The Ontology of Causal Process Theories

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Abstract

There is a widespread belief that the so-called process theories of causation developed by Wesley Salmon and Phil Dowe have given us an original account of what causation really is. In this paper, I show that this is a misconception. The notion of "causal process" does not offer us a new ontological account of causation. I make this argument by explicating the implicit ontological commitments in Salmon and Dowe's theories. From this, it is clear that Salmon's Mark Transmission Theory collapses to a counterfactual theory of causation, while the Conserved Quantity Theory collapses to David Fair's phsyicalist reduction of causation.

Keywords: Dowe, Salmon, Process Theories of Causation, Ontological Commitments.

1. Introduction

There is a widespread belief that the so-called process theories of causation developed by Wesley Salmon and Phil Dowe have given us an original account of what causation really is. The idea is that they offer us an alternative to counterfactual theories of causation, which should be more suitable for conceptual analysis. (see for example Chakravartty 2005, Handfield, Twardy, Korb & Oppy 2008)) In this paper, I will show that this is a misconception. The notion of "causal process" does not offer us a fundamentally new ontological account of causation. This is quite a contentious claim, since both Salmon and Dowe explicitly state that the aim of their theory is exactly to give a novel theory about what causation is in the real world. Nevertheless, I will show in this paper that this claim is not tenable by closely examining the fundamental ontological entities which figure in both theories.

In the next part of this paper, I will discuss Russell, Dowe and Salmon's process theories of causation with special attention to their general ontology. The aim of this part is to unearth the ontological commitments of these three theories.[1] What kind of ontology is presupposed by them, what are the fundamental entities of this ontology, and which part is played by causation? Russell's theory is incorporated because he developed the central intuition of Dowe and Salmon's theories. In the third part, I will then single out one specific part of their general ontology, namely the ontologically fundamental causal notion(s), the notion(s) in terms of which all other causal notions are defined and which is supposed to form the basic ontological entity, namely what causation is supposed to be in the real world. I will show that in Salmon's account, this notion is indeed counterfactual dependence. Furthermore, I will show that the ontological content of Dowe's theory really boils down to a physicalist reductionism which does not constitute an advance over David Fair's transference theory of causation. Because of these two points, neither Salmon nor Dowe can be said to have given an original ontological account of causation.

It is important to note that I do not claim that Salmon or Dowe would agree with what is stated about their theories. On the contrary, the aim of this paper is to show that their definitions and characterizations, if interpreted rigorously and literally instead of intuitively, contain some hidden ontological assumptions which will turn out to be problematic. Because of this hidden ontology, both Salmon and Dowe's theories are ruled out as ontological analyses of causation.

2. Causal process theories and their ontology

2.1. Bertand Russell & Causal Lines

In "*On the notion of cause, with applications to the free-will problem"*, Bertrand Russell famously states that the concept of cause is of no use at all to the so-called advanced sciences.

> The law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm. (Russell 1953, p 387).

In the fifth chapter of "*Human Knowledge"*, however, Russell allows causation to come back through the back door. First, Russell confirms that the traditional common sense and philosophical account of

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[1] I will use the terms "ontology" and "ontological commitment" in a strict sense, as referring only to those entities that are ontologically basic. So, if an ontological theory for example defines molecules in terms of atoms and not vice versa, I will say that this theory is ontologically committed to atoms, but not to molecules.

"cause" has no place in science. (Russell 1948 , p 474). It should be replaced by the notion of "causal law". Russell distinguishes three different kinds of causal laws, two of which, those expressed by differential equations and statistical laws, are relatively unproblematic and self-evident. (Russell 1948, p 474 & 477) The third, howeifver, is not. This is the so-called causal law of quasi-permanence, which is more or less a general version of Newton's first law of motion. Russell states that the existence of this law explains the success of the common-sense notion of "things" and the physical notion of matter.

> The causal law that I suggest may be enunciated as follows: "Given an event at a certain time, then at any slightly earlier or slightly later time there is, at some neighbouring place, a closely similar event." (Russell 1948 p 476)

What is striking here is that Russell believes that the concepts of thing and matter need explaining at all. This shows that he does not believe in an object ontology. The fundamental entities of the universe are not "things", but rather "events" and "time" (or rather, an ordered collection of different points in time). Russell therefore defines the concept of causal line in terms of events and time:

> A "causal line", as I wish to define the term, is a temporal series of events so related that, given some of them, something can be inferred about the others whatever may be happening elsewhere. (Russell 1948, p 477)

Note that the concept of causation is left unanalyzed at the ontological level. It is defined only in epistemological terms, by referring to our capacities to infer: if we can infer some properties of a certain event from properties of a different event at a different time, we have a causal relation. This presupposes that there are certain regularities or laws of nature which allow us to make this kind of inferences. Therefore, these natural laws or regularities form an additional basic concept in Russell's ontology, next to events and time

2.2 Wesley Salmon's causal process theory.

We have already seen that Russell's ontology has events, time and natural laws and/or regularities as its basic categories. Salmon's ontology is quite different.

