Erkenntnis (2005) 63:101–118
DOI 10.1007/s10670-005-0607-x

SUNGHO CHOI

UNDERSTANDING THE INFLUENCE THEORY OF CAUSATION: A CRITIQUE OF STREVENS

ABSTRACT. In this paper, I will first clarify Lewis's influence theory of causation by relying on his theory of events. And then I will consider Michael Strevens's charge against the sufficiency of Lewis's theory. My claim is that it is legitimate but does not pose as serious a problem for Lewis's theory as Strevens thinks because Lewis can surmount it by limiting the scope of his theory to causation between concrete events. Michael Strevens raises an alleged counterexample to the necessity of Lewis's theory that, if successful, would have a very important advantage over other alleged counterexamples. But I will assert that it is simply mistaken. My defense of Lewis's theory will shed interesting light on the relationship between Lewis's theory and Salmon's mark theory.

1. LEWIS'S INFLUENCE THEORY OF CAUSATION

Lewis's influence theory of causation is based on the idea that if causes were slightly altered then effects would also be altered. The official account of causal influence goes as follows (Lewis 2000, p. 190):

CI. When C and E are distinct actual events, C influences E iff there is a substantial range C_1, C_2, ...of different not-too-distant alterations of C (including the actual alteration of C) and there is a range E_1, E_2 ...of alterations of E, at least some of which differ, such that if C_1 had occurred, E_1 would have occurred, and if C_2 had occurred, E_2 had occurred, and so on.

An alteration of event C is either a very fragile version of C or else a very fragile alternative event that is similar to C, but numerically different from C. Lewis (2000, p. 191) does not identify influence with causation since he believes that causation is invariably transitive and the relation of influence is not invariably transitive. He takes an ancestral to get causation.

ITC. For two distinct events C and E, C is a cause of E iff C stands in the ancestral of influence to E.

It should be noted that Lewis has not given a clear enough definition of an alteration. In the first place, his definition that an alteration of *C* is either a very fragile version of *C* or else a very fragile alternative event raises questions like "What is a version of an event?" or "How fragile is very fragile?", which he leaves unanswered. Fortunately, however, we can provide a more refined definition of an alteration by relying on Lewis's own theory of events. Lewis (1986, pp. 244–249) holds that an event has a built-in necessary and sufficient condition – for short, occurrence condition – that, necessarily, a spatio-temporal region must satisfy iff that event is to occur there. For example, the occurrence condition for an event is John's saying "Hello" loudly in a spatio-temporal region *R* iff, necessarily, that event occurs iff John says "Hello" loudly in *R*. Suppose that when an event occurs in a spatio-temporal region, it is a concrete event iff its occurrence condition consists of all of its intrinsic and spatio-temporal properties, namely, all the intrinsic and spatio-temporal properties satisfied by that region (Hempel 1965, pp. 421–423; Strevens 2003, pp. 398–399). Then a concrete event is individuated by every one of its intrinsic and spatio-temporal properties. When an event occurs in a spatio-temporal region, it is a "non-concrete" or "high-level" event iff its occurrence condition consists of only some of the intrinsic and spatio-temporal properties satisfied by that region.[1] On the one hand, for instance, when John says "Hello" throughout a region *R*, the concrete event of John's greeting has an occurrence condition that consists of all the intrinsic and spatio-temporal properties satisfied by *R*. On the other hand, the event whose occurrence condition is John's saying "Hello" is a non-concrete or high-level event since its occurrence condition consists of only some of the intrinsic and spatio-temporal properties satisfied by *R*.

As Strevens (2003, p. 441) proposes, we can understand the notion of an alteration in terms of concrete events. Consider the following definition (Lewis 1986, p. 255): event *C* implies event *E* iff, necessarily, if *C* occurs in a region then also *E* occurs in that region. The event whose occurrence condition is John's saying "Hello" loudly implies the event whose occurrence condition is John's saying "Hello" since the second event occurs in every region where the first event occurs.[2] Let a realizer of an event *C* be a concrete event that implies *C*. For instance, when John actually says "Hello" loudly and abruptly in a region *R*, the actual concrete event of John's greeting is a realizer of the event whose occurrence condition is John's saying "Hello" loudly since, given that the occurrence condition for the first

event consists of all the intrinsic and spatio-temporal properties satisfied by *R*, the second event occurs in every region where the first event occurs. It is clear that one concrete event realizes more than one high-level event. The actual concrete event of John's greeting implies, and therefore realizes the event whose occurrence condition is John's saying "Hello" and the event whose occurrence condition is John's saying "Hello" abruptly as well as the event whose occurrence condition is John's saying "Hello" loudly. On the other hand, a high-level event has more than one (actual or merely possible) realizer. For example, a number of merely possible concrete events of John's greeting as well as the actual concrete event of John's greeting imply, and therefore realize the high-level event whose occurrence condition is John's saying "Hello" loudly.

Now we can understand a very fragile version of event *C* to be a realizer of *C* and a very fragile alternative event that is similar to but numerically different from *C* to be a concrete event that is not a realizer of *C* but similar to the (actual or merely possible) realizers of *C*. Then an alteration of event *C* is either a realizer of *C* or else a concrete event that is not a realizer of *C* but similar to the realizers of *C*.

