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Araştırma Makalesi - Research Article

Some Remarks on Hume, Reichenbach, and Einstein's views on Temporal and Causal Priority in Causation with Objections from Quantum Realm

Hume, Reichenbach ve Einstein'ın Nedensellikteki Zamansal ve Nedensel Öncelik Görüşleri Üzerine Kuantum Alanından İtirazlar ile Bazı Notlar

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ABSTRACT

Stunning new observations and theories deepen the concept of causation. Quantum theory is one of the most striking discovery of contemporary physics, and it challenges many facets of older theories, even though it lies on many assumptions that could not be empirically experimented. In this paper, I will recall the views of Hume, Reichenbach and Einstein about the issue of causation, whereas I will focus on causal priority and temporal priority criteria in causation. Nevertheless, one task that I perform is the interpretation of these ideas by arguing them within the quantum scope. That is, trying to manifest Hume, Reichenbach and Einstein views of causation that I think as close, but I shall avoid putting straight cuts on where they differ. Direction of causal processes is dependent on the direction of time in Hume's sense while Reichenbach explained the direction of time with irreversible processes, even if he follows the temporal priority criteria of Hume. It is stated that there is nothing faster than light by Einstein, as a result, a cause could not pass the upper limit of light. Crudely put, their thoughts all differ from the principles of quantum, because causation (causation might denote a different meaning in quantum realm) may be able to travel faster than light and the common cause principle between events is rejected in quantum realm.

Keywords- Causation, Temporal Priority, Causal Priority, Quantum

ÖZ

Yeni gözlemler ve teoriler nedensellik konseptini derinleştirmektedir. Kuantum teorisi modern fiziğin en çarpıcı buluşlarından biridir, ve kuantum teorisi ampirik olarak test edilemeyen birçok varsayıma dayanmasına rağmen, eski teorilerin birçok yönüne meydan okumaktadır. Bu yazıda, Hume, Reichenbach ve Einstein'ın nedensellik meselesi hakkındaki görüşlerini hatırlatacağım, fakat nedensellikteki nedensel öncelik ve zamansal öncelik kriterlerine odaklanacağım. Yine de yerine getireceğim görev, bu fikirleri kuantum kapsamında tartışarak yorumlamaktır. Yani, Hume, Reichenbach ve Einstein'ın nedensellik hakkındaki görüşlerinin yakın olduğunu, onların farklılaştıkları yerlere keskin sınırlar koymaktan kaçınarak göstermeye çalışacağım. Hume'un anlayışında nedensel proseslerin yönü zamanın yönüne Billiken, Reichenbach zamanın yönünü tersinemez proseslerle

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açıkladı, Reichenbach Hume'un zamansal öncelik kriterini takip etse bile. Einstein tarafından ışıktan hızlı bir şey olmadığı belirtildi, sonuç olarak, bir "neden" ışığın üst limitini geçemez. Kabaca söyleyecek olursam, Hume, Reichenbach ve Einstein'ın düşünceleri kuantum ilkelerinden farklıdır, çünkü nedensellik kuantum alanında farklı bir anlama gelir. Nedensellik Işıktan daha hızlı hareket edebiliyor olabilir ve olaylar arasındaki ortak neden ilkesi kuantum alanında reddedilmektedir.

Anahtar Kelimeler- Nedensellik, Zamansal Öncelik, Nedensel Öncelik, Kuantum

I. ASYMMETRIC CAUSAL RELATIONS IN HUME

A cause must be before an effect according to Hume. He argued three main criteria for a cause to be a cause of an effect. Firstly, a necessary connection between cause and effect is not always observed. We can conceive a case in which an effect would not occur even if there is a cause. When we do not avoid from effect if there is a cause, cause and effect may be necessarily connected to each other. Yet, conceiving the possibility of non-occurrence of the effect leads us to constant conjunction criteria of Hume. He also proposed that there is temporal priority between events. It means that cause must come before an effect. Moreover, they need to be contiguous. Actually, there should not be distant gaps between causal events. Let's look an example in order to expand what Hume means about causation. I can conceive that the moon disappears when I strike a match. There is not a contradiction in here. Therefore, there is not a necessary connection between striking a match and disappearance of the moon. However, there should be a regularity in causal events according to Hume. For instance, if I observe the moon disappears when I strike a match many times, I predict when I strike the match tomorrow, the moon will disappear. However, it may not occur tomorrow, because there is not a necessary connection between disappearance and striking a match.