> One of the fundamental changes that I propose in approaching causality is to take processes rather than events as basic entities. (Salmon 1984, p 139, see also p 182-183)

Salmon does not attempt to formulate a rigorous definition of the notion of "process", but appeals to intuitions and examples instead.

> I shall not attempt any rigorous definition of processes; rather, I shall cite examples and make some very informal remarks. The main difference between events and processes is that events are relatively localized in space and time, while processes have much greater temporal duration. In space-time diagrams, events are represented by points, while processes are represented by lines. A baseball colliding with a window would count as an event; the baseball, traveling from the bat to the window, would constitute a process. The activation of a photocell by a pulse of light would be an event, the pulse of light, traveling, perhaps from a distant star, would be a process. (Salmon 1984, p 183)

It is at this point that Salmon appeals to Russell's concept of causal line. Salmon does not state that he really uses this concept, but only that his notion of a process is in non-specified way similar to the notion of a causal line. Salmon then cites Russell in the following way:

> A causal line may always be regarded as the persistence of something – a person, a table, a photon, or what not. Throughout a given causal line, there may be constancy of quality, constancy of structure, or a gradual change of either, but not sudden changes of any considerable magnitude. (Russell, quoted in Salmon 1984, p 140)

Salmon conveniently leaves out the most important part of this passage in the original text:

> **A causal line, as I wish to define the term, is a temporal series of events so related that, given some of them, something can be inferred about the others whatever may be happening elsewhere.** A causal line may always be regarded as the persistence of something – a person, a table, a photon, or what not. Throughout a given causal line, there may be constancy of quality, constancy of structure, or a gradual change of either, but not sudden changes of any considerable magnitude. (Russell 1948, p 477, my emphasis)

The part Salmon strategically left out is precisely the part where Russell defines the notion of causal line with regard to his event ontology.[2] Strangely enough, Salmon does mention Russell's definition in terms of events at page 144 of (Salmon 1984)

In itself, this is not a problem, since Salmon does not pretend to literally adopt Russell's concept, but only to incorporate some of its intuitions. If he would state that causal lines and (causal) processes really are ontologically speaking the same things and that causation can and should be defined in terms of causal processes, he would end up in a vicious circle. A causal line is defined in terms of events and causal relations between events. If a causal line would be the exact same thing as a process, the notion of process cannot be used to define causation, since causal relations would then be used to define causation. Therefore, a causal line cannot be equal to a process in a too strict way.

We have seen that Salmon does not define the notion of process. Therefore, the most plausible way to interpret his theory is to take the notion of process as primitive. This compels Salmon to a process ontology, which is in accordance with the citation given above. Chris Hitchcock also takes Salmon's ontology with respect to the Mark Transmission Theory to be a process ontology (Hitchcock 1995, p 306 & 314).

The concept of "process" then is the first central concept of Salmon's theory. The second one is the distinction between "causal processes" and "pseudo-processes", the third one the concept of "causal interaction". In order to make the difference between causal and pseudo-processes, Salmon introduces the concept of "mark transmission". A causal process is capable of transmitting a mark, while a pseudo-process is not. It should be noticed that this criterion functions more or less as a proxy. We can indeed distinguish causal processes from pseudo-processes by means of their ability to transmit a mark. Yet this ability is itself only a symptom of a deeper ontological distinction which separates pseudo-processes from causal processes at the ontological level. The mark transmission criterion is merely a method by which we as human agents can spot the ontological difference between causal and pseudo-processes.(Salmon 1984, p 142 & 146) This ontological difference is defined in terms of structure: a causal process transmits its own structure, while a pseudo-process does not. (Salmon 1984 p 144) Both the definition of mark and mark transmission are given in the following principle:

> MT: Let P be a process that, in the absence of interactions with other processes, would remain uniform with respect to a characteristic Q, which it would manifest consistently over an interval that includes both of the

[2] Phil Dowe, by the way, does exactly the same, see (Dowe 2000) p 63.

> space-time points A and B (A≠B). then, a *mark* (consisting of a modification of Q into Q'), which has been introduced into process P by means of a single local interaction at point A, is *transmitted* to point B if P manifests the modification Q' at B and at all stages of the process between A and B without additional interventions. (Salmon 148).

