesis and Theory of Time

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This paper offers a critical interpretation of Hume's argument for the temporal priority of causes in light of his theory of time. Hume's view on causation and time is interesting because he is one of the first philosophers who noticed the connection between causation and time and offered a sophisticated argument for the claim that all causes, even sufficient ones, temporally precede their effects. Hume's idea that causation as an asymmetrical relation entails the temporal priority of causes points to the close connection between causation and the direction of time, a topic of huge relevance for contemporary debates in philosophy of physics. Hume's view shows much affinity to the modern theories which postulate the temporal order as the basis for causal order, disagreeing with those which affirm the possibility for simultaneous causation. Because of the contemporary relevance of Hume's view, I undertake to review his argument and venture a Humean defense for it on the basis of his theory of time. I believe my defense avoids the flaws that plague his own argument, even if my Humean presupposition still faces some difficulties. In doing so, I hope to rediscover, and critically engage with, the Humean insight that there exists a close connection between causal asymmetricality and the direction of time.

In the first part of this paper, I present Hume's argument for the temporal priority of causes and point out its problems. Then I turn to Todd Ryan's attempt to defend Hume, which, as I shall show later, remains problematic. The second part offers an alternative defense on the basis of Hume's theory of time and his argument against its infinite divisibility: the temporal priority thesis obtains on the level of *minima sensibilia*, and can be extended to all circumstances. The last part contains two objections to Hume's conception of time, exposing the counterintuitive consequences of his theory. In other words, Hume's theory of time, which forms the basis of a plausible defense of the temporal priority thesis, seems to be quite problematic.

Hume thinks that it is essential to causation that all causes, even sufficient ones, should temporally precede their effects. In other words, a cause must exist before its effect takes place. It is an interesting question whether Hume intends this thesis to be understood epistemologically or metaphysically: is the temporal priority of causes a feature of causation as we conceive of it on the cognitive level, or do causes really precede their effects on the metaphysical level? Hume is neither explicit nor clear on this matter, but he seems to endorse the temporal priority thesis on both levels. On the one hand, Hume presents the temporal priority of causes as characterizing our idea of causation. In our conception of causation, all causes, even sufficient ones, precede their effects. Hume presents the temporal priority of causes as an essential characteristic of the idea of causal relation as he undertakes to investigate and explain the idea of causation and its origin. According to the Copy Principle, the idea of causation derives, or to be more precise, is copied, from some original impression(s).[1] To trace the idea of causation to its original impression(s), Hume thinks it necessary to examine the idea with a view of its distinguishing features, which may shed light on what the original impression(s) may be.[2] Even if no single original impression is found, this inquiry provides important clues with respect to the mechanism by which this idea arises. Having embarked on this inquiry, Hume discovers that the temporal priority of causes, together with the spatiotemporal contiguity and necessary connection between causes and effects, constitutes an important feature that characterizes the idea of causation. This suggests that Hume seems to intend his temporal priority thesis to be understood on the epistemological level.

On the other hand, at other places of the *Treatise*, Hume seems to imply that all causes precede their effects on the metaphysical level. This point is clear from the fact that the temporal priority thesis forms an integral part of both of Hume's definitions of causation. In the first

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[1] For a general discussion of the Copy Principle, see Garrett, 41ff.
[2] Hume, T.1.3.2.3 – 5.

definition, a cause is an object c of type C that is always temporally precedent to, spatially contiguous to, and constantly conjoined with, another object e of type E, which is c's effect. The fact that Hume's temporal priority thesis features prominently in this formulation apparently descriptive of causation on a metaphysical level constitutes evidence that Hume intends his temporal priority thesis to be understood on the metaphysical level. The temporal priority of causes is also emphasized in the second definition, which states that a cause is an object c of type C constantly conjoined with another object e of type E that is temporally subsequent and spatially contiguous to c, such that the mind automatically passes from the idea of object c to that of e.[3] The conjunction of the two objects has to such that one is temporally prior to the other, so that the mental transition is unidirectional, with the mind passing from the idea of c to that of e, but not in the reverse direction. It seems reasonable to say that in the second definition, Hume takes causes to have the metaphysical feature of temporal priority, a feature which makes it possible for the mind to pass from the idea of the cause to that of the effect in a fixed and irreversible direction. The metaphysical reading of the temporal priority thesis receives further support from the fact that Hume lists the temporal priority of causes as a criterion by which causes and effects can be judged. If an object is conjoined with another which is spatially contiguous to it, it is unclear which one is the cause of the other, unless one object is observed to be immediately precedent to the other, and so is to be declared as the cause.[4] It seems reasonable to read this criterion as picking out causes on the basis of the metaphysical feature of causation, namely the temporal priority of causes in any causal relations.

