The Issue of Temporal Asymmetry in David Lewis's Concept of Counterfactual Dependence

*Emre Arda ERDENK**

Abstract

David Lewis in his remarkable project of counterfactual analysis of causation tries to formulate causal relations in terms of counterfactual statements and his account of possible worlds that he introduces in his account of modal realism. Lewis's analysis consists of many various aspects that could not all be looked up in this paper. Nonetheless, in this paper, I am going to evaluate one of the most famous components of his analysis and critically point out one of the most critical issue concerning counterfactual analysis; namely the "temporal asymmetry of counterfactual dependence". I will argue that Lewis's argument for the temporal asymmetry of counterfactual dependence relies on the conceptual fiat that there is time asymmetry, even though Lewis himself would say that this claim is philosophically well argued.

Keywords: Possible Worlds Semantics, Truth-Makers, Laws of Nature, Miracles.

David Lewis'in Karşıt-Olgusal Bağlılık Kavramında Zamansal Asimetri Meselesi

Özet

David Lewis nedenselliğin karşıt-olgusal analizini yaptığı çarpıcı projesinde nedensel bağıntıları karşıt-olgusal önermeler ve kipsel gerçekçilik görüşünde ortaya koyduğu olası dünyalar

*   Yrd. Doç. Dr., Karamanoğlu Mehmetbey Üniversitesi, Edebiyat Fakültesi, Felsefe Bölümü, eerdenk@kmu.edu.tr

görüşü ile formüle etmeye çalışır. Lewis'in analizi bu makalede ele alınamayacak kadar çok çeşitli yönlere sahiptir. Bununla birlikte, bu makalede, bu analizin önemli bir parçası olan ve karşıt-olgusal analizin en kritik meselesi olarak nitelendirilebilecek "karşıt-olgusal bağlılığın zamansal asimetrisi" problemini ele alacağım. Lewis'in karşıt-olgusal bağlılığın zamansal asitmerisine dair olumlayıcı iddiasının kavramsal bir emri vaki olduğunu ve bunu iddianın, Lewis inkâr etse bile, felsefi temellendirme yönünden zayıf olduğunu göstereceğim.

Anahtar Kelimeler: Olası Dünyalar Semantiği, Doğru-Yapıcılar, Doğa Kanunu, Mucizeler.

1. Introduction

David Lewis (1973)'in his remarkable project of counterfactual analysis of causation tries to formulate causal relations in terms of counterfactual statements and his account of possible worlds that he introduces in his account of modal realism (Lewis 1986a). Lewis's analysis consists of many various aspects that could not all be looked up in this paper. Nonetheless, in this paper, I am going to evaluate one of the most famous components of his analysis and critically point out one of the most critical issue concerning counterfactual analysis; namely the "temporal asymmetry of counterfactual dependence" (Lewis 1979). I will argue that Lewis's argument for the temporal asymmetry of counterfactual dependence relies on the conceptual fiat that there is time asymmetry, even though Lewis himself would say that this claim is philosophically well argued.

2. Lewis's Argument for "The Temporal Asymmetry of Counterfactual Dependence"

Lewis (1979) argues for an adequate explanation of why there is temporal asymmetry in causation: the cause precedes its effect and not the *vice versa*. As Lewis's comprehensive account for the counterfactuals that he introduces in *Counterfactuals* is not the main concern of this paper, I would not exclusively deal with the key features of his counterfactual analysis. However, it might be useful and rather more appealing to look at Stalnaker's explication of Lewis's analysis of counterfactuals:

> Consider a possible world in which A is true, and which otherwise differs minimally from the actual world. *"If A, then B" is true (false) just in case B is true (false) in that possible world* (Stalnaker 1968: 102).