2. THE SCOPE OF LEWIS'S ACCOUNT OF CAUSAL INFLUENCE

Suppose that *X* and *Y* are two actual high-level events. Then there are two actual concrete events, *x* and *y*, that imply *X* and *Y*,[3] respectively, in which case the concrete events are the actual alterations of the high-level events. According to CI, to say that *X* influences *Y* is roughly to say that there are not-too-distant alterations of *X* that would result in the occurrence of non-actual alterations of *Y*. Note that such alterations of *X* would result in the occurrence of non-actual alterations of *Y* if small changes in *x* would result in the occurrence of concrete events unlike *y*. But, the antecedent of this conditional means just that *x* influences *y*. Therefore, we have that, according to CI, if *x* influences *y* then *X* influences *Y*.

For example, let us consider the following case (Strevens 2003, pp. 403–404). Sylvie fires a pellet from her laser-sighted slingshot at a dartboard. A strong gust of wind blows the pellet to the right. Meanwhile, unbeknownst to Sylvie, Bruno has sabotaged her laser sight so that the slingshot consistently shoots too low. After all, the pellet hits a spot below and to the right of the bull's eye. Let C_1, C_2, E_1, E_2 be high-level events whose occurrence conditions are Bruno's

sabotaging Sylvie's laser sight, a lateral gust of wind, the pellet's hitting below the bull's eye and the pellet's hitting to the right of the bull's eye, respectively. And, let c_1 be the concrete event of Bruno's sabotage, c_2 the concrete event of the gust of wind, e the concrete event of the pellet's hitting such-and-such a point on the dartboard. The concrete events, c_1 and c_2, are actual realizers of C_1 and C_2, respectively; and the concrete event e is an actual realizer of both E_1 and E_2.

It is clear that c_1 has a great degree of influence on e because if Bruno's sabotage were slightly different, then the angle of Sylvie's laser sight would be different and so the pellet would hit a different point on the dartboard. Since c_1 implies C_1 and e implies E_1, it follows that C_1 influences E_1. Therefore, according to ITC, C_1 is a cause of E_1, which is a satisfying result. On the other hand, c_2 has a great degree of influence on e since if the lateral gust of wind were slightly different, then the pellet's sideways drift would be different, and therefore, the pellet would hit a different point on the dartboard. Then, according to ITC, C_2 is a cause of E_2 since c_2 implies C_2 and e implies E_2, which is also a satisfying result.

So far so good. Note that e implies both E_1 and E_2. Therefore, it also follows from the fact that c_1 influences e, that C_1 influences E_2. Therefore, according to ITC, C_1 is a cause of E_2. However, as Strevens correctly claims, this is an unacceptable consequence. The explanation of why the pellet hits to the right of the bull's eye would not include a reference to Bruno's sabotage. Also, Bruno would not be held morally responsible for the consequences of the pellet's hitting to the right of the bull's eye. This suggests that Bruno's sabotage has no distinctive connotations of being a cause of the pellet's hitting to the right of the bull's eye. Then we have to say that the first event is not a cause of the second event. By the same token, it follows from the fact that c_2 influences e, that C_2 influences E_1. Yet this result is at variance with our common sense opinion.

I think this poses a real threat to Lewis's theory of causation: Lewis's theory, in its current form, mistakes C_1 to be a cause of E_2 and C_2 to be a cause of E_1. Then what should be blamed for these counterintuitive consequences? Strevens (2003, p. 404) holds that the culprit is ITC or, in Strevens's terminology, the *causation equals influence* account.[4] However, I disagree. C_1 comes out as a cause of E_2 by ITC because, according to CI, C_1 influences E_2. Here I take it that the claim that C_1 influences E_2 is as objectionable as the claim that C_1 causes E_2: Bruno's sabotage (C_1) influences the pellet's hitting the dartboard too low (E_1) but does not influence the pellet's hitting to

the right of the bull's eye (E_2). Likewise, the claim that C_2 influences E_1 is as objectionable as the claim that C_2 causes E_1: the gust of wind (C_2) influences the pellet's hitting to the right of the bull's eye (E_2) but does not influence the pellet's hitting the dartboard too low (E_1). Then we would have to say that what should be blamed is not ITC but CI, i.e., Lewis's account of causal influence.

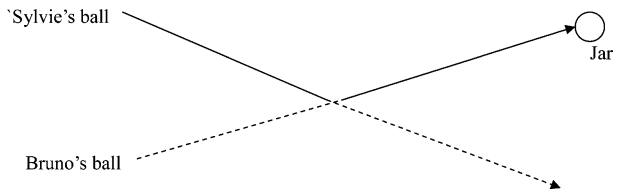
I take it that the Lewis's best possible response to this charge is to elude it. It should be realized that, as far as causation between concrete events is concerned, Lewis's theory remains intact. CI delivers the verdict that each of c_1 and c_2 influences e, and therefore each of them comes out a cause of e by ITC. This verdict is unobjectionable. After all, both c_1 and c_2 are causally responsible for the pellet's hitting such-and-such a point at such-and-such a time. This means that Lewis's theory is not vulnerable to the charge in question when it comes to causation between concrete events. In fact, the basic idea of that charge is that, when two concrete events stand in an influence relation, it is possible that high-level events implied by them do not stand in an influence relation; yet, according to CI, such high-level events invariably stand in an influence relation. This means that Lewis can overcome it by limiting the scope of CI to causal influences between concrete events. Moreover, this move would not reduce the importance of Lewis's theory since it would be a nontrivial achievement if Lewis's theory can provide an adequate account of causation between concrete events.