As Salmon himself admits, this principle is formulated by means of counterfactual statements.

The final basic concept in Salmon's theory is that of *causal interaction*, which is caught by the following principle:

> CI: Let P1 and P2 be two processes that intersect with one another at the space-time point S, which belongs to the histories of both. Let Q be a characteristic that process P1, would exhibit throughout an interval (which includes subintervals on both sides of S in the history of P1) if the intersection with P2 did not occur; let R be a characteristic that process P2 would exhibit throughout an interval (which includes subintervals on both sides of S in the history of P2) if the intersection with P1 did not occur. Then, the intersection of P1 and P2 at S constitutes a causal interaction if:
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> (1) P1 exhibits the characteristic Q before S, but it exhibits a modified characteristic Q' throughout an interval immediately following S; and
> (2) P2 exhibits the characteristic R before S, but it exhibits a modified characteristic R' throughout an interval immediately following S. (Salmon 1984, p 171)

This principle CI, just as MT, explicitly uses counterfactual statements.

Salmon's theory was amply criticized, most importantly by Phil Dowe (Dowe 1992a, 1995), Philip Kitcher (1989) and Chris Hitchcock (1995). The main point was the counterfactual formulation of both MT and CI. Not only are counterfactuals seen as too context-dependent and involving hidden powers (Dowe 1992a, p 207), but the fact that the essential concepts of Salmon's process theory involve counterfactuals seems to indicate that Salmon's theory is in fact a counterfactual theory of causation. (Kitcher 1989, p 472). In the third part of this paper, I will show that this is indeed the case. As a result, Salmon modified his process theory in such a way that the result can best be regarded as a different theory, which I will discuss in parallel with Dowe's Conserved Quantity Theory.

2.3 The Conserved Quantity Theory

In the paper in which he first criticized Salmon, Dowe also presented his own alternative, the Conserved Quantity Theory. The theory did not change significantly since it was first presented. In its most concise form, it is quite accurately represented in the following way:

> DEFINITION 1: A causal interaction is an intersection of world lines which involves exchange of a conserved quantity
>
> DEFINITION 2: A causal process is a world line of an object which manifests a conserved quantity
>
> A *world line* is the collection of points on a spacetime (Minkowski) diagram which represents the history of an object. A *conserved quantity* is any quantity universally conserved according to current scientific theories. Some conserved quantities are mass-energy, linear momentum, angular momentum, and charge. An *exchange* means at least one incoming and at least one outgoing process manifest a change in the value of the conserved quantity. "Outgoing" and "incoming" are delineated on the spacetime diagram by the forward and backward light cones, but are essentially interchangeable. The exchange is governed by the conservation law. The intersection can therefore be of the form X, Y, λ or of a more complicated form. An

> *object* can be anything found in the ontology of science (such as particles, waves or fields), or common sense. (Dowe 1992a, p 210, see also Dowe 1992b, p 126-127)

Dowe's ontology is clear: it is an object ontology. Contrary to Salmon, processes are not taken as primitive, but are defined in terms of objects. World lines are not ontological entities in themselves, but are a means of representing objects through time and space. The notion of object itself is primitive and is left unanalyzed. Identity over time is included as part of this primitive concept. (Dowe 2000 p 91) Therefore, time-wise gerrymanders are excluded from the start. Space-wise gerrymanders seem to be excluded as well, since Dowe refers to an example of a space-wise gerrymander as a *putative* object, not as an object. (Dowe 1995, p 328) One plausible idea is that they are excluded because space-time gerrymanders do not belong to the ontology of science or common sense.

Responding to the objections by Dowe and Kitcher, Salmon adopted a theory which is very similar to Dowe's. It is expressed in the following definitions.

> DEFINITION 1. A causal interaction is an intersection of world-lines which involves exchange of a conserved quantity.
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> DEFINITION 2. A causal process is a world-line of an object that transmits a nonzero amount of a conserved quantity.
>
> DEFINITION 3. A process transmits a conserved quantity between A and B (A≠B) if and only if it possesses [a fixed amount of] this quantity at A and at B and at every stage of the process between A and B without any interactions in the-open interval (A, B) that involve an exchange of that particular conserved quantity. (See Salmon 1994 & Salmon 1997, The third definition is Salmon's revised 1997 version. I have used the term "conserved" quantities, because Salmon states (Salmon 1997, p 462) that he prefers this term to the term "invariant" which is used in definitions 1 and 2 in (Salmon 1994)

Just as Dowe, Salmon defines process in terms of objects instead of taking them to be primitive. This entails that Salmon switched from a process ontology to an object ontology. The only remaining difference between Salmon and Dowe's versions of the Conserved Quantity Theory is definition 3. This is important for us, because it points to a difference in ontology between Salmon and Dowe. As we have seen, both have adopted an object ontology, since both define processes in terms of objects. For Dowe, however, objects possess conserved quantities. Salmon on the other hand, as becomes clear in definition 3, is convinced that objects do not possess (or transmit) conserved quantities. Only causal processes do.

