attentive audience (*Ac*) would reasonably take the utterer (*U*) to be exploiting.[8]

The University of Sheffield
Sheffield S10 2TN, UK
k.romluc@sheffield.ac.uk

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[8] I am indebted to Jennifer Saul for many helpful discussions and her invaluable comments on earlier versions of this paper. Thanks also to Michael Clark, Rosanna Keefe and Stephen Makin for their useful comments and advice.

The 'actual events' clause in Noordhof's account of causation

SUNGHO CHOI

Recently, Paul Noordhof (1999) has developed his account of indeterministic causation from the PCA account of deterministic causation (Ganeri, Noordhof and Ramachandran 1996; Ganeri, Noordhof and Ramachandran 1998):

(NC′) For any actual, distinct events $e1$ and $e2$, $e1$ causes $e2$ (if and) only if there is a (possibly empty) set of possible events Σ such that

(I) $e2$ is probabilistically Σ-dependent on $e1$, and
(II′) for any superset of Σ, Σ^*, if $e2$ probabilistically Σ^*-depends upon $e1$, then every event upon which $e2$ probabilistically Σ^*-depends is an actual event.
(III) $e2$ occurs at one of times for which $p(e2 \text{ at } t) \geq x >> y$.

where $e2$ probabilistically Σ-depends upon $e1$ iff

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(1) If $e1$ were to occur without any of the events in Σ, then for some time t, it would be the case that, just before t, $p(e2 \text{ at } t) \geq x$.
(2) If neither $e1$ nor any of the events in Σ were to occur, then for any time t, it would be the case that, just before t, $p(e2 \text{ at } t) \leq y$.
(3) $x >> y$.

Noordhof relativizes (NC′) to a temporal period (1999, 114) and introduces the requirement of probabilistic A-dependence into (NC′) (1999: 115–20). But my discussion below does not rely on it.

In this note I discuss the 'actual events' requirement (II′) in (NC′). Noordhof formulated (II′) by modifying the requirement – let me call this requirement (II†) – that every event upon which $e2$ probabilistically Σ-depends is an actual event. I will argue that Noordhof's motivating argument for the actual events requirement fails and that another motivating argument Noordhof might offer also fails.

Let me call Noordhof's account consisting of the original requirement (II†) instead of (II′): (NC). Noordhof (1999: 105–7) argued that (NC) allows a counter-example depicted in Diagram 1.[1]

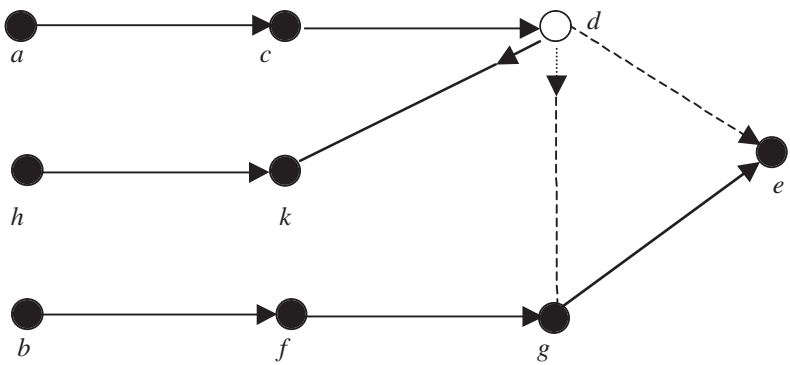

Diagram 1

Noordhof describes Diagram 1 as follows. The *a*–*e* process is very reliable overall but the *d*–*e* connection is much less reliable than the corresponding connection on the *b*–*e* chain: *g*–*e* connection. The *d*–*g* inhibitory axon is very reliable. The *c*–*d* connection is so strong that, if *k* had not fired to inhibit *d*, then the chance of *d*'s firing given that *c* fired is 1. All the connections in *b*–*e* chain except *g*–*e* connection are very unreliable. What

[1] Diagram conventions: filled circles represent neurons that fire, unfilled circles represent neurons that do not fire, forward arrows represent stimulatory connections, and reverse arrows inhibitory connections.

happens is that *a*, *h* and *b* fire; *d* fails to fire because of the inhibitory *h*-chain; so *e* fires because of the *b*-chain.

Noordhof argues that, contrary to our intuition, (NC) delivers the verdict that *a*'s firing – *a** – is a cause of *e*'s firing – *e** – and that since (NC′), in contrast to (NC), delivers the verdict that conforms to our intuition, (NC) should give way to (NC′). According to him, when we put *h** into the Σ-set, *e** probabilistically Σ-depends on *a**, but not on *d**. Then (II†) does not rule *a** out from being a cause of *e** because it does not apply to *d**. In contrast, *a** seems to be disqualified from being a cause of *e** by (II′). For a superset $\Sigma^* = \{h^*, g^*\}$ of $\Sigma = \{h^*\}$, *e** probabilistically Σ^*-depends on *d** as well as *a**. But, *d** is not actual, so (II′) is not fulfilled.