It is remarkable that even if Lewis confines CI to causal influences between concrete events, he has something useful to talk about causation between high-level events. We have seen that it is objectionable that, if two concrete events stand in an influence relation, two high-level events implied by them always stand in an influence relation. However, it is quite reasonable to suggest that two concrete events stand in an influence relation if there exist two high-level events implied by them that stand in an influence relation.[5] As we have seen, C_1 influences E_1, while c_1 influences e; likewise, C_2 influences E_2, while c_2 influences e. Consequently, the suggestion in question is not in trouble with the case of the pellet stated above. Furthermore, when we suppose that an actual concrete event d – say, the concrete event of a dog's barking at a distance from Suzy – does not influence e at all, it is plausible to say that no influence relation holds between two high-level events that are implied by d and e, respectively. For instance, d does not influence the pellet's hitting the dartboard too low (E_1) nor the pellet's hitting to the right of the bull's eye (E_2). Hence I suggest that the causal influence between two

high-level events entails the causal influence between two concrete events that imply those high-level events, respectively. Once this suggestion is endorsed, we can get a necessary condition for causal influences between high-level events by applying CI to concrete events that imply those high-level events, respectively. This means that even if Lewis limits the scope of CI to causal influences between concrete events, he can provide a necessary condition for causal influences between high-level events by relying on CI.

3. STREVENS'S EXAMPLE

In the light of the previous section, it will be instructive to investigate the viability of Lewis's theory as an account of causation between concrete events. Let us consider Strevens's following case that seems to threaten Lewis's theory of causation between concrete events. Sylvie and Bruno both throw intrinsically identical round steel balls that are inclined to bounce. Sylvie's ball hits a jar and Bruno's does not because the balls collide in mid-air at a time t^*. The following figure depicts the relation between the trajectories of the balls:



The solid line represents the trajectory of Sylvie's ball and the dashed line the trajectory of Bruno's ball. The speed of Sylvie's ball is always identical with that of Bruno's ball. In addition, the trajectory of the one ball after t^* is identical to the trajectory that the other ball would take after t^* without the collision. Therefore, if Sylvie were not to throw her ball, then Bruno's ball would hit the jar and cause it to break at exactly the same time and in exactly the same way as it actually does.[6]

Does Lewis's influence theory of causation get Strevens's case right? Suppose that the balls are very small and moving very fast. Then, Strevens claims, even very small variations in Sylvie's throw would result in no collision, in which case Bruno's ball would hit the jar and cause it to break at exactly the same time and in exactly the same way as Sylvie's ball actually does. If so, Sylvie's throwing her ball has almost no influence on the breaking of the jar. Intuitively,

however, it is a cause of the breaking. Here we must not forget that Lewis identifies causation not with influence itself but with the ancestral of influence. It may be that though Sylvie's throw has almost no influence on the breaking of the jar it has a great degree of influence on a certain intermediary event that in turn has a great degree of influence on the breaking. In that case, Strevens's case would spell no trouble for Lewis's theory.

Strevens (2003, pp. 406–407) is well aware of Lewis's possible appeal to the transitivity of causation and says "there is no event that both influences the breaking to a sufficient degree, and is itself influenced by the throw to a sufficient degree." On his view, the collision does not serve as such an event because when the colliding balls are sufficiently fast and small very small changes in the collision would result in the balls' not colliding at all. But, if the two balls were not to collide one another, Bruno's ball would take the place of Sylvie's ball with the result that Bruno's ball would hit the jar and cause it to break at exactly the same time and in exactly the same way as it actually does. This means that small changes in the collision would not bring about changes in the breaking of the jar. Since the collision does not influence the breaking of the jar, it does not permit an ancestral of influence from Sylvie's throw to the breaking of the jar. For essentially the same reason, Strevens goes on to argue, any events that are causally between Sylvie's throw and the collision do not influence any events that are causally between the collision and the breaking of the jar. If so, there are no other events than the collision that would permit an ancestral of influence from Sylvie's throw to the breaking of the jar. So Strevens concludes that the transitivity of causation is of no help to Lewis.

It is noteworthy that Strevens argues to the effect that the concrete event of Sylvie's throw does not influence nor stands in the ancestral of influence to the concrete event of the jar's breaking. On his view, if Sylvie's throw were different, however slightly, then Sylvie's ball would not collide with Bruno's ball; thereby, the concrete event of the breaking of the jar with all the intrinsic and spatio-temporal properties it actually has would still occur. If so, we would have to say that the concrete event of Sylvie's throw does not influence the concrete event of the jar's breaking. Moreover, for Strevens, the two concrete events do not stand in the ancestral of influence because the collision functions as a weak link. In consequence, Strevens's case, if successful, will serve as a counterexample against Lewis's theory of causation between concrete events; and it will preclude Lewis's possible response to the charge stated in Section 2.