The condition "minimally differs" is not a strict criterion for deciding the truth-value of a counterfactual statement. By means of this criterion, Lewis proposes conditions by which we can execute a "comparative similarity" and decide whether

a given would-counterfactual is true or false. For this, the whole argument can be construed in the following steps. First, he emphasizes that the asymmetry in question here cannot be grounded on our intuitive grasp of the time's arrow so easily. He mentions some of the candidates of hypothesis offering explanation for the asymmetry of time and rejects them by raising objections, which I will not discuss here (Lewis 1979: 460-464). Accepting that his objections are plausible enough, we should concentrate on his explanation, by which he introduces the notion of asymmetry of counterfactual dependence. Unfortunately, though, his explanation is quite short to be persuasive and falls short of being able to expose its point. Briefly, the argument forces us to believe that the past is unchangeable and the 'openness' of the future gives us an understanding of the asymmetry of time's arrow in a counterfactual way. That the future is counterfactually independent of the present, whereas the present is counterfactually dependent on the past. Although he seems to be convinced by this, he also mentions some exceptions for this view. It is also noted by himself that if this explanation were complete by itself, then it would only allow forward-counterfactuals and no backward-counterfactuals can be examined. However, Lewis admits that sometimes we need to enable backward-counterfactuals. In extreme cases, or in very far possible worlds such counterfactuals might have been true. Nonetheless, in worlds just like ours we have them seldom being true (Lewis 1979: 476). We might say here that this rareness in the actual world is justified in terms of the second law of thermodynamics[1]. I think Lewis also admits that his understanding of convergence is related to the asymmetry of entropy: "I regret that I do not know how to connect the several asymmetries I have discussed and the famous asymmetry of entropy" (Lewis 1986b: 51). However, Adam Elga famously argues that even if we consider any event in terms of thermodynamics it is extremely difficult to reverse that process, even though it is not completely impossible. He shows that it is quite possible to consider an ordinary event as a reversed process which possesses small and localized miracles in the molecular level. In this case, he concludes that Lewis's own analysis fails to yield the asymmetry of counterfactual dependence. (Elga 2000). However, as Elga's own point is directly related to the asymmetry of overdetermination and his own counter-example shares the same commitment to time's asymmetry in terms of entropy, I will not evaluate it any more in detail.

After pointing out this asymmetry of miracles, as the second step, Lewis introduces some instructions that must be used when analyzing counterfactuals. He claims that when we analyze counterfactuals, the best strategy is to examine counterfactuals "based on comparative similarity of possible worlds" (Lewis 1979: 465). Again, without evaluating the sequence of his argument, we can merely focus on the four criteria of comparison that Lewis suggests for the comparative similarity. Accordingly, these criteria are:

———————

[1] For a very concise introduction to understand the thermodynamic asymmetry in time see, Craig 2016.

(1) It is of the first importance to avoid big, widespread, diverse violations of law.

(2) It is of the second importance to maximize the spatio-temporal region throughout which perfect match of particular fact prevails.

(3) It is of the third importance to avoid even small, localized, simple violations of law.

(4) It is of little or no importance to secure approximate similarity of particular fact, even in matters that concern us greatly. (Lewis 1979: 473)

As we can see, Lewis wants to execute the comparative similarity examination based on miracles, small or big, leading to divergence or convergence. It may seem to be at face value that the order of this list is questionable because worlds, in which miracles of any kind take place, might be considered not to be close-possible-worlds to the actual world by appealing to our intuitive understanding of comparative similarity. Jonathan Bennett in "Counterfactuals and Temporal Direction" (1984) raises this issue. According to him, similarity with respect to law-likeness might be necessary for comparison because intuitively we believe that the actual world has regularities and we do not expect any violations of the laws of nature in the actual world.

However, Lewis is careful with the laws and does not want to get involved in a detailed account for the laws and regularities. From *Counterfactuals,* what we can only infer is that for Lewis a P-world, which has the same past as the actual world until t and a miracle striking up at t is closer than a world which has a different past until t and involving no miracles. In this case, it seems quite plausible to say that here the notion of fixed and unchangeable past plays a key role. As Bennett asks, when objecting to miracles, "If all miracles were prohibited, a closest P-world might be unlike the actual world in respect of all times earlier than T –but why not?" (Bennett 1984: 67). Here Bennett criticizes Lewis in terms of the second criterion of the comparative similarity. Accordingly, without any miracles, the P-world can only differ from the actual world by means of its difference in its spatial-temporal region and that can be so by a different past, or in some occasions by a present different from than that of the actual world.