Therefore, there is textual evidence for the claim that Hume intends his temporal priority thesis to be understood both on the epistemological and the metaphysical level. In this paper, I

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[3] Hume, T.1.3.14.31.
[4] Hume, T.1.3.15.4.

shall restrict my discussion to the metaphysical reading of the temporal priority thesis, leaving out most epistemological considerations. This treatment is primarily motivated by the fact that Hume's own argument for the temporal priority thesis seems to have the force of establishing it on the metaphysical level. In addition, I choose to focus on the metaphysical reading because I intend to bring Hume into the contemporary debates on the metaphysics of causation and time, a topic on which he presents views and arguments which I think deserve modern attention.

Hume offers an interesting argument for the temporal priority thesis. It is noteworthy that his treatment here differs from that of the spatiotemporal contiguity, where he merely appeals to the general intuition and asserts without further argument that causes and their effects must exist contiguously and cannot be separated by any intervening distance or duration. However, as Hume proceeds to deal with the temporal priority of causes, he adopts a different strategy. The argument here is based on a more or less rigorous "inference or reasoning."[5] Two points are worth noting. Firstly, at the most obvious level, this shift in strategy seems to result from the lack of general consensus on whether some cause could be simultaneous with its effect. As Hume himself notes, some people think that it is not necessary that a cause precedes its effect. The major opponent whom Hume has in mind is probably Hobbes, who argues that a sufficient cause has to be simultaneous with its effect: "in whatsoever instant the cause is entire, in the same instant the effect is produced. For if it be not produced, something is still wanting, which is requisite for the production of it; and therefore the cause was not entire, as was supposed."[6] The disagreement on this matter leads Hume to state his own view as defense. After all, Hume's theory of causation makes extensive use of the temporal priority thesis. It hardly seems appropriate to assert a claim on which some prominent philosopher holds an opposite view without providing any explanation

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[5] Hume, T.1.3.2.7.
[6] Cited in Ryan, 33.

or rationale. Hume no longer has the luxury of taking for granted what almost everyone agrees upon, as when he asserts the spatiotemporal contiguity of causes and effects. Secondly, an additional fact brings further complication to the role that this argument here plays in his theory. Hume later claims that even if one is not persuaded by this argument, it does not matter very much for his entire project. This results from the fact that in Hume's mind the most essential relation that characterizes the common idea of causation is that of the necessary connection, to which he accordingly devotes extensive treatment. Although Hume has good reasons to do so, one must resist the temptation to marginalize Hume's discussion of the temporal priority of causes. A serious, in-depth treatment of Hume's view on the temporal priority of causes is justified by the lack of consensus on whether all causes must precede their effects. Further, in order to bring Hume into a discussion with those who maintain the possibility of simultaneous causation – a discussion still quite relevant nowadays – it is necessary to examine in detail Hume's view and his argument for it.

With the preliminaries settled, I now turn to look at Hume's argument in greater detail. As Hume's presentation incurs no little confusion, it is necessary to quote his argument in its entirety. In a rather short paragraph, Hume presents his argument as follows.

> The second relation I shall observe as essential to causes and effects, is not so universally acknowledg'd, but is liable to some controversy. 'Tis that of PRIORITY of time in the cause before the effect. Some pretend that 'tis not absolutely necessary a cause shou'd prec'de its effect; but that any object or action, in the very first moment of its existence, may exert its productive quality, and give rise to another object or action, perfectly co-temporary with itself. But beside that experience in most instances seems to contradict this opinion, we may establish the relation of priority by a kind of inference or reasoning. 'Tis an establish'd maxim both in natural and moral philosophy, that an object, which exists for any time in its full perfection without producing another, is not its sole cause; but is assisted by some other principle, which pushes it from its state of inactivity, and makes it exert that energy, of which 'twas secretly possest. Now if any cause may be perfectly co-temporary with its effect, 'tis certain, according to this maxim, that they must all of them be so; since any one of them, which retards its operation for a single moment, exerts not itself at that very individual time, in which it might have operated; and therefore is no proper cause.

> The consequence of this wou'd be no less than the destruction of that succession of causes, which we observe in the world; and indeed, the utter annihilation of time. For if one causes were co-temporary with its effect, and this effect with *its* effect, and so on, 'tis plain there wou'd be no such thing as succession, and all objects must be co-existent.[7]

The general structure of the argument seems clear. It is a *reductio ad absurdum* which starts by assuming the contradictory of what is to be proved and then draws absurd results from it. Since nobody holds the apparently quite implausible view that there can be some sufficient cause that is subsequent to its effect, in order to establish the temporal priority thesis, Hume only needs to show that no sufficient cause can be simultaneous with its effect. His argument runs as follows. (a) "An object, which exists for any time in its full perfection without producing another, is not its sole cause" (the established maxim). (b) There is some sufficient cause that is simultaneous with its effect (*hypothesis reductionis*). (c) All sufficient causes must be simultaneous with their effects [from (a) and (b), as Hume claims]. (d) These effects, as new causes, must be simultaneous with their effects, and in turn these effects, as new causes, must be simultaneous with their effects, etc. [from (c)]. (e) All causes and effects are simultaneous [from (d)]. (f) There would be no succession [from (e)]. (g) But succession surely exists, for we have undeniable experience of it. So (f) contradicts (g). Since the inference is valid, the hypothesis must be wrong. Therefore, all sufficient causes must precede their effects.