One important advantage of Strevens's case as a counterexample against Lewis's theory of causation is that it does not exploit the not-too-distant requirement, namely, the requirement that influence-conferring alterations should be not-too-distant from the actual alteration. Once we exploit that requirement, it is an easy job to make an counterexample against the necessity of Lewis's theory of causation: we have only to drive the influence of a cause all the way to zero by making its alterations that would bring about changes of its effect too distant from its actual alteration (Kvart 2001; Schaffer 2001; McDermott 2002). On behalf of Lewis, however, Noordhof (2001) objects that, in such an alleged counterexample, there is no principled way to rule out the influence-conferring alterations of a cause as being too distant. I think that Noordhof's objection enjoys some *prima facie* plausibility. It is clear that Strevens's case against Lewis's theory does not rely on any strange stipulations that some alterations of Suzy's throw are too distant from the actual alteration. Thus it does not take advantage of the not-too-distant requirement. For this reason, it is not vulnerable to something like Noordhof's objection.

4. THE TRANSITIVITY OF CAUSATION

In this section I will argue that Strevens's case does not stand under scrutiny. As stated above, Strevens holds that very small variations in Sylvie's throw would result in no collision, from which he draws the conclusion that Sylvie's throw does not influence the breaking of the jar. But I disagree. I am afraid that Strevens does not take into account every kind of variation in Sylvie's throw. What he might have in mind is something like a counterfactual situation where Sylvie throws her ball slightly earlier or slightly later or in a slightly different direction. I admit that in such a counterfactual situation Sylvie's ball would not collide with Bruno's ball and thereby Bruno's ball would hit the jar and cause it to break at exactly the same time and in exactly the same way as it actually does. But there are other kinds of variation in Sylvie's throw – for example, variations in the mass, size, shape and surface properties of Sylvie's ball.[7]

This idea leads us to the following objection – call it *the direct influence objection* – to Strevens's case that is ultimately unsuccessful but interesting in its own right. Let us idealize Strevens's example by supposing that the air resistance encountered by Sylvie's ball is negligible. What if Sylvie were to throw a ball with a different shape, say, a rectangular ball – actually Sylvie's ball is round? Initially, the

rectangular ball would take exactly the same trajectory as Sylvie's ball actually does. Therefore, it would collide with Bruno's ball at t^*. However, the collision would be different than the actual one because it would not be between two round balls but between a round and a rectangular ball. Hence Sylvie's ball after t^* would take a different trajectory than it actually does. Moreover, due to the collision, Bruno's ball after t^* would not take the same trajectory as Sylvie's ball actually does. Since neither of the two balls after t^* would take the same trajectory as Sylvie's ball actually does, either the jar would not break or if it does it would break differently. This means that according to CI Sylvie's throw directly influences the breaking of the jar by way of alterations in the shape of Sylvie's ball.

We can draw the same conclusion by varying the mass of Sylvie's ball. Given that air resistance is negligible, changes in the mass of Sylvie's ball would not bring about changes in its trajectory before t^* since, as a result of the equivalence of the gravitational and inertial mass, Sylvie's ball would experience the same gravitational acceleration.[8] Accordingly, if Sylvie were to throw a ball with a slightly different mass, Sylvie's ball would initially take exactly the same trajectory as it actually does, and thereby would collide with Bruno's ball at t^*. The collision, however, would be different because it would be between two balls with different masses. Hence neither of the two balls after t^* would take the same trajectory as Sylvie's ball actually does; thereby, either the jar would not break or if it does it would break differently. In consequence, CI delivers the verdict that Sylvie's throw influences the breaking of the jar by way of alterations in the mass of Sylvie's ball. As a result, according to the *direct influence objection*, Sylvie's throw directly influences the breaking of the jar, and therefore, contrary to Strevens's view, Sylvie's throw qualifies as a cause of the breaking by ITC.

However, Strevens can meet the *direct influence objection* by responding in this way: ''Since the balls are very small and moving very fast, their movements and collision are very sensitive to external factors like air resistance, and therefore the supposition that air resistance is negligible is unwarranted. Or we can simply assume that air resistance is not negligible.'' Once we take air resistance into account, *the direct influence objection* does not work. If Sylvie were to throw a rectangular ball then it would take a different trajectory than it actually does because it would encounter different air resistance; thereby it might not collide with Bruno's ball; thereby, Bruno's ball after t^* might take the same trajectory as Sylvie's ball actually does; thereby, Bruno's ball might hit the jar and cause it to break at exactly

the same time and in exactly the same way as it actually does. We can get the same result for the case of mass. As noted above, given that air resistance is negligible, even if Sylvie were to throw a slightly heavier or lighter ball, Sylvie's ball would still collide with Bruno's ball. Once air resistance comes into play, however, this is no longer the case. Since the amount of air resistance encountered by Sylvie's ball is not directly proportional to its mass, a change in its mass would cause it to experience a different acceleration. Therefore, on the assumption that air resistance is not negligible, if Sylvie were to throw a ball with a different mass, it would take a different trajectory before t^*; thereby, it might not collide with Bruno's ball; thereby, Bruno's ball might hit the jar and cause it to break at exactly the same time and in exactly the same way as it actually does. To wrap up, given that the unwarranted supposition is dumped, it is not the case that variations in the shape or mass of Sylvie's ball would bring about changes in the breaking of the jar, and therefore Sylvie's throw does not directly influence the breaking of the jar by way of alterations in the shape or mass of Sylvie's ball.