Miracles are important in the discussion here for another reason. Lewis in his 1979 paper in the section "Asymmetry of Miracles" introduces another claim, which bothers me a lot by virtue of his intuitive conception of the direction of time. Lewis distinguishes miracles as, on the one hand, convergence miracles and, on the other hand, divergence miracles. And, ultimately, he claims that there is an asymmetry between these two types of miracles.

First, let me explain them briefly. A divergence miracle is the following. If a world w is exactly the same until a time t and after a short period of time after t

it differs from the actual world and if this difference is caused by an event which conflicts with the laws of nature of the actual world, then this event is a divergence miracle. For instance, suppose in the actual world a scientist in CERN stands near a button of the great hadron collider. If a neuron in his brain miraculously fires, then he pushes that button and the world goes for a fallout. In this case after he pushes the button the spatial-temporal region of the actual world radically differs comparing the case where *he would have not pushed that button*. On the other hand, a convergence miracle is the opposite process of divergence miracles. If a world w differs from the actual world till the time t, and after t it is similar to the actual world, and if the event that causes this change conflicted with the laws of nature in the actual world, then this event is a convergence miracle. This time suppose, a scientist in a possible world, which differs from the actual world in its every single atom, stands near a button-like thing which may trigger a catastrophic event that may change every single atom and configuration that makes that world to become almost identical to the actual world. For instance, a neuron fires miraculously in his brain and that world becomes almost identical to the actual world due to a catastrophic event. So, before the time he pushes that button two worlds are entirely different, but after that event, this possible world converges into the actual world. Concerning these two notions, Lewis asserts that divergence can only occur by a small miracle; that the miracle is not too extraordinary and does not require bigger violations of laws. On the other hand, convergence can only occur by a bigger miracle, which requires a lot of laws being violated. According to the standards of similarity, this distinction between miracles is asymmetrical because the standards themselves are symmetrical.

This asymmetry relation turns out to be very odd because the asymmetry relies on the standards of comparative similarity. It seems to me that just because Lewis puts the standard (1) above (3), it cannot be conclusive as such that the asymmetry relation of the miracles may be grounded. If we, for a minute, forget the time's arrow, then we can intuitively say that in a p-world, in which the direction of time is reversed, the notions of convergence and divergence should also be reversed. What that means is that a convergence miracle by a time's arrow, which points to the future, would be a divergence miracle by a time's arrow, which points to the past. To obtain this we do not need, as Lewis suggests, worlds consisting of only one atom (Lewis 1979: 474), but instead reversed-time worlds of the kind I have mentioned are quite satisfactory. This relation follows from the definition of a miracle. In this case, it is rather drastic to say that the asymmetry comes from the standards of similarity. Perhaps, instead of this, it derives from the commonsensical assumption that time's arrow always points to the future. If we can show that the time's arrow pointing the future might be a conceptual fiat for the theory, then we can rely on a symmetry relation concerning the miracles.

There is more to say here about this issue. To support this former claim, it is important to see the link between the asymmetry of counterfactual dependence and the asymmetry of miracles. Lewis says, "The asymmetry of counterfactual dependence arises because the appropriate standards of similarity, themselves symmetric, respond to this asymmetry of miracles" (Loc. cit.). It seems to me that the whole issue about the temporal asymmetry of counterfactual dependence supervenes on the asymmetry of miracles. Recalling that we need to have miracles in the theory, the problem has now pop up to the surface.