In a nutshell, temporal priority is one of the ingredients in the concept of causation. According to Hume, "if any cause were co-temporary with its effect" the upshot would be "the utter annihilation of time". (Bennett, 1971:196) He combines the view of contiguity and priority to establish the idea of cause.

We may define a cause to be "An object precedent and contiguous to another, and where all the objects resembling the former are placed in like relations of precedency and contiguity to those objects, that resemble the latter." If this definition be esteemed defective, because drawn from objects foreign to the cause, we may substitute this other definition in its place, viz. "A cause is an object precedent and contiguous to another, and so united with it, that the idea of the one determines the mind to form the idea of the other, and the impression of the one to form a more lively idea of the other." (Hume, 2000:114)

One objection to Hume's argument concerns that some causes might be synchronous with their effects and another objection concerns the suggestion that a cause might occur later than its effect. (Bennett, 1971:196)

Fundamentally, causal relations are assuredly asymmetric. "If having a property *P* is a causally sufficient condition for having a property *Q*, then having property *Q* cannot be causally sufficient condition for having property *P*." (Tooley, 1987:179) Causal necessitation is definitely asymmetric. It is also compatible with the causal relations between states of affairs. If state of affairs *a* causes state of affairs *b*, it is not possible to say that *b* causes *a*. Since, the relation of causation is also necessarily asymmetric. (Tooley, 1987:179) In addition to this, causal relations refer to an ordering of causal priority. The ideas of causal priority and asymmetry of causal relations provide the account of the direction of causal processes. (Tooley, 1987:179) Hume has used the ingredient of temporal priority in the analysis of the relation of cause and effect. It seems that the relation between causal concepts and temporal concepts is crucial in the analysis of causation. Hume has defined a cause to be an object followed by another, and where all the objects followed by objects. Moreover, whether causal processes manifest spatiotemporal continuity or not is another debated issue. Hume alleges that it is logically necessary that causal processes to be spatiotemporal continuous. (Tooley, 1987:181) I will leave spatiotemporal continuity aside, since what I shall focus on is the temporal priority criteria in order to show the similar points has been put forward in Reichenbach, Hume and Einstein's analysis on causation.

II.CAUSAL PROCESSES IN REICHENBACH

Causal priority is the central aspect of the nature of causation and there are two main approaches to the problem of causal priority. The first claim is that one state of affairs can be causally prior to the other if it is also temporally prior. The second approach is that asymmetry of causal relations and the direction of causation. (Tooley, 1987:205) The relation of cause and effect is asymmetric, as the relation of being earlier than is asymmetric. The first account argues that the concept of temporal priority can be analysed in terms of the concepts past, present and future, while the latter account holds that the direction of time can be evaluated with respect to the direction of irreversible processes (Tooley, 1987:207).

Furthermore, Hans Reichenbach offered a mark method so as to determine the direction of causal processes.

Causality establishes not a symmetrical but an asymmetrical relation between two events. If we represent the cause-effect relation by the symbol C, the two cases

C (E1, E2) and C (E2, E1)

can be distinguished; experience tells us which of the two cases actually occurs. We can state this distinction as follows:

If E1 is the cause of E2, then a small variation (a mark) in E1 is associated with a small variation in E2, whereas small variations in E2 are not associated with variations in E1.

If we wish to express even more clearly that this formulation does not contain the concept of temporal order, we can express it in the following form, where the events that show a slight variation are designated by E*:

We observe only the combinations

E1E2 E1*E2 E1E2*

and never the combination

E1*E2. (Reichenbach, 1951:136-7)

The direction of causal processes is defined by the combinations E1E2, E1*E2 and E1E2* occurrence, while the combination E1*E2 does not occur. Besides, Reichenbach embarked on defining the direction of causation by utilizing from irreversible processes. This was an attempt to explain the direction of time by appealing the direction of irreversible processes. This way of establishing the direction of causation grounds on the notion of entropy or the exhibition of non-entropic irreversibility. (Tooley, 1987:221) It is asserted that entropy never decreases in any closed system by the second law of thermodynamics. In view of the fact that increasement in entropy, the direction of time is defined. In brief, the direction of time is identifiable by means of irreversible processes according to Reichenbach. 2nd law of thermodynamics states that there exists a quantity entropy which remains constant in some changes, but increases in some changes whereas it is impossible that it decreases. Irreversible processes are cases in which entropy increases. Reichenbach also says that the second law of thermodynamics is a statistical law, not a deterministic law.