In short, *the direct influence objection* does not work. But it does not follow from this that Strevens's case succeeds in refuting Lewis's influence theory. In fact, I think to the contrary, that Lewis can overcome Strevens's alleged counterexample by relying on the transitivity of causation together with the basic idea of the *direct influence objection*. There is an intermediary event that is considerably influenced by Sylvie's throw and, at the same time, influences the breaking of the jar by way of alterations in the shape or mass of Sylvie's ball. Let e_1 be a concrete event whose occurrence condition consists of all the intrinsic and spatio-temporal properties satisfied by the region that Sylvie's ball occupies at a time t_1 just before the collision. It is clear that Sylvie's throw has every influence on e_1: very many variations of Sylvie's throw would make difference to e_1. Therefore, if e_1 influences the breaking of the jar, Sylvie's throw will stand in the ancestral of influence to the breaking of the jar. When we let t_1 be very shortly before the collision, variations in the shape or mass of Sylvie's ball at t_1 would not prevent the ball from colliding with Bruno's ball even if it is granted that air resistance is not negligible. But they would bring about different collisions, and therefore would make difference to the breaking of the jar. For example, if Sylvie's ball were rectangular at t_1, it would collide with Bruno's ball but the collision would be different from the actual one; thereby, neither of the two balls after t^* would take the same trajectory as Sylvie's ball actually does; then either the jar would not break or if it does it would

break differently. This means that e_1 influences the breaking of the jar to a sufficient degree by way of alterations in the shape or mass of Sylvie's ball. As a result, e_1 both influences the breaking of the jar to a sufficient degree and is influenced by Sylvie's throw to a sufficient degree. Therefore, there is an ancestral of influence from Sylvie's throw to the breaking of the jar.

Moreover, every concrete event that involves Sylvie's ball at a time between the collision and the breaking of the jar can also serve as an intermediary event that permits an ancestral of influence from Sylvie's throw to the breaking of the jar. Let e_2 be a concrete event whose occurrence condition consists of all the intrinsic and spatio-temporal properties satisfied by the region that Sylvie's ball occupies at a time t_2 after the collision. It is clear that e_2 has a very great degree of influence on the breaking of the jar: very many variations of e_2 would make difference to the breaking of the jar. Then does Sylvie's throw considerably influence e_2? I think it does.

What if Sylvie were to throw a steel ball with a non-zero electric charge - let us suppose that actually Sylvie's and Bruno's balls are electrically neutral? In this case, Sylvie's ball would be subject to the same total force as it actually is. Moreover, since it would have the same mass, it would experience the same acceleration as it actually does. Therefore, Sylvie's ball would collide with Bruno's ball at t^*. In addition, the collision would be exactly the same as the actual one except that Sylvie's ball has a non-zero electrical charge. Then the entire trajectory of Sylvie's ball would be exactly the same as the one it actually takes. Consequently, the jar would break at exactly the same time and in exactly the same way as it actually does. This means that Sylvie's throw does not directly influence the breaking of the jar by way of alterations in the electric charge of Sylvie's ball. However, Sylvie's throw influences e_2 by way of alterations in the electric charge of Sylvie's ball. Admittedly, if Sylvie were to throw a steel ball with a non-zero electric charge, her ball would fly at the same place in the same direction at t_2 as it actually does. But, since not an electrically neutral ball but an electrical charged ball would be traveling toward the jar at t_2, e_2 would correspondingly change. In consequence, variations in the electric charge of Sylvie's ball at the time of the throw would bring about changes of e_2. Thus, although Sylvie's throw does not directly influence the breaking of the jar by way of variations in the electric charge of Sylvie's ball, it does e_2.

Strevens, however, can plausibly respond by assuming that the two balls are under a very strong external electromagnetic field. Then variations in the electric charge of Sylvie's ball might result in no

collision because Sylvie's ball before t^* would be subject to a different amount of electromagnetic force than it actually is. If Sylvie's ball were not to collide with Bruno's ball, then Bruno's ball would take the place of Sylvie's ball. Therefore, if Sylvie were to throw an electrically charged ball, Bruno's ball that has exactly the same intrinsic properties including electric charge as Sylvie's ball actually does might be traveling at the same place in the same direction at t_2 as Sylvie's ball actually is. Then variations in the electric charge of Sylvie's ball at the time of throw would not bring about any changes of e_2.

I agree that, on the assumption that the two balls are under a very strong external electromagnetic field, Sylvie's throw does not influence e_2 by way of alterations in the electric charge of Sylvie's ball. On that assumption, however, e_1 influences the breaking of the jar by way of alterations in the electric charge of Sylvie's ball. Since t_1 is supposed to be very shortly before the collision, if Sylvie's ball were to possess a different amount of electric charge at t_1, it would still collide with Bruno's ball; yet, Sylvie's ball after t^* would not take the same trajectory as it actually does because it would be subject to a different amount of electromagnetic force; therefore, either the jar would not break or if it does it would break differently. Consequently, on the assumption under consideration, we have another reason to believe that e_1 influences the breaking of the jar to a sufficient degree.