To obtain a criterion of fixed-past in the counterfactual analysis of causation, Lewis introduces the notion of miracles. This notion leads him to give the standards of similarity in such a way that it preserves the time asymmetry, which brings, consequently, the asymmetry of miracles. Finally, the asymmetry of counterfactual dependence relying on the standards of similarity, as well as the asymmetry of miracles, is actually coming from the intuitive grasp of the time's arrow -the temporal asymmetry-. It seems to me that this is not a pleasant outcome of Lewis's analysis, because at the very beginning, what Lewis argues is to avoid such convention and rather give a more sophisticated account for the time's arrow. Unfortunately, as Lewis uses miracles so loosely and he based the asymmetry of counterfactual dependence on the asymmetry of miracles, his sophisticated account for the temporal asymmetry loses its strength.

3. A Case Comparison by Reversed-Time-Possible-Worlds

3.1. Preliminaries

I concluded the last section by claiming that the commitment to the temporal asymmetry based on counterfactual dependence is not as plausible as Lewis suggested. In this section, I am going to reconstruct the well-known Nixon and nuclear war example for the counterfactual analysis in terms of reversed-time-possible worlds. In other words, this time I will rely on the temporal symmetry instead of the temporal asymmetry of causal relations. The legitimacy of this examination has its grounds in the last section. In terms of the problem of temporal asymmetry it is at least conceivable that there are some worlds, in which time flows in the opposite direction of ours. However, first, I need to say a little more about how can we be justified in considering such reversed-time-possible worlds empirically.

First, in the first section I showed that Lewis's analysis of the temporal asymmetry is too shaky to be something sophistically well explained. That is why, we have the right to give an analysis this time for the temporal symmetry as shaky as it may be similar to Lewis's. However, for the symmetrical relation of causal events, we may also appeal to some notions of physics. After all, what

we want to do here must be based on a broad understanding of how we must treat the laws of nature and how physics conceptualizes the causal relations. So, according to this understanding, we may look at Stephen Hawking's reaction towards the tendency of appealing to thermodynamics when it comes to justify time asymmetry of causation[2]. As a physicalist per se, Hawking says:

> It laid great stress on causation, in distinguishing the forward direction of time from the backward direction. But in physics we believe that there are laws that determine the evolution of the universe uniquely. So, if state A evolved into state B, one could say that A caused B. But one could equally well look at it in the other direction of time, and say that B caused A. So, causality does not define a direction of time (Hawking 1994 quoted in Price & Weslake 2009: 417).

In terms of this, I will let the door be open for possible objections concerning Hawking's point. For instance, as many philosophers would react, one might be thinking that causation is something which cannot be reduced to what physics says. After all, the concept of causality is not merely about physical events but it is also stringently related to other non-physical types of causation such as agent-causation, mental-causation, etc. Let this be a good and reasonable objection, I think I am still justified in using physics as the justification of imagining reversed-time-worlds possible. I have already occasionally referred to Lewis and said that the time asymmetry of counterfactual dependence relies mostly on the crude naïve physics and laws of thermodynamics. In this case, I should be equally allowed to appeal to pure physical conception of causality.

Of course, my aim is not to accept what Hawking says blindly and say that causation does not define a direction of time. However, by knowing "the fundamental physics seems to be time-symmetric" (Price & Weslake 2009: 417) and combining it with Hawking's point, we can clearly but controversially say that a time-reversed universe is similar (or even closer) to the actual world based on plausible physical explanations. In other words, there is no need to think that in such worlds laws of nature differ drastically from ours.[3] Hence, if such a world

---

[2] We may also point out some other discussions similar to this. For instance, Arntzenius 1993 and Frisch 2005 criticizes the notion of time-asymmetry in the case of electromagnetics. See also, North 2003; Popper 1956; and Price 1996.