This is strange, because Salmon does define causal process in terms of objects. Yet these objects do not in themselves possess conserved quantities. Conserved quantities seem to be some kind of emergent property which "appears" when an object is thought of as a causal process. Because of this, the fact that conserved quantities are not tied to objects, the identity of conserved quantities over time is independent form the identity of objects over time as well.

The question now is: why doesn't Salmon consider conserved quantities to be possessed by objects? There seems to be no real gain in refusing to do this. It is counterintuitive (how can a property which is not instantiated by an object *in se* suddenly arise when this object is considered as a process?) and it makes his ontology needlessly more complex. The answer can, I believe, be found in Salmon's general ontology. As we have seen, by following Dowe in defining processes in terms of objects, Salmon apparently changed his ontology from a process to an object ontology. I believe that the fact that Salmon disconnected the identity of conserved quantities over time from that of objects can best be understood by presuming that Salmon still intuitively thinks in terms of some kind of process ontology. Nevertheless, he does commit himself to a theory which presupposes an object ontology. In such an object ontology, the identity of an object over time would not be primitive, but would be defined by the transmission of a conserved quantity. Nevertheless, Salmon never explicitly stated that objects should be defined in terms of the transmission of conserved quantities. A plausible reason for this is that he is not aware that the Conserved Quantity Theory commits him to a different ontology than the Mark Transmission Theory. If he would have paid more attention to both his own and Dowe's underlying ontology, he would have noticed this, and would probably have reformulated Definition 2 in which he defined processes in terms of objects, possibly by stating explicitly that conserved quantities are possessed by processes rather than objects.

3. The ontology of causal processes

In this part, I will discuss the three theories mentioned again, but with a different aim. We will go in search of the fundamental causal ontological relation in each theory. By "fundamental causal ontological relation", I mean the relation in terms of which what we call "causal relations" are defined. If interpreted in an ontological sense (which is what Salmon and Dowe clearly do) it is this relation which can be said to be really "out there" in the real world. As already said, this takes us beyond what Salmon and Dowe themselves would probably agree with. Nevertheless, my analysis remains strictly internal. It only refers to the definitions and characterizations Dowe and Salmon themselves provide. The only thing which happens is that the implicit ontology of their theories is made explicit.

3.1 Russell

As we have seen, Russell's ontology is primarily an event ontology. The basic categories of his theory, and therefore the entities out of which the universe is built according to Russell, are events, time, and regularities between events. Events are discontinuous and disparate. Therefore, Russell needs a principle or concept by which he can show that the universe, which according to him essentially consists of disparate events and laws or regularities between events, appears to the (scientific) human eye as consisting of orderly objects which (seem to) persist through time. He introduces the concept of causal line to make this connection between his basic ontology on the one hand and the scientific and common sense notions of "thing", "person" and "matter" on the other.

> When "substance" is abandoned, the identity, for common sense, of a thing or person must be explained as consisting in what may be called a "causal line".(Russell 1948, p 476)

As we have seen, the term "causal" in the concept of "causal line" is defined in an epistemological way. We construct, as it were, an object in our minds with the help of an epistemological relationship between these events. As already said, this epistemological relation consists out of the fact that if we know something about one of them, we can infer something about all of the others. It is this epistemological relationship that we call causation. If we can indeed infer things in the way explained above, we are entitled to say that each of these events is the cause of its immediate successor in time. Therefore, we are also entitled to group all of these events under a single "object". As a consequence, Russell's concept of causal line does not have anything to do with a metaphysical or ontological theory about the nature of causation. Russell uses one specific kind of causation to defend his event ontology, namely by showing that by applying this concept, an event ontology is compatible with the common-sense notions of "thing" and "person", and the scientific notion of "matter". His theory of causation is therefore not a theory about what causation is. Russell does not say anything about this. His account of causation is purely epistemological.