Another claim I want to make is that there are some properties of Sylvie's ball by way of alterations of which Sylvie's throw influences e_2. Suppose that Sylvie's ball is actually black. Note that the forces on it would not be affected by variations in its color. Therefore, if Sylvie were to throw a yellow steel ball, the ball would be subject to the same total force as it actually is. Therefore, Sylvie's ball would collide with Bruno's ball at t^*. In addition, the collision would be exactly the same as the actual one except that Sylvie's ball is yellow. Then the entire trajectory of Sylvie's ball would be exactly the same as the one it actually takes. Hence, if Sylvie were to throw a yellow steel ball, her ball would be traveling at the same place in the same direction at t_2 as it actually does. However, since not a black ball but a yellow ball would be traveling toward the jar at t_2, e_2 would correspondingly change. So variations in the color of Sylvie's ball at the time of the throw would bring about changes of e_2. This means that Sylvie's throw influences e_2 by way of variations in the color of Sylvie's ball.[9] It is evident that every concrete event that involves Sylvie's ball at a time between the collision and the breaking of the jar serves the same purpose as e_2.

To wrap up, all the concrete events after the collision and some concrete events before the collision influence the breaking of the jar, and are influenced by Sylvie's throw. It follows that each of them permits an ancestral of influence from Sylvie's throw to the breaking of the jar. This means that Sylvie's throw unquestionably counts as a cause of the breaking by ITC. Consequently, we come to the conclusion that Strevens's case spells no trouble whatsoever for Lewis's theory of causation nor for CI.

It is remarkable that it makes no difference to modify Strevens's case such that it involves two elementary particles, not two meso-scopic steel balls.[10] Admittedly, it does not make much sense to speak of the shape or color of elementary particles and hence we cannot appeal to variations in the shape or color of them in order to establish an ancestral of influence. Even in the modified case, however, we can invoke variations in the mass or electric charge of elementary particles. Also, such a particle-physical property as spin, baryon number and lepton number will provide us sufficient resource to show that Lewis's influence theory gets Strevens's case right.

Of course, there is a cure-all. That is to exploit the not-too-distant requirement by stipulating that Sylvie's ball cannot have a different shape, mass, electric charge, color and the like. On this view, for example, alterations in the shape of Sylvie's ball are too-distant alterations such that, in Strevens's case, they should not be taken into account in assessing the degree of influence. Then, my objection to Strevens's case fails because it depends on the assumption that they are not-too-distant alterations. This cure-all, however, will cost very much. That will deprive Strevens's case of the main advantage as a counterexample against Lewis's influence theory of causation that it has over other alleged counterexamples, namely, that it does not exploit the not-too-distant requirement. Moreover, it will become vulnerable to something like Noordhof's objection.

5. THE MARK THEORY OF CAUSAL PROCESS

My defense of Lewis's theory against Strevens's alleged counterexample sheds interesting light on the relationship between Lewis's theory and Salmon's mark theory. The basic idea of Salmon's (1984, pp. 147–157; 1994, pp. 249–250) mark theory of a causal process is that a causal process has such a characteristic C that it is capable of transmitting a mark consisting of a single local modification of C at every stage of it, in which case we can simply say that it carries its

own characteristic *C*. For example, consider a moving car that actually is not scratched. If it were to collide with a stone wall and then have been scratched, then it would transmit the scratches by regularly manifesting them along with it long after the collision has taken place. Then, the process of the moving car is capable of transmitting a mark consisting of the scratches and thereby carries its own shape. This means that it qualifies as a causal process by Salmon's mark theory.

As Lewis (2004, p. 91) roughly states, Salmon's theory is in a close relation with Lewis's influence theory. We have found that the process of the moving car carries its shape since if the moving car were to undergo a single local modification of its shape at a time, thereafter the car would transmit the modification by regularly manifesting it. Let e_3 be a concrete event whose occurrence condition consists of all the intrinsic and spatio-temporal properties satisfied by the region that the moving car occupies at a time t_3. Similarly, let e_4 be a concrete event whose occurrence condition consists of all the intrinsic and spatio-temporal properties satisfied by the region that the moving car occupies at a later time t_4. I claim that e_3 influences e_4 by way of alterations in the shape of the moving car "in virtue of" the fact that the process of the moving car carries its shape. Let us consider a counterfactual situation where e_3 involves a car with a different shape from the actual one. Given that the process of the moving car carries its own shape, in such a counterfactual situation, the moving car would keep manifesting that shape after t_3; thereby, e_4 would also involve a car with a different shape. Therefore, if e_3 were to involve a car with a different shape, so would e_4. This means that e_3 influences e_4 by way of alterations in the shape of the moving car, and therefore that e_3 comes out a cause of e_4 by Lewis's influence theory of causation. Then we can say that it is because the process of the moving car carries its shape that two concrete events involving the moving car stand in an influence relation by way of alterations in the shape of the moving car.[11]