[3] According to the entropy theory, this claim is not acceptable. However, there is a slight maneuver which makes the whole argument crucially distinct. If the entropy theory is true, then we should say that in the actual world, when a state of affair moves from high entropy to low entropy there must be miracle happening for this event to occur. In this case it must be a convergent miracle indeed. However, in my thought experiment, I will not examine events in a reversed-timed order in the *actual world*. Events will be the events of the reversed-time-possible worlds for which we may think that they violate laws of nature from the framework of our universe. From the framework of that possible world there are, however, no laws being violated. Ultimately, considering the four criteria of counterfactual dependence, it is perfectly

is evaluated by means of the standards of comparative similarity, then this world must be one of the closest worlds to the actual world[4] because, as Lewis says, the standards are symmetric by themselves.

This examination has the following rationale. If such worlds are the closest possible worlds in terms of the aforementioned reasons, then we should expect some change in the conception of the divergence and convergence miracles. This is expected because in a reversed-time-p-world all divergence miracles must be replaced by convergence miracles and *vice versa*. In such a world, the so-called "future" must be replaced by "past". In other words, in the actual world we have the spatio-temporal region ordered as past-present-future, whereas in the p-world it should be future-present-past relative to the actual world.[5] As a result, we can get the symmetry of miracles instead of an asymmetry relation. The expected outcome of this is that it would make Finean objections (Fine 1975; Jackson 1977; Slote 1978) to the counterfactual "If Nixon had pressed the button, there would have been a nuclear war" stronger. Since we must at least be allowed to consider time-reversed-p-worlds, this counterfactual has the possibility to come out to be false. If I can succeed in showing that this is plausibly the case, then it will show that Lewis's analysis intuitively relies on the direction of time.

3.2. The Nixon – Nuclear War Example (The Future Similarity Objection)

Before looking at Lewis's reaction to the future similarity objection, let us first see what Fine says about the Nixon – Nuclear War counterfactual:

> The counterfactual "If Nixon had pressed the button there would have been a nuclear holocaust" is true or can be imagined to be so. Now suppose that there never will be a nuclear holocaust. Then that counterfactual is, on Lewis's analysis, very likely false. For given any world in which antecedent and consequent are both true it will be easy to imagine a closer world in which the antecedent is true and the consequent false. For we need only imagine a change that prevents the holocaust but that does not require such a great divergence from reality. (Fine 1975: 452)

This tiny bit of change that is sufficient to stop the war can be a mere change of a molecule of Nixon's brain. As we can see, the future similarity objec-

---

legitimate to consider such possible worlds.

4   It cannot be, by no means, the same world with the actual world because the phenomenal awareness of the agents in terms of the direction of time in that possible world might differ from ours.

5   These indexical terms designate its spatial-temporal area from our perspective in the similarity comparison.

tion is not directly related to the direction of time, but it tries to show that there is no symmetry between the change in spatial-temporal region and miracle that causes that change. Since my objection is not based on Finean objections to future similarity, I will not elaborate this point any more. In this case, what is more important for my purpose is to see Lewis's answer to this objection.

Let us, then, look at Lewis's own explanation of why the counterfactual "If a nuclear war had occurred, Nixon would have pressed the button" comes out to be true. Very briefly, there is a world w0 "that may or may not be ours" (Lewis 1979: 467), in which Nixon does not press the button (not P) and no nuclear war ever occurs (not Q). In another world w1, Nixon with the aid of a divergence miracle presses the button (P), and the war occurs (Q). Thirdly in w2, Nixon presses the button due to a convergence miracle (P), and the war miraculously does not occur (not Q). From the facts of similarity standards w1 is closer to w0 than w2 because it involves a divergence miracle instead of a convergence one. In other words, in w1, less laws are violated comparing it to w2.

Recalling the point that I've made earlier about the time symmetry of physical laws and Hawking's remark on this issue, I want to make one crucial stipulation concerning the Nixon counterfactual. As Hawking points out "A causes B" is equivocal to say that "B causes A"; similarly we can think of a counterfactual P $\Upsilon \to$ Q is equivalent to Q $\Upsilon \to$ P.[6] This stipulation crucially relies on the idea that counterfactual statements that are issued in this context express causal relations and we concluded that causal relations can be construed as time symmetric. Therefore, it is plausible to accept this stipulation. Hence the Nixon counterfactual, then, turns out to be: "If a nuclear war had occurred, Nixon would have pressed the button".