This argument is not without problems. Admittedly, this argument suffices to disarm Hobbes' challenge, because Hobbes has already agreed with (c) without (a) and (b). But Hobbes' position is very strong. For him, every sufficient cause is simultaneous with its effect. However, Hume's another opponent might adopt a weaker version, according to which it is quite possible that only some, but not all, sufficient causes are simultaneous with their effects. In fact, this opponent is just Hume's assumed enemy. Hume himself presents his opponent as arguing "that 'tis

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[7] Hume, T.1.3.2.7.

not absolutely necessary a cause shou'd prec'de its effect."[8] For this opponent, Hume's argument is puzzling at best. Much confusion arises in (c). It is unclear why all sufficient causes must be simultaneous with their effects given that some sufficient causes are simultaneous with their effects. Hume claims to derive (c) from (a), the established maxim, and (b), the *hypothesis reductionis*, but the validity of this inference seems quite dubious.

To save Hume's *reductio ad absurdum*, Todd Ryan attempts a reconstruction of Hume's argument for (c), which is the most plausible I know of. Ryan interprets the established maxim (EM) as stating that all sufficient causes produce effects as soon as possible.[9] As Ryan does not provide much explanation of what he means by "as soon as possible," I now try to clarify his interpretation as I understand it. *X* is said to occur as soon as possible in relation to *Y* if and only if (i) *X* occurs either at the same moment as *Y* or at some moment after *Y* has occurred, (ii) the moment at which *X* occurs has to be as close as possible to the moment at which *Y* occurs, with the possibility that these two moments could be the same, in which case these moments are said to be the closest in all possible scenarios. With this clarified, now I quote Ryan's reconstruction:

> (1) At least one sufficient cause is possibly simultaneous with its effect (assumption for conditional proof).
> (2) All sufficient causes act as soon as possible (EM).
> (3) If a sufficient cause is possibly simultaneous with its effect, then it is in fact simultaneous with its effect (from 2).
> (4) At least one sufficient cause is in fact simultaneous with its effect (from 1 and 3).
> (5) If at least one sufficient cause is possibly simultaneous with its effect, then all sufficient causes are possibly simultaneous with their effect.
> (6) All sufficient causes are possibly simultaneous with their effect (from 1 and 5).
> (7) All sufficient causes are in fact simultaneous with their effect (from 3 and 6).[10]

This reconstruction presumably establishes (c) in Hume's own argument, and thereby fixes the problem in his *reductio ad absurdum*.

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[8] Hume, T.1.3.2.7.
[9] Ryan, 36.
[10] Ryan, 36, with omission.

The success of Ryan's argument depends on (5). But this assumption is problematic for two reasons. Firstly, this assumption is not evidently true. From the claim that a sufficient cause is possibly simultaneous with its effect, it does not follow that every sufficient cause is possibly simultaneous with its effect. Generally speaking, that A is possibly φ does not imply that B, of which A constitutes a proper subset, is possibly φ, for it might be the case that C, another proper subset of B sharing no common element with A, cannot possibly be φ. At the very least, it is not obvious that (5) is the case. Secondly, this assumption merely begs the question. In fact, Hume's opponent would deny (5), for she has already conceded that some sufficient causes are precedent to their effects, but insists that there are others which are simultaneous with their effects. Therefore, Ryan's argument fails to convince this opponent of Hume's temporal priority thesis.

But to be fair to Ryan, I think his interpretation of the established maxim is right and quite close to what Hume has in mind. The major merit of this reading is that it avoids reading Hume as directly contradicting himself. According to Hume's formulation of the established maxim, "an object, which exists for any time in its full perfection without producing another, is not its sole cause."[11] Some read Hume as saying that if a cause exists by itself without any effect, then it is not a sufficient cause, and that a sufficient cause, by contrast, has to be simultaneous with its effect, since nothing is lacking or preventing the cause from acting immediately. This interpretation ascribes to Hume the problematic claim that all sufficient causes are simultaneous with their effects, a position quite inconsistent with his temporal priority thesis, according to which all sufficient causes precede their effects. Ryan's interpretation, which takes Hume to be saying that all sufficient causes act as soon as possible, suggests an alternative that successfully avoids this problematic ascription.

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[11] Hume, T.1.3.2.7.