This relation between Salmon's and Lewis's theories of causation underlies my defense of Lewis's theory against Strevens's alleged counterexample. The entire process of Sylvie's ball carries its own mass because if Sylvie's ball were to undergo a single local modification of its mass at any time, thereafter the ball would transmit the modification by regularly manifesting it.[12] Therefore, it qualifies as a causal process by Salmon's mark theory of causation. What if e_1, i.e., the concrete event that involves Sylvie's ball at the time t_1 just before the collision, were to involve a ball with a different mass from the

actual one? Then thereafter Sylvie's ball would keep manifesting that mass since the process of Sylvie's ball carries its own mass; and thereby the collision between Sylvie's and Bruno's balls would be different from the actual one; and thereby neither of the two balls after t^* would take the same trajectory as Sylvie's ball actually does; and thereby either the jar would not break or if it does it would break differently. Hence, e_1 influences the breaking of the jar by way of variations in the mass of Sylvie's ball, and therefore, permits an ancestral of influence from Sylvie's throw to the breaking of the jar. It is essential to this reasoning that the process of Sylvie's ball carries its own mass. In this sense, e_1 influences the breaking of the jar by way of variations in the mass of Sylvie's ball in virtue of the fact that the process of Sylvie's ball carries its own mass. The same applies to the shape of Sylvie's ball.

The entire process of Sylvie's ball carries its own color and electric charge as well as mass and shape. This is related to the fact that Sylvie's throw influences e_2, i.e., the concrete event that involves Sylvie's ball at the time t_2 after the collision, by way of variations in the color or electric charge of Sylvie's ball. The entire process of Sylvie's ball carries its own color because if Sylvie's ball were to have a different color at any time, thereafter the ball would transmit that color by regularly manifesting it. Therefore, it counts as a causal process by Salmon's mark theory. What if Sylvie were to throw a yellow ball rather than a black ball? Since the color of Sylvie's ball does not affect its trajectory, its entire trajectory would be exactly the same as the one it actually takes. If so, Sylvie's ball would be traveling at the same place in the same direction at t_2 as it actually does. But Sylvie's ball would be yellow, not black at t_2 because the process of Sylvie's ball carries its own color. Accordingly, e_2 would involve not a black ball but a yellow ball. As a result, Sylvie's throw influences e_2 by way of variations in the color of Sylvie's ball, and therefore, permits an ancestral of influence from Sylvie's throw to the breaking of the jar. It is essential to this reasoning that the process of Sylvie's ball carries its own color. Therefore, we can say that Sylvie's throw influences e_2 by way of variations in the color of Sylvie's ball in virtue of the fact that the process of Sylvie's ball carries its own color. We can draw the same conclusion for the electric charge of Sylvie's ball.

To conclude, Sylvie's throw stands in the ancestral of influence to the breaking of the jar in virtue of the fact that the process of Sylvie's ball carries such characteristics as its mass, shape, color, etc. I think that this relation between Lewis's and Salmon's theories of causation is interesting because Lewis and Salmon seem to take very different

approaches to causation. Roughly speaking, Lewis's theory views causation primarily as a relational property between two events, namely, cause and effect; whereas Salmon's theory views causation primarily as a non-relational property of processes and interactions. Nevertheless, the close relationship between the two theories is not surprising in that, on Salmon's (1984, p. 155) view, a causal process is supposed to propagate causal influence from one space-time locale to another and the propagation of causal influence by means of causal processes constitutes the connection between cause and effect. This suggests that though apparently the two theories look very different, they share some insight into causation.

ACKNOWLEDGMENTS

An earlier draft of this paper was presented at the 2004 conference of the 2004 British Society for the Philosophy of Science Conference held in Canterbury, UK. I would like to thank the audience of my presentation. Also I wish to thank my Korean colleagues, Chiwook Won and Inkyo Chung for providing me with a lot of useful and detailed feedback. Finally, thanks to two anonymous referees for their thoughtful comments.

NOTES

[1] Here I rule out what Lewis (1986, p. 263) calls extrinsic events, which he thinks are objectionable.

[2] Lewis applies his definition of implication to events with different essences. The essences of events are necessary conditions for their occurrences (Lewis 1986, pp. 247–248). For example, an event is essentially John's saying "Hello" loudly iff, necessarily, that event occurs only if John says "Hello" loudly. On Lewis's (1986, p. 255) view, the event C that is essentially John's saying "Hello" loudly implies the event E that is essentially John's saying "Hello" but only accidentally loud because the second event occurs in every region where the first event occurs. However, this is not clear to me. Suppose that C occurs in a region R. Then, John says "Hello" loudly in R, and therefore E's essential properties are satisfied by R. But it does not follow from this that E also occurs in R because E's essential properties are not jointly a sufficient condition but only a necessary condition for E's occurrence. Therefore, it is not the case that, necessarily, if C occurs in R, then E occurs in R as well. For this reason, I believe that Lewis is wrong that C implies E.

[3] The occurrence condition for x consists of all the intrinsic and spatio-temporal properties satisfied by the region where X actually occurs. The same holds for y and Y.

[4] Strevens (2003, p. 403) makes a slightly different interpretation of Lewis's view on the relation between influence and causation from ITC and calls it the *causation*

equals influence account of causal claims. Fortunately, however, that makes no difference to my following discussion.

[5] To put another way, if two high-level events stand in an influence relation, two (actual) realizers of them stand in an influence relation.