In summary, the concept of "causal line" has a definite use in Russell's ontology. Without it, we would be left with a world consisting only of a huge network of events which are related to each other by natural laws and regularities. The concept of causal line allows Russell to make the connection between the world how it really is, a huge network of disparate events, and the world how we perceive it, consisting of a much more manageable number of common-sense objects. Most importantly, a causal line is called a *causal* line because it is regarded as a chain consisting of a number of causal relations. This point may seem quite trivial at this moment, but we will see in the following part that the reason why a causal process or a causal line is called a *causal* line can be quite telling.

3.2 The Mark Transmission Theory

Step 1: the ontological core of the Mark Transmission Theory is formed by the CI principle

Concerning Wesley Salmon's Mark Transmission Theory, however, things are a lot less clear. There is an important question concerning the Mark Transmission Theory which is often neglected. What is it exactly that is "causal" about causal processes? Why is a causal process called a "causal process"? In contrast to a causal line, there is no feature of a causal process in itself that has anything to do with causation. There is only an external reason. A causal process is called causal because it propagates a so-called causal influence (Salmon 1984, pp 154-155). A causal influence in its turn is only called causal because it can engage in a causal interaction, as becomes clear by the examples Salmon uses. (Salmon 1984, pp 146-147) Therefore, causal processes are called causal because they can participate in causal interactions. This means that "causal interaction" is a basic notion with respect to causal processes. Therefore, the notion of causal interaction is primitive with respect to that of causal process. This entails that the Mark Transmission theory is ontologically committed to causal interactions, and not to causal processes.

Let us now recall the two central principles of the Mark Transmission theory.

> MT: Let P be a process that, in the absence of interactions with other processes, would remain uniform with respect to a characteristic Q, which it would manifest consistently over an interval that includes both of the space-time points A and B (A≠B). then, a *mark* (consisting of a modification of Q into Q'), which has been introduced into process P by means of a single local interaction at point A, is *transmitted* to point B if P manifests the modification Q' at B and at all stages of the process between A and B without additional interventions. (Salmon 148).

> CI: Let P1 and P2 be two processes that intersect with one another at the space-time point S, which belongs to the histories of both. Let Q be a characteristic that process P1, would exhibit throughout an interval (which includes subintervals on both sides of S in the history of P1) if the intersection with P2 did not occur; let R be a characteristic that process P2 would exhibit throughout an interval (which includes subintervals on both sides of S in the history of P2) if the intersection with P1 did not occur. Then, the intersection of P1 and P2 at S constitutes a causal interaction if:
>
> (1) P1 exhibits the characteristic Q before S, but it exhibits a modified characteristic Q' throughout an interval immediately following S; and

(2) P2 exhibits the characteristic R before S, but it exhibits a modified characteristic R' throughout an interval immediately following S. (Salmon 1984, p 171)

In the MT principle, we can see that causal processes are defined in terms of the transmission of a characteristic structural feature Q. From principle CI, on the other hand, it is clear that interactions are defined in terms of modifications of this structure. This presents a problem. In the CI principle, Salmon states that causal interactions are modifications of the structure of a process. Obviously, if a process does not have a structure, it is automatically ruled out from participating in a causal process. Thus, principle CI implies that the only processes which can participate in causal interactions are processes with a stable structure. Let us now look again at the MT principle. This principle basically states, as we have seen, that the only processes which can participate in a causal interaction are processes with a fixed structure. But this is exactly what is already implied by CI! The only additional information in MT, information which does not follow directly from CI, is the Mark Transmission criterion. But, as we have seen, the Mark Transmission criterion is only a proxy. It is a method by means of which we can determine the ontological status of a process. It does not give any extra ontological information about how causal process are in themselves. All the required properties a process should have in order to participate in a causal interaction is already present in CI. Therefore, the ontological distinction between causal processes and pseudo-processes, i.e. what causal and processes and pseudo-processes *are* in themselves, can be made entirely on the basis of CI. As already said, the only extra information we get from MT is how we, as human observers, can spot the difference between causal and pseudo-processes. But as we have seen already, this does not contribute to our understanding of what causal or pseudo-processes are like ontologically speaking, independent of human observers.

In conclusion, the ontological core of the Mark Transmission Theory is, contrary to what its name might suggest, formed by the concept of "causal interaction" and the CI principle.[3]

Step 2: Causal interactions are defined in terms of counterfactual dependence

Causal interactions are, as we have seen, defined as intersections between processes which result in the modification of structural properties of both these processes. These modifications of processes are defined in terms of counterfactual statements. Since "causal interaction" is the basic causal concept in Salmon's theory, every effect has to be the result of a causal interaction.