However, as mentioned above, even if one grants the established maxim read in this way, Ryan still fails to save Hume's temporal priority thesis. Below I propose an alternative defense for Hume on the basis of his theory of time. For Hume, time is not infinitely divisible: any finite duration of time consists of a finite number of small indivisible moments, the length of which each constitutes the lower limit of our perception of duration. These moments are the shortest durations that we can possibly perceive. They are the *minima sensibilia* which succeed each other, which, for the sake of convenience, might be called *minima successa* (*MS*).

Hume gives three arguments against the infinite divisibility of time. In the first argument, the basic idea is that if it cannot be conceived that a given extension consists of infinite number of parts, this extension must consist of a finite number of tiny indivisible extensions. Now, (a) there are limits to our capacity to conceive the duration of events. (b) There are some durations than which no shorter duration can be conceived. (There are *MS*.) (c) By repeating our ideas of these *MS*, we form compound ideas of longer durations. (d) Any longer duration is conceivable only if it is conceived as consisting of finite number of *MS*, which we repeat and align together in our conception [from (b) and (c)]. (e) It is inconceivable that a longer duration consists of infinite number of parts [from (d)]. (f) According to the Conceivability Principle, which states that what is inconceivable is impossible, it is impossible that a longer duration consists of infinite parts.[12] To this argument Hume adds a second one, which can be reconstructed as follows. (a) A duration is a quantity. (b) A quantity presupposes units in the sense that the notion of a quantity would make no sense if this quantity cannot be measured in units or does not consist of them. (c) Units are basic and indivisible. So (d) a duration must consist of some indivisible units (*MS*) [from (a), (b), and (c)].[13] The arguments above are analogous to the arguments showing that space is not infinitely

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[12] Hume, T.1.2.2.2 and 4.
[13] Hume, T.1.2.2.3 and 4.

divisible. Hume raises a third argument which is specific to time. The argument runs as follows. (a) It is an inseparable property of time that it consists of parts which succeed one another. (b) If each part which succeeds another were not indivisible, then there would be an infinite number of moments simultaneous with one another. But (c) it is absurd to hold that there could be an infinite number of simultaneous moments. Therefore (d) time consists of many basic indivisible parts (*MS*).[14] It is not my project to offer a comprehensive discussion of Hume's theory of time, so I will not embark on a critical evaluation of the philosophical merits of these arguments. Here it suffices to say that Hume has an atomistic theory of time, which, as I shall show below, sheds light on, and offers support for, his temporal priority thesis.

On the basis of Hume's theory of time outlined above, I now try to defend his temporal priority thesis. To do so, I appeal to a thought experiment, Humean in spirit, in order to show that, at the microscopic level, there could not be any sufficient cause simultaneous with its effect. Imagine that there exists a closed system with two objects, *A* and *B*. Now, suppose that *A* and *B* stay in some states, α and β respectively, both of which lasts only one *MS*. Now, consider whether the following scenario is possible: (i) *A* in state α, or *A(α)*, causes *B* in state β, or *B(β)* and (ii) *A(α)* occurs at the same moment, say at *t1*, as *B(β)*. I expect that my opponent would concede that this scenario is possible, but this is probably too rash a response. The crucial point here is that in this case *A* and *B* are perfectly symmetrical. Both *A(α)* and *B(β)* exist at *t1*, and it makes no difference to switch their letters, substituting *A* for *B*, *B* for *A*, etc. There is no asymmetricality which favors *A(α)* as the cause of *B(β)*, or *B(β)* as the cause of *A(α)*. But causation is incompatible with a complete symmetricality between causes and effects: in a causal relation, a cause and its effect cannot be reversed, and no cause can at the same time be caused by the effect of which it is now a

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[14] Hume, T.1.2.2.4.

cause. This asymmetricality requirement is not met by $A(\alpha)$ and $B(\beta)$ in the thought experiment, because there is no more reason for $A(\alpha)$ to be the cause of $B(\beta)$ than $B(\beta)$ to be the cause of $A(\alpha)$. Therefore, on the microscopic level, it involves a contradiction to hold $A(\alpha)$ and $B(\beta)$ as both simultaneous and causally related. If there is any causal relation between them, $A(\alpha)$ and $B(\beta)$ have to occur sequentially. So for instance, a necessary condition for $A(\alpha)$ to be the cause of $B(\beta)$ is that $A(\alpha: t1)$ occurs at $t1$, prior to $B(\beta: t2)$, which occurs at $t2$.

I now anticipate three objections to my argument above. The first objection argues that from the symmetricality between A and B it cannot be validly inferred that one of them cannot possibly be the cause of the other. What follows from the symmetricality between $A(\alpha)$ and $B(\beta)$ is merely that it cannot be known which of them is the cause of the other, but it is still possible that one can be the cause of the other. In other words, the symmetricality between $A(\alpha)$ and $B(\beta)$ implies the unknowability of their causality rather than its impossibility.