Whether causal relations fall under probabilistic laws or not is also another crucial issue in the analysis of causation. Reichenbach holds that causation allows for the possibility of probabilistic causal relations. He suggests that causal concepts, such as the direction of causal processes, might be explained in terms of statistical relations. (Tooley, 1987:228) Reichenbach formulated the principle of *common cause* by stating that "the frequent occurences of causal processes with a common centre has the consequence that certain types of events occur at different places, at the same time, much more frequently than would be the case if their occurrences were independent." (Tooley, 1987:230) Reichenbach states that when two events co- occurred improbably, there must be a common cause. Causal processes are variant to a central event according to him, he clearly explained the idea of *conjunctive fork* in order to show their dependency. Conjunctive fork is a kind of statistical relation between events, A, B and C. Supposing that A and B are events involved in two causal processes with a common centre, C is the central event which A and B are related. (Tooley, 1987:231) According to his own words:

In order to explain the coincidence of *A* and *B*, which has a probability exceeding that of a chance coincidence, we assume that there exists a common cause *C*. If there is more than one possible kind of common cause, *C* may represent the disjunction of these causes. We will now introduce the assumption that the fork *ACB* satisfies the following relations:

(1)P(*C*, *A.B*) = P(*C*, *A*) . P(*C*,*B*)

(2)P(not *C*, *A.B*) = P(not *C*, *A*) . P (not *C*, *B*)

(3)P(*C*,*A*) > P(not *C*, *A*)

(4)P(*C*, *B*) > P (not *C*, *B*) (Reichenbach, 1971:159)

Let's suppose that two toy boats are floating in a pond where a rock is dropped: "The probability that boats will be capsized given that a stone of a certain size is dropped in a certain place, from a specific height is equal to the probability that one of the boats will capsize, under those conditions, times the probability that the other's capsizing." (Tooley, 1987:232) The events form a conjunctive fork in this example case. Causal priority is defined in terms of these aspects of causal processes by Reichenbach. In his book *The Direction of Time*, he differentiates open and closed conjunctive forks. If (*a*,*e*,*b*) is a conjunctive fork and *e* is the common effect of *a* and *b*, then there is an event *c* such that (*a*,*c*,*b*) is a conjuntive fork, and *c* becomes the common cause of *a* and *b*. In addition to this, there may also be cases in which (*a*, *c*,*b*) is a conjunctive fork, and *c* is the common cause of *a* and *b*, but there may not be an event *e* such that (*a*,*e*,*b*) is a conjuntive fork and *e* is the common effect of *a* and

b.(Tooley, 1987:233) "A conjuntive fork (*a*,*c*,*b*) is open if and only if there is no *e* , distinct from *c*, such that (*a*,*e*,*b*)is a conjuntive fork. A conjunctive fork (*a*,*c*,*b*) is closed if and only if (*a*,*c*,*b*) is closed."(Tooley, 1987:233)

When we know the initial conditions, we can predict the future states resulting from these conditions to a limit. The probability of the prediction increases approaching *1* with more precise characterization. Nature's governed by strictly causal laws means that we can predict the future states with a determinate probability close to certainty. Reichenbach did an empiricist analysis of the concept of causality. The laws of classical physics are temporally directed laws in which causal chains extend in the direction of time. The principle of causality in classical physics is not compatible with quantum physics. Since in the book *Philosophical Foundations of Quantum Mechanics* Reichenbach says that there is not a construal of quantum mechanics independent of causal anomalies. (Reichenbach, 1946:44) A causal anomaly is a violation of the common cause principle that I have mentioned above. The order of time depends on normal causality according to Reichenbach, but he insists on that neither theory is sufficient for giving a consistent definition of the direction of time. It is possible to define a direction of time for only sections of time, not for the whole time.

Both philosophical and physical theory of space& time grounds on the principle of causality. He says that the direction of time is definable by means of irreversible processes but the second law of thermodynamics is a statistical law, therefore it seems that some processes are reversible. Most of the time, we use the assumption of causality in conditional form. However, conditional form is not enough to guarantee the truth of prediction. Since we may not include all the relevant parameters in our prediction. There may be some other factors that we ignore but influence on the occurrence. (Reichenbach, 1971:82) The probability of the prediction can be improved by including more elements. One of the most striking outcomes of this new way of understanding of causality is that extending it to an unconditional form. At least in the framework of classical physics, conditional form of causality helps us to qualify our predictions, but in quantum physics, conditional form is abandoned. (Reichenbach, 1971:83) He formulated a new determinism in physics by proposing the role of statistical laws, and the probability of prediction increases towards the value 1, even though it never becomes 1, namely there is not decisive certainty.