Now, what does an effect consist of according to the Mark Transmission Theory? As we have seen, a causal interaction consists of a modification of the structures of two different processes which spatiotemporally intersect with each other. Let us take an easy example to make the argument more clear. Suppose there is a collision of two billiard balls. The effect of this collision is that one of the balls is rolling in one specific direction while the other is rolling in a different direction at a certain given time t. Let us call this state of affairs E. Now, the collision between the two balls is a causal interaction if both balls were rolling in a different direction at a time t'<t and if they would have continued to do so at t, if they would not have intersected spatiotemporally. If they hadn't, E would

[3] One of the important consequences of this is that the criticisms of the Mark Transmission Theory which focus on the concept of "mark" (see Dowe 1992a, pp 200-202) miss the point. By stating that some pseudo-process can allow the transmittance of a mark, they criticize the test but not the theory itself, since its central statement, that only processes which possess permanent structural characteristic features can engage in causal interactions, remains untouched.

not have been the case. Let us call the event of both balls interacting spatiotemporally C. In summary, if the balls would not have collided (C), they would have gone on in the same direction, or, in other words, E would not have been the case. So, given a certain state of affairs, there is only one way of knowing whether this state of affairs was produced by a causal interaction, namely by discovering a relation of counterfactual dependence between the causal interaction and the effect it produces.

Contrary to the Mark Transmission criterion, counterfactual dependence is not a proxy. It is not a way of knowing a different and more fundamental relation such as, for example, “production”. Terms such as “production” do not figure in the definition of CI, while counterfactual dependence is essential to it. Therefore, counterfactual dependence is the essential element in the CI principle.

Step 3: counterfactual dependence is the fundamental causal term in the Mark Transmission Theory

This follows from the combination of step 1 and step 2. From the fact that the MT criterion does not offer us any extra ontological information and from the fact that the essential part of the CI principle is counterfactual dependence, it follows that counterfactual dependence is indeed the basic ontological relation between a causal interaction and its effect. Therefore, we end up with a slightly modified classical counterfactual account of causation. The only difference with other counterfactual definitions of causation is that causes are called “causal interactions”. This view is supported by Philip Kitcher who has already remarked (Kitcher 1989 p 472) that the Mark Transmission Theory should be seen as a counterfactual theory of causation with some extra machinery attached to it.

3.1 The Conserved Quantity Theory

As we have seen, the two central definitions of Dowe’s Conserved Quantity Theory are the following two propositions:

> CQ1: A causal process is a world line of an object that possess a conserved quantity
>
> CQ2: A *causal interaction* is an interaction of world lines that involves an exchange of a conserved quantity. (Dowe 2000, p 90)

Salmon states that causal processes are called “causal” because of their ability to engage in a causal interaction. As a result of this, the concept of causal interaction is primitive to that of causal process in the Mark Transmission Theory. Dowe, on the other hand, gives a supplementary reason. He states that this concept captures the notion of immanent causation, the causation implied when we state that an object’s inertia is the cause of its continuing motion, which he believes to be an important yet often neglected part of causation. (Dowe 2000 p 52). A causal process is in this case called “causal” because it defines a specific kind of causation. Dowe argues for this in the following way:

> The spaceship moves according to Newton’s First Law, which states that a body will continue in motion unless acted on by a force. But consider Aristotle’s physics. According to Aristotle, a body requires a force for it to continue in motion. According to Aristotle, then, the spaceship comes to a halt, or if it does continue to move, then there must be some external force acting. So in the case where the spaceship moves with constant motion, Newton and Aristotle disagree about what is the cause of that motion. Newton says the cause is the body’s inertia, Aristotle says the cause is some unknown field. Both offer causal explanations of the motion.

The idea is that there are two very distinct kinds of causal explanation, and that only the first, the Aristotelian, can be described by referring to causal interactions. Therefore, we need the concept of "causal process" to describe the second. This second concept of causal process, as Dowe describes it, reminds us of Bertrand Russell's causal theory of identity, in which identity is defined in terms of causation by saying that the state of an object at a certain point in time is the cause of its state at the following point in time. Dowe's theory, however, has to be different from Russell's, since Dowe's aim is to define or at least describe causation, while Russell's theory leaves open the question what causation really is. (see Dowe 2000, p 105).[4]

Step 1: immanent causation a la Dowe is not an ontological notion

Let us take a closer look at the specific nature of immanent causation. Since Dowe wants this to be an original ontological concept, he cannot define causal processes in terms of causal interactions. If he would, the CQ theory would be open to the same observations as those mentioned above with respect to the Mark Transmission Theory. Nevertheless, immanent causation is still formulated (by Dowe himself) in terms of causes and effects and the relation between the two. The movement of the spaceship is the effect, the inertia is the cause, and (immanent) causation is the relation between the two. The idea that Dowe states that causation is essentially not a relation between cause and effect, but a process, is therefore false.