To the first objection I reply as follows. It is assumed that at least some asymmetricality is constitutive of causation as a metaphysical relation rather than an epistemological one. Now, note that the symmetricality between $A(\alpha)$ and $B(\beta)$ is metaphysical insofar as $A(\alpha)$ and $B(\beta)$ are actually symmetrical by themselves, not just with respect to the cognizer. To see why this is the case, recall the Humean point that metaphysically there is no necessary connection between $A(\alpha)$ and $B(\beta)$ such that either of them can possibly contain the ground of the other. As Hume points out, the necessary connection that we perceive or experience between $A(\alpha)$ and $B(\beta)$ does not actually exist between them. The phenomenological experience that such a connection exists is to be explained by the fact that $A(\alpha)$ and $B(\beta)$ are constantly conjoined, with the result that our mind naturally passes from the idea of $A(\alpha)$ to that of $B(\beta)$. Nothing intrinsic to $A(\alpha)$ or $B(\beta)$ exists that can possibly connect them asymmetrically. Therefore, $A(\alpha)$ cannot possibly be grounded in $B(\beta)$, nor $B(\beta)$ in

A(α). In other words, neither *A(α)* nor *B(β)* can metaphysically imply the other. Therefore, to summarize, the absence of any necessary connection between *A(α)* and *B(β)* implies the lack of any grounding relation between them, which in turn implies their metaphysical symmetricality. However, the existence of at least some metaphysical asymmetricality between *A(α)* and *B(β)* constitutes a necessary condition for the possibility that they are causally related. This condition is not met in the thought experiment, where *A(α)* and *B(β)* are simultaneous and metaphysically symmetrical. Therefore, the temporal priority of either *A(α)* or *B(β)* is necessary to introduce any metaphysical asymmetricality between them.

The second objection challenges the claim that temporal priority is necessary to introduce any metaphysical asymmetricality in causation. The challenge proposes a counterfactual relation which connects causes and effects asymmetrically without depending on the temporal priority requirement. According to this proposal, even if *A(α)* and *B(β)* exist at the same time, they can be asymmetrical in the following way: were *A(α)* not to exist, *B(β)* would not exist, but were *B(β)* not to exist, it would still be possible for *A(α)* to exist.

Two points can be made in reply to this objection. Firstly, if *A(α)* is to be the sufficient cause of *B(β)*, *A(α)* is to act, or to have effect, as soon as possible, in the sense which I read Ryan as ascribing to Hume in the established maxim. Therefore, if *B(β)* can exist simultaneously with *A(α)* and if *A(α)* is the sufficient cause for *B(β)*, then in every possible scenario, *A(α)* and *B(β)* are actually simultaneous, with the result that it is impossible for *A(α)* to exist were *B(β)* not to exist. Secondly, since, according to Hume's skeptical doctrine on causation, there exists no necessary connection between *A(α)* and *B(β)*, *B(β)* cannot be grounded in *A(α)* in the way which meets the contrafactual criterion. To ascribe the counterfactual asymmetricality to *A(α)* is to assume that there is something intrinsic to *A(α)* that connects to *B(β)* in a way in which *A(α)* and *B(β)* are not

on the same footing, or in other words, asymmetrical. However, this assumption is problematic, as Hume has made a good case for denying the existence of any such necessary connection between causes and effects on the metaphysical level. Therefore, from a Humean perspective, since the lack of any necessary connection in causation implies the lack of any grounding relation necessary to introduce any asymmetricality to causation, the second objection fails to propose a viable criterion of asymmetricality independently of temporal priority.

The third objection argues that $A(\alpha)$ and $B(\beta)$ in the thought experiment can be reciprocal causes. In other words, $A(\alpha)$ is the cause of $B(\beta)$, and at the same time, $B(\beta)$ is the cause of $A(\alpha)$. To see how this case challenges my defense, imagine that two completely identical elastic balls, A and B, of mass m moving at the same speed v yet in opposite directions collide together. According to Newton's third law, as the objection goes, at the moment of collision, the motion of each ball is the cause of the change in the motion of the other ball. Reciprocal causes such as these constitute counterexamples to the claim that all sufficient causes precede their effects.

I think a careful analysis of the example above can resolve the problem. It is B's previous motion towards A, described by B's momentum defined as the product of B's mass and previous velocity, that causes the change in the motion of A. It is not the change in B's motion that causes the change in A's motion. Similarly, the change in B's motion owes to the previous motion of A rather than the change in A's motion. However, to hold that the collision is a case for reciprocal causes is to hold that the changes in A and B cause each other. This is a mistake in light of the previous analysis. Therefore, the example of collision is not a case of reciprocal causes. Along the same line, similar cases of motion and impact, which appear to be instances of reciprocal causes, are not what they seem to be. Generally speaking, the notion of reciprocal causes violates the assumption that at least some asymmetricality is metaphysically constitutive of causation, or more

specifically, that no cause can at the same time be caused by the effect of which it is now a cause. Therefore, strictly speaking, the notion of reciprocal causes is not consistent.