According to Q $\Upsilon \to$ P we can get the following similarity relations in time-reversed possible worlds. Let w0 (not Q, not P) be a world in which time is reversed. Secondly w1 (Q and P) –again time-reversed– has different earlier events than w0 until the time t because before t, w1 is at the end of a catastrophic fallout and will converge eventually to w0 by a miracle after a brief period. Thirdly, w2 (not Q, P), also a time-reversed world, which has the same earlier events as does w0 and at t two miracles will occur and after t it will remain the same as w0. Let me illustrate the initial scenario and the time-reversed one in Figure 1.[7]

---

[6] (1) "$\Upsilon\to$" refers to the would-counterfactual operator box arrow. (2) No doubt that (Q $\Upsilon\to$ P) seems like a backtracking counterfactual. However, though, it is not; because (Q $\Upsilon\to$ P) is just an equivocation of (P $\Upsilon\to$ Q) and has no intrinsic difference that of from what the latter does.

[7] "o" represents convergence miracles, "%" represents divergence miracles, "-" parts are the same in each world, ">" parts are diverged parts. The lengths and numbers of "-" and ">" parts are thought to be the same.

Initial Scenario (A)		Time-Reversed Scenario (B)	
Time flow:	past-present-future		future-present-past
(P, not Q)	w2: --------o--------	(Q, P)	w1: >>>>>o--------
(P, Q)	w1: --------%>>>>	(not Q, P)	w2: -------%o---------
(not P, not Q)	w0: ------------------	(not Q, not P)	w0: ------------------

Figure 1

As we can see in (B) the similarity relation is changed. In (B) w2 is the closest possible world to w0 because of the standards of comparative similarity. But before that, we should also realize that the notion of miracle is also changed. By the definitions of miracle that Lewis gives, a convergence miracle turned out to be a divergence miracle in B and a divergence miracle becomes a convergence one. As the counterfactual dependence is time asymmetric, the standards of similarity themselves are symmetric. Ultimately, if we reverse the spatial-temporal regions of any two worlds, converging into and diverging from any region to another should also be reversed. Now, regarding the similarity issue, w2 is now closer to w0 than w1 because of the first and the second standards of the comparative similarity. This time, then, a convergence miracle turns to be a divergence one, and since the standards do not depend on time's arrow by fiat, we should execute the same similarity conditions in the time-reversed scenario too.

What are the consequences? We have three consequences that should be emphasized here. First, if we must have the same events until t in all the possible worlds under consideration, then w1 in (B) should be irrelevant for the comparison because it does not share the same earlier events with w0. Secondly, if we do not need to have the same events until t, then we have symmetry of miracles contrary to what Lewis argues, or he must admit that his conception of divergence and convergence miracles depend stringently on time's arrow by fiat. Thirdly, Lewis must accept that in B the counterfactual $(Q \; \Upsilon \rightarrow P)$ is false because w1 is not the closest possible world and even it is irrelevant for the comparison. This means that $(P \; \Upsilon \rightarrow Q)$ in A is also false as we stipulated that it is the equivocal transposition of $(Q \; \Upsilon \rightarrow P)$ in B.

What we have seen in this paper is that reliance on the time asymmetry concerning counterfactual dependence has some vital errors. This will remain so, if some remedies are not done. Our discussion shows that the temporal asymmetry of counterfactual dependence could not be conclusive until some exclusive

explication is given to show why it is plausible to rely on such an asymmetry. Apart from these problems, there might be, as I have said, some remedies. For instance, as Bennett argues that miracles can be ruled out from the theory entirely (even if this suggestion is way more than a remedy). Similar to what Bennett points out, I have shown that in (B) there is no sufficient reason to rely on the asymmetry of miracles. Secondly, fixing the past in similarity comparisons might be a bad idea, if (B) is plausible, because worlds like w1 can be ruled out in time-reversed possible worlds. Ultimately, I conclude that it is not a clever idea to rely on the direction of time when we analyze causal relations in terms of counterfactuals. Thus, we should not fix the past.