Once we ask ourselves what the cause, the effect and the relation between the two are in this example, however, there appear to be some essential problems with Dowe's ambition. Dowe cannot state that the movement of an object at a certain time t is the cause of its movement at a certain time t' (t'>t). This would lead to a causal theory of identity over time in which causation itself is unidentified. Neither can he say that the inertia of the object is the cause of its movement at t, since this is just a reformulation of the previous statement. The only way left in which it could be possible for the inertia of our spaceship to be the cause of its movement is by saying that the causal relation in question is a relation between the inertia and the movement of an object at the same point of time. So immanent causation entails that the inertia of an object (for example a spaceship) at t is the cause of its movement at t. More generally, it entails that the fact that a certain object has a certain property is the cause of the fact that it has a different property. This is why immanent causation is called "immanent", since both the cause and effect are instantiated by the very same object at the very same time, which rules out the concept of causal interaction.

The question is whether this kind of relation can still be legitimately called "causation". The relation between movement and inertia in the statement "the movement of an object is caused by its inertia", for example, is more tautological than causal. Inertia is just another (scientific) term for movement (at least for the kind of movement involved in this example). One could say with equal right that the roundness of an object is caused by its circularity. If such a relation is considered to be causal, it can only be so in a very broad, conceptual sense. In any case, it is far removed from Dowe's intention, which is to give an empirical analysis of causation, and therefore of empirical causal relations.

It is an essential feature of an empirical causal relation that its converse is a possibility. If we say, for example, that the throwing of a rock was the cause of the window breaking, it is necessary that we

[4] More correctly, Dowe rejects David Armstrong's causal theory of identity, but this automatically entails rejecting Russell's theory as well.

see it is a possibility that the rock did not break the window because, for example, the window is too solid. If this is not the case, the statement does not contain any empirical information, and is therefore not a possible subject of an empirical/ontological analysis of causation. The inertia case is an example of this. It is not possible to imagine a case in which an object's inertia at a certain time does not cause this object to move at the very same point of time. Of course, it is possible to imagine a case in which an object's inertia at an earlier time is not the cause of its movement at a later time, but, as we have seen, this is not what immanent causation in Dowe's sense is (or can be) about. Because of this, immanent causation in Dowe's sense can never be the subject of an empirical theory, and therefore the concept of immanent causation is an empty notion in Dowe's theory. It exists as a concept, but there is no case of empirical causation which can be captured by this concept. The only cases of causation in the empirical world according to Dowe's theory are causal interactions.

Step 2 the notions of "causal process" and "world line of an object" can be cut away by Occam's razor

We are now ready to turn to causal interactions.The Conserved Quantity Theory gives rise to a question which has even broader consequences than the one posed with respect to the CI principle in the Mark Transmission Theory. First, the essence of a causal interaction is that there is an exchange of conserved quantities. Second, conserved quantities are always possessed or manifested by objects, not by causal processes. (cf. supra) Then why does Dowe speak of an interaction between causal processes? He could have just as well talked about interactions between objects. The only gain in talking about causal processes as world lines of objects is that it makes clear that the spatiotemporal location of objects is changeable. But isn't this trivial? How could objects interact if they could not move? And isn't the realization that objects can move so doubtful that it needs a conceptualization of its own?

Let us take a closer look. First, Dowe defines causal processes as world lines of objects. Causal processes really are objects moving through spacetime. Second, what causal processes/world lines do, is exchanging conserved quantities. Third, conserved quantities are possessed by objects. The big question now is, why doesn't Dowe simply speak of interactions between objects which exchange conserved quantities? Let us take up the example of two billiard balls colliding again. Why can't we just say that the two balls exchange direction and momentum? Why must we say, according to Dowe, that it's the world lines constituted by these balls that intersect with each other, resulting in a change of the properties of these world lines, namely a change in speed and direction of the balls on the basis of which these world lines are constituted? Dowe's account simply makes things overly complicated without adding any extra information. Therefore, the CQ1 principle is an obvious victim to Occam's razor. The concepts of "causal process" and "world line of an object" can simply be cut away, as an unnecessary relic from Salmon's theory.[5] This has two consequences. First, CQ1 (where

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[5] Of course, it can still be useful to make a distinction between causal objects and pseudo-objects instead, but this does not add any extra information which is not already contained in the definition of causal interactions. The CQ theory is only a theory of causal objects in the same way as the MT theory is a theory about causal processes. Dowe defines causal interactions as exchanges of conserved quantities. Of course, this implies that objects which do not possess such quantities cannot take part in a causal interaction. There is no need to state this explicitly in a different condition or definition. In any case, it is impossible that such a definition could contain extra ontological information.

causal processes are defined in terms of world lines of objects) can be simply left out of Dowe's theory without losing any ontological information. Second, the phrase "world lines of objects" in CQ2 can be replaced by "objects". As we have seen from the billiard ball example, references to world lines only make things needlessly complex without adding ontological information.