My defense is not yet complete. Above I have established the temporal priority thesis on the microscopic level. Below I extend this thesis to other circumstances. Imagine an object C as a cause which (i) lasts from $t3$ to tn, where n is a positive integer and $n > 4$, during which time it undergoes some change γ, and (ii) is contained in a close system, free from any external influence. If this situation is reducible to the circumstance described in the thought experiment, then all causes must precede their effects. Now, break $C(\gamma)$ down to a chain of micro-causes and micro-effects, each of whose duration takes one MS. Consider the duration from $t3$ to tn as consisting of $t3$, at which C stays in state δ, $t4$, at which C stays in state ε, …, and tn, at which C stays in state v, where $\delta, \varepsilon, …, v$ are the temporal cross-section of γ at each MS from $t3$ to tn respectively. In other words, the reduction can be summarized in the following formula: $C(\gamma: t3 \sim tn) = \{C(\delta: t3), C(\varepsilon: t4), …, C(v: tn)\}$. Now, from the thought experiment, it is clear that if $C(\delta: t3)$ should have any effect, its effect would have to be subsequent to $t3$. The same holds for $C(\varepsilon: t4), …, C(v: tn)$. These effects need not take place subsequent to tn. In fact, it is quite possible that, for instance, the effect of $C(\delta: t3)$ occurs at tk, where k is a positive integer and $3 < k < n$. However, $C(\gamma: t3 \sim tn)$ begins to exist at $t3$ when there is no effect. Therefore, even if causes and effects may temporally overlap each other, all causes necessarily precede their effects. Therefore, Hume's thesis that all causes must precede their effects holds in all circumstances. Whether it is a micro-cause which occurs during one minimum successum, or it is a cause of longer duration, the effect has to be subsequent to the cause. This is because temporal priority, by introducing asymmetricality, is metaphysically constitutive of cause as such, and therefore forms a necessary condition for the possibility of causation as such. This I take to be Hume's main insight.

One may wonder whether my defense of Hume's temporal priority thesis presupposes his theory of time. If my defense could be freed from the further assumption that time is atomistic, then any objection to Hume's theory of time would pose no threat to his temporal priority thesis. I think Hume would have some reason to believe that his atomistic conception of time is quite necessary for my Humean defense. If the statement that all causes precede their effects in time is to make sense, there has to be some theory of time that offers a satisfactory account for what it means for something in the physical world to precede another temporally. Therefore, part of what is necessary for my defense of Hume's temporal priority thesis is some theory of time in light of which the notion of temporal priority can make physical sense. Now, a cause C can precede its effect E in two ways. In the first way, under the assumption that time is discrete, C is said to precede E if (a) the first MS at which C exists lies before the first MS at which E exists, and (b) between the two MS, there lie a finite number of MS. If no further MS can possibly exist between the two MS, then C is said to precede E *immediately*. In the second way, under the assumption that time is not discrete, C is said to precede E if (a) the first point at which C exists lies before the first point at which E exists, and (b) between any two such points, however close they are, there always lies at least another determinate point. The notion of temporal priority understood in the first way seems quite clear. However, the second way seems problematic. To fully appreciate the counterintuitive implication of temporal priority understood in the second way, consider the following scenario. Imagine that C precedes E in the second way. Suppose that a machine is designed to show 1 on its screen at the first point at which C exists and at every point before the first point at which E exists, and 0 at every point at which E exists. Since it is possible that the machine begins to show 1 on its screen at the first point at which C exists, there is nothing strange about the possibility that the machine begins to show 0 on its screen at the first point at which E

exists. Now, note that the first point at which E exists is also the first point at which the machine is showing 0 instead of 1 on its screen. If the set of real numbers, graphically represented on the number axis, is used to represent time, then the corresponding representation of the duration of the event *the machine is showing 1 on its screen* would be a half-open interval, graphically represented on the number axis as a segment with one of its terminal point removed. What is strange about this event is that it has a determinate beginning, but no determinate ending, for there is no last point at which the machine is showing 1. Suppose that the screen of the machine is filmed, assuming that the technology is perfect. Now, play the video backwards, so that what occurs later now happens earlier. The event *in the video the machine is showing 1 on its screen* now has no determinate beginning, for there is no first point at which the machine is showing 1 on its screen. This, again, is very strange. The above scenario conflicts with the intuition that for every event that is physically meaningful there exists a determinate beginning and a determinate ending. The strangeness of the scenario derives not so much from the assumption about the machine as from the fact that for any given point in time there is no point immediately adjacent to it. A natural response to the strange scenario above is to conclude that the notion of temporal priority understood in the second way, though conceptually consistent, does not make much physical sense. Insofar as time is physically significant, it is discrete in the sense that (a) all events begin and end only at determinate points in time, and (b) given a random determinate point in time, it is possible to find another point so close to it that no point can possibly exist between them. This exactly accords with Hume's atomistic conception of time, which consists of a set of indivisible MS such that for any MS there is at least an MS than which there exists no MS that is closer to the former MS. Thus, the argument concludes that the notion of temporal priority in his thesis makes sense only if time is atomistic. I am not claiming that this argument is conclusive. Rather, I am merely

suggesting that Hume would have *some* reason to believe that his theory of time is quite necessary for my defense of his temporal priority thesis.