III.CAUSALITY AND DIRECTION OF TIME IN QUANTUM REALM AND REICHENBACH'S ORTODOX VIEW

Quantum mechanics has an indeterministic character which has been expressed in Heisenberg's indeterminacy principle. There is always a limitation for measurement which leads us to limitation of prediction. As a result, even if we have done very precise measurements, we could not predict the future states necessarily. Actually, the conditional form of causality is physically meaningless in the *indeterminacy principle* of quantum physics. In sum, quantum physics is based on causal indeterminism. It is difficult for us and Reichenbach to answer what the direction of time is as a whole. The question of the direction of time as a whole is a different question of time direction observed by us. Parts of it might have directions, but it is not necessary to assume that it has one direction as a whole. As it seems that Reichenbach offered an analysis of time by formulating a conditional character of causality in classical physics, then he proposed that the role of probability in the occurrence of events, and said that comprising all relevant parameters in our computation is difficult. *The unconditional form of causality* has also been considered by Reichenbach in the analysis of the direction of time in quantum realm. Definition of time order depends just as much as on classical physics, while depending on quantum physics. Thus, he has not considered the direction of time as a whole.

Within what Reichenbach holds about the direction of time, the role of temporal priority is crucial. Because he does not ignore *the conditional form of causality* in classical physics, even though he argues that some processes might be reversible. Since the second law of thermodynamics is a statistical law even if the direction of time is definable by means of irreversible processes and the second law of thermodynamics states the entropy's decrease is impossible. The role of probability is important in causation. He has brought a statistical character to causation. Causal connection expresses a conditional relation according to him. He has already told that a cause must precede its effect in *The Rise of Scientific Philosophy*. (Reichenbach, 1951:148) Therefore, I shall now remark that Reichenbach does not tried to give the direction of time as a whole. He does not ignore the priority criteria in causation. The point that leads our minds get confused is that whether it is a kind of temporal priority in which cause must precede its effect and temporality is based in our observations, such as past-future-present or, it includes causal priority in which time is not uniform, namely time is understood by means of the notion of entropy and the role of probability in laws. We push the probability as close to certainty as we want, but we will never do the exact prediction. Since conditional form of causality also gained a probabilistic character. As such, the causal priority might not necessarily imply that temporal priority when time is defined by means of probabilistic laws.

IV. CONCLUSION

It is hard to prove the aforementioned principles of quantum theory, thus, they are not easy to experiment, or they do not tend to be experimented in essence. To conclude, we might follow the traditional meaning of

causation, rather than considering a sort of influence between events. As it might provide us to see the infrastructure of the causation, but this method is not abandoning quantum realm. Crudely put, it is barely an approach in order to see the similar points in Einstein, Hume and Reichenbach's arguments about causation. We must also think that Einstein, Hume and Reichenbach's arguments are not tantamount, since they all describes an aspect of causation, even though they have closely related. Considering the issue by utilizing their view illuminates temporal priority and causal priority are two traditional grounding of causation. A cause always precedes its effect in Hume's idea of cause, and designates his fundamental view of causation. Direction of causal processes is dependent on the direction of time. Causal processes should be asymmetric, in some sense.

Causal processes gained a statistical character in Reichenbach and as he offers that causal processes are dependent on a common event. He tried to explain the direction of time by appealing irreversible processes, but this is appropriate to express the direction of a part of time, not the time as a whole. The order of time is variant to normal causality according to Reichenbach, whereas neither theory is enough to define the direction of time as a whole. Since it depends on how you define time. It is committed that it has probabilistic laws. Causal link between events will still express a conditional relation according to him, and distinguishing cause from effect will be a problem. He does not abandon the temporal priority criteria in causation. Whether it is a sort of temporal priority in which cause must precede its effect and temporality is based in our observations, such as past-future-present or, it includes causal priority in which time is not uniform, namely time is understood by means of the notion of entropy and the role of probability in laws are the questions might also be addressed. The probability may become as close to certainty as we want, but we will not do the exact prediction. Conditional form of causality may also have gained a probabilistic character. As such, the causal priority might not necessarily imply temporal priority if time is defined by means of probabilistic laws. Einstein is also insisting on that there is nothing faster than the speed of light, therefore, he puts a restriction to the causation, by appealing the upper limit of light. Indeed, there is not a cause travels faster than light, so it is not possible to change causally related events, they are fixed chains.

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