Step 3 There is no ontological information about what causation is in Dowe's account which is not already present in Fair's transference theory.

From step 1, we have seen that the notion of immanent causation is vacuous. From step 2, we have seen that we can (and if we respect Occam's razor, we must) drop the notions of causal process and world line. Therefore, the only remaining definition needed in the Conserved Quantity Theory is CQ2, which can be reformulated it in the following way:

> CQ2' A *causal interaction* is an interaction of objects which possess a conserved quantity that involves an exchange of a conserved quantity.

So causation is reduced to interactions between objects which possess a conserved quantity. Formulated in this way, the Conserved Quantity Theory is very much the same theory as David Fair's energy-momentum transference theory of causation. Fair argued for a classical phsyicalist, mechanicist and atomistic reduction of causation to interactions between physical objects, such as waves, particles etc, which involve an exchange of energy or momentum. (Fair 1979) He states that this kind of causation is the only real one, in terms of which our common sense use of the terms "cause", "effect" and "causes" should be understood. What is important is that Fair's agenda is different from Dowe's: Fair does not aim to give an empirical or ontological description of what causation is, but he argues for a redefinition of the concept of causation along physicalist and reductionist lines. (Fair 1979, p 220)

It is not surprising that this trimmed-down version of Dowe's Conserved Quantity Theory seems to be very much similar to Fair's theory. Dowe himself has described his theory as an attempt to combine the strong points of those of Fair and Salmon. (Dowe 1995, p 322) The strong point of Salmon's theory, however, is the fact that it captures immanent causation, which on closer inspection appears to be an empty concept. As a result, Dowe's Conserved Quantity Theory does not constitute a significant advance over Fair's transference theory.[6] Just as Fair's theory the Conserved Quantitiy Theory is a programmatic and physicalist reduction of causation to certain interactions between physical objects. (see also De Vreese 2008, pp 9-10)

As a consequence, Dowe's theory should, parallel to Fair's, not be seen as a theory of what causation is, but rather as a proposition about what we should consider it to be. The fact that Dowe sees himself as givinge an empirical description is the consequence of a kind of up-side down naturalistic fallacy. Dowe has gone from the "ought" in Fair's theory to the "is" in his own. Dowe has hidden this important step behind some new concepts, such as "process" and "causal process". Nevertheless, it has been shown that these concepts are obsolete. They do not give as any extra information about

[6] The main difference is that Dowe has traded in Fair's notion of a transfer of a conserved quantity fora n exchange of a conserved quantity, which makes his theory symmetrical. As a consequence, Dowe supplements his theory with some conditions which involve statistical correlations in order to distinguish between cause and effect. (see the final chapter of Dowe 2000)

what causation is in the real world, independent of our conceptualizations. Therefore, Dowe's theory does not contain any ontological information about what causation really is which is not already present in Fair's theory.

I shall not discuss Wesley Salmon's modified version of the Conserved Quantity Theory here. As we have seen, this version is commited to the same ontology as Dowe's theory, and therefore susceptible to the same criticisms.

4. Summary and conclusion

In this paper, I have argued that, contrary to what is often thought, process theories of causation do not offer us an original ontological account of causation. I have shown this by analyzing the ontological presuppositions of Russell, Dowe and Salmon's process theories of causation. First, Russell does not aim to offer an account of causation, but rather an causal account of the existence of objects which possess identity over time. Second, the essential ontological notion in Salmon's Mark Transmission Theory turns out to be counterfactual dependence. Therefore, his theory is just another chapter in the counterfactual tradition of defining causation. Thirdly, the conserved Quantity Theory does not contain any ontological information which is not already present in David Fair's transference theory of causation.

Does this mean that causal process theories are simply useless? I do not believe this to be the case. First, the Mark Transmission theory does indeed provide us with some extra machinery which can be used to refine the counterfactual definitions of causation. Second, some of the intuitions and concepts in causal process theories can be used as tools in a pluralistic approach of understanding scientific explanation. (see for example Weber 1998, Froeyman 2009)

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