However, it is indeed a common intuition that a cause, if it is really sufficient, must act immediately so that its effect is temporally simultaneous with it. It remains to be explained where the mistake arises and how it leads the intuition astray. I think this intuition results from a double confusion in our common usage of the following terms: simultaneity, sufficient cause, and sufficient condition. A sufficient condition obtains only if that of which it is such a condition obtains, for if a sufficient condition obtains, then that of which it is such a condition also obtains. This leads many to hold that a sufficient condition is simultaneous with that of which it is such a condition. However, a sufficient condition can include many things. For instance, the sufficient condition for me to get to class from the library involves walking on the campus for five minutes. Here some duration of time – five minutes – is part of the sufficient condition. But it makes little sense to say that some duration of time is simultaneous, or occurs at the same time, with some event. Clearly simultaneity here must not be taken in the temporal sense, but in the logical one: a sufficient condition is only logically simultaneous with that of which it is such a condition. However, the two senses of simultaneity are often confused in the common use of language, with the temporal one prevailing over the logical one, as is clear from the fact that in our daily usage *simultaneous* is often simply glossed as *at the same time*. This is the first confusion.

The second confusion occurs between the notion of a sufficient condition and that of a sufficient cause. A sufficient condition provides the reason that explains that of which it is such a condition. It is important to note that such an explanation need not be causal. For instance, the reason why the Pythagorean Theorem holds is explained by deducing this theorem from some axioms and definitions, which constitute the self-evident sufficient condition for this theorem.

However, it makes little sense to hold that the sufficient condition specified by the proof is a sufficient cause for the fact that the theorem obtains. To fully appreciate the distinction between a sufficient condition and a sufficient cause, consider my previous instance. The sufficient condition for my arrival at class is my walking from the library to the classroom and the time it takes. However, time is not efficacious and therefore cannot be called a cause: my walking is already a sufficient cause for my arrival, and that duration of time is just what it takes this cause to produce its effect. But in common usage, we tend to confuse a sufficient condition or reason with a sufficient cause. Therefore, to summarize, in our daily life we are not quite aware of the double confusion, in which the temporal sense of simultaneity first usurps the logical one in the notion of a sufficient condition, which in turn usurps that of a sufficient cause. This finally leads us to hold that all sufficient causes are temporally simultaneous with their effects.

In the argument above, from a Humean standpoint, I have shown that Hume's temporal priority thesis is defensible on the basis of his theory of time and his argument against its infinite divisibility. However, if his theory that time consists of many indivisible moments should prove unsound, then the foundation of my defense for his temporal priority thesis would be undermined. I have to confess that Hume's theory of time faces serious challenges, which I am not in any position to disarm. Below I shall raise two problems without attempting to resolve them.

The first challenge is in fact an ancient one. The Pre-Socratic philosopher Zeno of Elea famously raises a series of paradoxes in order to show that motion is impossible. The first challenge to Hume gives up Zeno's thesis, but appropriates his argumentative strategy. What is relevant here is Zeno's stadium paradox. Of this paradox Bertrand Russell and G. E. L. Owen offer a modern interpretation, which, as will be clear soon, significantly undermines the foundation of my

proposed defense for Hume.[15] The basic idea is that if space and time consist of *minima extensa* (*ME*) and *successa* (*MS*) respectively, counterintuitive consequences will follow. The objection against Hume, which is based on Zeno's thought experiment, asks us to imagine three rows of objects with the same length *L* initially arranged in the following fashion:

Initial set-up:

[*A*1] [*A*2] [*A*3]

[*B*2] =>

  <= [*C*1]

The first row remains at rest, serving as a reference frame. The second and the third row move in opposite directions parallel to the first at the rate of 1*L*/*MS*. Now, motion is possible only if for two objects that move in opposite directions passing each other, there exists a *MS* at which they are aligned with each other. Now, in the thought experiment, after 1*MS*, [*B*2], which was initially aligned with [*A*1], is now aligned with [*A*2], whereas [*C*1], which was initially aligned with [*A*2], is now aligned with [*A*1].

After 1MS:

[*A*1] [*A*2] [*A*3]

  => [*B*2]

[*C*1] <=

In this case, [*B*2] and [*C*1] pass each other without being aligned together at any *MS* at all. No *MS* in between can be found so as to allow these objects to be aligned with each other. Therefore, if Hume's atomistic theory of time is correct, then real motion would be impossible. But clearly there is real motion. Therefore, Hume's atomistic conception of time is problematic.