4. Conclusion

I want to recall briefly what I have shown in this paper. I argued that even if the temporal asymmetry of counterfactual dependence is not a conceptual fiat, it is still strongly dependent on our intuitive grasp of the direction of time and also may be implicitly on the laws of thermodynamics. I have shown this by criticizing the asymmetry of miracles and the strong connection between the asymmetry of miracles and the asymmetry of time's arrow. By showing this, I think it is at least equally reasonable to argue that we can rely on temporal symmetry for causal events. By means of this legitimate estimation I evaluated the Nixon-Nuclear War counterfactual example by explicating it in terms of time-reversed-possible-worlds. At the end of that explication, I concluded that analyzing the Nixon-Nuclear War counterfactual in terms of Lewis's standards of counterfactual dependence is problematic due to the reasons: (i) the asymmetry of miracles, (ii) pre-fixed earlier events, and (iii) the truth-value of the counterfactuals in terms of time symmetry. Ultimately, it seems to me clear that Lewis's account needs a reconsideration and even a fixation both in its details and in its foundations.

References

Arntzenius, F. (1993). The Classical Failure to Account for Electromagnetic Arrows of Time. In G. Massey, T. Horowitz & A. Janis (Eds.), *Scientific Failure* (pp. 29-48). Lanham: Rowman and Littlfield.

Bennett, J. (1984). Counterfactuals and Temporal Direction. *The Philosophical Review, 93*, 57-91.

Craig, C. (2016). Thermodynamic Asymmetry in Time. *The Stanford Encyclopedia of Philosophy,* (Winter 2016 Edition), Edward N. Zalta (ed.). Retrieved from https://plato. stanford.edu/ archives/win2016/entries/time-thermo/

Elga, A. (2000). Statistical Mechanics and the Asymmetry of Counterfactual Dependence. *Philosophy of Science*, *68*(Supplement), 313–324.

Fine, K. (1975). Review of Lewis's Counterfactuals. *Mind, 84*, 451-458.

Frisch, M. (2005). *Inconsistency, Asymmetry and Non-Locality: Philosophical Issues in Classical Electrodynamics*. New York: Oxford University Press.

Hawking, W. S. (1994). The No Boundary Condition and the Arrow of Time. In J. J. Hal-liwell, J. Pérez-Mercader & W. H. Zurek (Eds.), *Physical Origins of Time Asymmetry* (pp. 346-357). Cambridge: Cambridge University Press.

Huw, P. (1996). *Time's Arrow and Archimedes' Point*. Oxford: Oxford University Press.

Huw, P. & Weslake, B. (2009). The Time-Asymmetry of Causation. In H. Beebee, C. Hitchcock & P. Menzies (Eds.), *The Oxford Handbook of Causation* (pp. 414-443). Oxford: University Press.

Jackson, F. (1977). A Causal Theory of Counterfactuals. *Australasian Journal of Philosophy, 55*, 3-21.

Lewis, D. (1973). *Counterfactuals.* USA: Basil Blackwell Ltd.

Lewis, D. (1979). Counterfactual Dependence and Time's Arrow. *Noûs, 13*, 455- 476.

Lewis, D. (1986a). *On the Plurality of Worlds.* USA: Blackwell Publishing.

Lewis, D. (1986*a*). *Philosophical Papers II*. New York: Oxford University Press.

North, J. (2003). Understanding the Time-Asymmetry of Radiation. *Philosophy of Science*, *70*, 1086–1097.

Popper, K. (1956). The Arrow of Time. *Nature*, *177*, 538.

Slote, A. M. (1978). Time in Counterfactuals. *The Philosophical Review, 87*, 3-27.

Stalnaker, R. (1968). A Theory of Conditionals. In N. Rescher (Ed.), *Studies in Logical Theory* (pp. 98-112). Oxford: Blackwell.