[6] At first sight, it looks like this case is a case of early preemption since (1) actually the jar is struck by Sylvie's ball; (2) without Sylvie's throw, the jar would be struck by Bruno's ball; (3) the causal process of Bruno's ball is cut short by the causal process of Sylvie's ball before the breaking of the jar. However, I don't think so. On the one hand, in an ordinary case of early preemption, (1) a preempted backup is not a genuine cause of the effect; and (2) without the preempted backup, the preempting cause would still cause the effect. On the other hand, in Strevens's case, (1) Bruno's throw is actually a genuine cause of the breaking of the jar; and (2) without Bruno's throw, Sylvie's throw would not cause the jar to break. Hence I maintain that it is misleading to take Strevens's case as a case of early preemption and that it is of different type from those much discussed by recent philosophers of causation.

[7] Lewis will certainly be willing to take such alterations into account since when he deals with the famous Suzy – Billy case of late preemption he counts Suzy's throwing a rock with a different mass as a legitimate alteration of Suzy's throw (Lewis 2000, p. 191).

[8] Here I am much indebted to an anonymous referee.

[9] It is easy to find other properties of Sylvie's ball that can serve the same purpose as color once we start looking for them. Let us consider an intrinsic property P of Sylvie's ball like its color variations of which at the time of the throw would make no difference to its trajectory. Suppose that the ball's having P is not affected by the collision with Bruno's ball. If Sylvie were to throw a ball that differs from the actual one with respect to P, then Sylvie's ball would still be traveling at the same place in the same direction at t_2; yet Sylvie's ball would differ from the actual one with respect to P at t_2; therefore, e_2 would correspondingly change. Accordingly, for every such property P, variations of Sylvie's throw with respect to P would result in changes of e_2. This means that Sylvie's throw considerably influences e_2 by way of variations in P.

[10] This modification has been brought to my attention by anonymous referees.

[11] One might have ontological questions with regard to the nature of processes and events. On ontological issues, I am inclined to maintain that there is no ontological basis for discriminating between processes and events. Fortunately, however, we do not need a detailed ontological commitment for the present purpose.

[12] According to Salmon's (1994, p. 250) official account of mark transmission, a mark is transmitted over an interval when it appears at each spacetime point of that interval *in the absence of interactions*. This could lead one to object: "If Sylvie's ball were to undergo a single local modification of its mass at a time shortly before the collision with Bruno's ball, it would keep manifesting the modification but not in the absence of interactions because soon thereafter it would causally interact with Bruno's ball; thereby, it would not transmit the modification. Accordingly, it is not true that the entire process of Sylvie's ball carries its own mass, namely, is capable of transmitting a mark consisting of a single local modification of its mass." In my opinion, however, this objection is based on a literal reading of the phrase "in the absence of interactions". The point of the phrase is to obviate the possibility that a pseudo-process is claimed to be causal on the ground that if it undergoes a single local modification of one of its characteristic, thereafter it will regularly manifest the

modification *owing to* interactions with outside (Salmon 1984, p. 142). This suggests that when we read the phrase in a way that is congenial to Salmon's intent, it requires a process to regularly manifest a modification on its own, i.e., not owing to interactions with outside. It is important to realize that if Sylvie's ball were to undergo a single local modification of its mass at a time before the collision, it would regularly manifest the modification on its own and not owing to the collision with Bruno's ball. Then, on the new reading of the phrase ''in the absence of interactions'', it would transmit the modification. This means that the entire process of Sylvie's ball is capable of transmitting a mark consisting of a single local modification of its mass and therefore that it carries its own mass. Thus, when the phrase in question is properly understood, it does not cause any trouble for my claim that the entire process of Sylvie's ball carries its own mass. The same applies to shape, electric charge, color and the like.

REFERENCES

Hempel, C.: 1965, *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*, Free Press, New York.

Kvart, I.: 2001, 'Lewis's 'Causation As Influence', *Australasian Journal of Philosophy* **79**, 409–421.

Lewis, D.: 1986, 'Events', in D. Lewis (ed.), *Philosophical Papers,* Vol II, Oxford University Press, Oxford.

Lewis, D.: 2000, 'Causation As Influence', *Journal of Philosophy* **97**, 82–197.

Lewis, D.: 2004, 'Causation As Influence', in J. Collins, N. Hall and L. Paul (eds.), *Causation and Counterfactuals*, MIT Press, Massachusetts, pp. 75–106.

McDermott, M.: 2002, 'Causation: Influence Versus Sufficiency', *Journal of Philosophy* **99**, 84–101.

Noordhof, P.: 2001. 'In Defence of Influence', *Analysis* **61**, 323–327.

Salmon, W.: 1984, *Scientific Explanation and the Causal Structure of the World,* Princeton University Press, Princeton.

Salmon, W.: 1994, 'Causality Without Counterfactuals', *Philosophy of Science* **61**, 297–312, Reprinted in Wesley Salmon (1998), *Causality and Explanation*, Oxford University Press, Oxford. (References are to the reprint Salmon.)

Schaffer, J.: 2001, 'Causation, Influence, and Effluence', *Analysis* **61**, 11–19.

Strevens, M.: 2003, 'Against Lewis's New Theory of Causation: A Story with Three Morals', *Pacific Philosophical Quarterly* **84**, 398–412.

Seoul National University
Programs in History and Philosophy of Science
Kwanak-gu
Seoul 151-742
Korea
E-mail: choise80@snu.ac.kr

Manuscript submitted 9 June 2004
Final version received 13 January 2005