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[15] For Russell and Owen's argument, which I have paraphrased below, see Salmon, 11 – 12, 53 – 54, and 148.

The second challenge, which is my own, takes the first as its source of inspiration. It highlights how counterintuitive the consequences of the atomistic theory of time turn out to be. Again, suppose that Hume is right that time and space consist of *MS* and *ME*. Imagine a race course with the length of 4*ME*. For the sake of convenience, suppose that an object with the length of 1*ME*, (1*ME*), is resting at [*ME*1].

Scenario (i), initial set-up:

[*ME*1] [*ME*2] [*ME*3] [*ME*4]

(1*ME*)　=>

Now, suppose that the object, (1*ME*), starts to move to the right at the rate of *xME*/*MS*. Here *x* has to be a positive integer given Hume's atomistic theory of space and time. For if *x* is positive but is not an integer, then after 1*MS*, where is this object? It would have to end up partially overlapping with the previous *ME*, partially with the next one, just as shown in the following graph ($0 < x < 1$):

If 0 < x < 1, after 1MS:

[*ME*1] [*ME*2] [*ME*3] [*ME*4]

　　(1*ME*)

Recall that, *ex hypothesi*, the length of the object is 1*ME*, which cannot be conceived to be further divisible. However, if the object partially overlaps with [*ME*1] and partially with [*ME*2], it can be conceived as having two parts, which leads to a contradiction. The same could be said about [*ME*1] and [*ME*2]. This shows that *x* has to be a positive integer. Now, if $x > 1$, say $x = 3$, i.e. if the object, (1ME), moves to the right at the speed of 3*ME*/*MS*, then after 1*MS*, this object arrives at [*ME*4].

Scenario (i), after 1MS:

[*ME*1] [*ME*2] [*ME*3] [*ME*4]

　　　　　　(1*ME*)

Note that there is no *MS* at which the object, (1*ME*), is at [*ME*2] or [*ME*3]. Rather, the object jumps from [*ME*1] directly to [*ME*4]. Now, imagine that at [*ME*2] and [*ME*3], a huge wall is built. This wall is completely solid, allowing for no passage. Again, the object, (1*ME*), starts at [*ME*1] and moves to the right at the speed of 3*ME*/*MS*.

Scenario (ii), initial set-up:

[*ME*1] [*ME*2] [*ME*3] [*ME*4]

(1*ME*) [*GW*2] [*GW*3]

Here an interesting question arises: what would happen to the object? There is no reason to suppose that this object would run into the wall, because there is no *MS* at which the object is at [*ME*2] or [*ME*3]. Rather, the object would jump from [*ME*1] directly to [*ME*4], as it did in scenario (i), without touching [*ME*2] or [*ME*3], where the wall is now standing.

Scenario (ii), after 1MS:

[*ME*1] [*ME*2] [*ME*3] [*ME*4]

[*GW*2] [*GW*3] (1*ME*)

But this is very counterintuitive. The solid wall stands in vain. Presumably, if I start from the right position with the right speed, I can walk through the walls of the library without touching them or hurting myself. However, experience tells me that attempting to do so probably is not a very good idea. To avoid the counterintuitive consequences that occur when $x > 1$, Hume is left with the only option to assert that $x = 1$. However, this move does not solve the problem. If $x = 1$, then all objects would move at the same speed 1*ME*/*MS*. This is already quite counterintuitive, because in common experience, there apparently are objects which move at different speeds. Aside from this intuitive objection, let it be granted that in the current reference frame, *RF*1, an object moves to the right along the race course at the speed of 1*ME*/*MS*. Now imagine a reference frame, *RF*2, which moves

to the left in the opposite direction at the speed of $1ME/MS$ relative to $RF1$. From the perspective of $RF2$, the object, which moves at $1ME/MS$ in $RF1$, moves at $2ME/MS$. Now Hume again encounters all the counterintuitive consequences that follow when $x > 1$. For Hume there seems to be no way of evading these difficulties.

The objections raised above show that Hume's theory of time and space is problematic. As I have shown earlier, my defense for Hume's temporal priority thesis is predicated on his theory that time is not infinitely divisible but consists of numerous MS. To be frank, I am not unwilling to agree with Hume that all causes precede their effects. However, I am aware that my defense for him is not free from problems given the problematic nature of his theory of time.

Nevertheless, my attempt shows that within Hume's own system, it is quite possible to develop a defense for his temporal priority thesis. If his theory of time should obtain despite its counterintuitive consequences, his temporal priority thesis would in fact turn out to be sound on the philosophical ground. Thus, it becomes clear that the problem of whether all causes precede their effects is closely related to the problem whether time is atomistic. Solving the latter is likely to shed light on the former. This I take to be the Humean insight that deserves modern attention.

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