However, Noordhof's argument to the effect that *e** probabilistically Σ-depends on *a** is mistaken. For the sake of argument let us accept Noordhof's proposal (2000: 318–20) that we have to add the following principle to Lewis's similarity weighting for possible worlds in order to solve a problem with indeterministic causation: it is of second importance to minimize differences of particular fact from the actual world which are improbables. In the first place let us consider a counterfactual situation where *a** occurs but *h** does not: since the *a*–*d* connection is supposed to be very reliable, according to Noordhof's principle *d** would occur; since the *d*–*g* inhibitory axon is supposed to be very reliable, according to Noordhof's principle g would not occur; so, the probability of *e** assessed just before *e** would be low because *d*–*e* connection is supposed to be unreliable. In the second place let us consider a counterfactual situation where neither *a** nor *h** occurs. In such a counterfactual situation *d** would not occur, so *g** would occur. Since the *g*–*e* connection is supposed to be very reliable, the probability of *e** assessed just before *e** would be high. Thus when we put *h** into the Σ-set, *e** does not probabilistically Σ-depend on *a**. Contrary to Noordhof's contention, (NC) seems to deliver the right verdict that *a** is not a cause of *e**.

Note that since the *b*–*g* connection is supposed to be unreliable, the probability of *g** just before *g** would be very low in a counterfactual situation where neither *a** nor *h** occurs. So, Noordhof might reply that *g** would not occur in the counterfactual situation on the grounds of his principle about similarity weighting for possible worlds. However, since *b** and *g** are actual events, the principle does not apply to *g**. That is, the non-occurrence of *g** does not follow from the fact that the probability of *g** just before *g** would be very low in the counterfactual situation. In consequence, Noordhof's possible reply gets him nowhere.

In short, *e** does not probabilistically Σ-depend on *a** with $\Sigma = \{h^*\}$. How about putting *h** and *b** into the Σ-set? Then *e** probabilistically Σ-depends on *a**. However, with $\Sigma = \{b^*, h^*\}$, *e** also probabilistically Σ-depends on *d** and *d** is a non-actual event. Accordingly, (II†) can rule out

a^* from being a cause of e^*. Thus Noordhof's argument to the effect that (NC) fails to rule out a^* from being a cause of e^* does not succeed. As a result, Noordhof's motivating argument for (II′) fails.

Noordhof might attempt to provide another example that is purported to motivate the modification of (II†) into (II′). Consider the following case.[2]

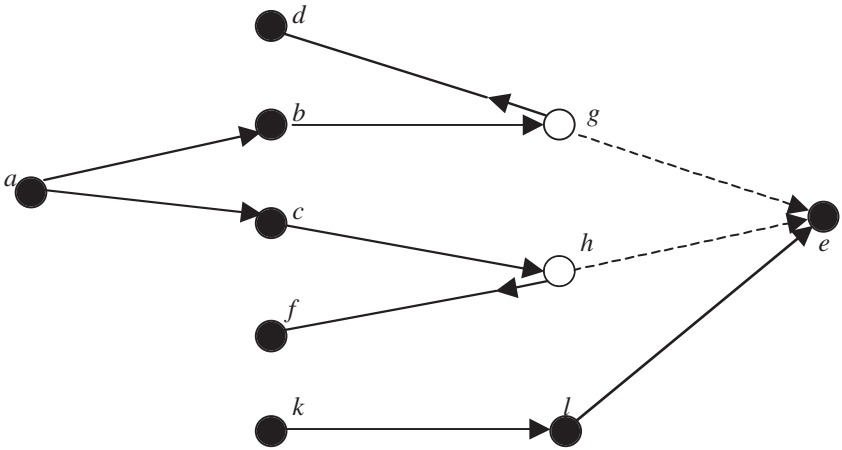

Diagram 2

Here all the connections between neurons are deterministic.

It seems that (NC) delivers the wrong verdict that a^* is a cause of e^*. When we put d^*, f^* and k^* into the Σ-set, according to (NC) e^* probabilistically Σ-depends on a^*. For if a^* were to occur without any of the events in Σ then e^* would occur, whereas if neither a^* nor any of the events in Σ were to occur then e^* would not occur. Furthermore, e^* does not probabilistically Σ-depend on g^* or h^*, so (II†) does not disqualify a^* from being a cause of e^*. In the first place, e^* does not probabilistically Σ-depend on g^*. Clearly if g^* were to occur without any of the events in Σ, then e^* would occur. But, e^* would also occur in a counterfactual situation where neither g^* nor any of the events in Σ occurs, because h^* would occur and cause e to fire. This means that e^* does not probabilistically Σ-depend on g^*. It follows from the symmetrical reasoning that e^* does not probabilistically Σ-depend on h^*. Thus (NC) seems to deliver the wrong verdict that a^* is a cause of e^*.

By contrast, (NC′) delivers the right verdict that a^* is not a cause of e^*. For a superset $\Sigma^* = \{d^*, f^*, k^*, g^*\}$ of $\Sigma = \{d^*, f^*, k^*\}$, e^* probabilistically

[2] In personal communication, Noordhof said that he had had cases like this one in mind.

Σ^*-depends on a^*. For if a^* were to occur without any of the events in Σ^* then h^* would bring about e^*, whereas if neither a^* nor any of the events in Σ^* were to occur then e^* would not occur. However, e^* does probabilistically Σ^*-depend on h^*. For if h^* were to occur without any of the events in Σ^* then e^* would occur, whereas if neither a^* nor any of the events in Σ^* were to occur then e^* would not occur. If so, (II′) is not fulfilled because h^* is a non-actual event. It follows from the symmetrical reasoning that, for a superset $\Sigma^{**} = \{d^*, f^*, k^*, h^*\}$ of $\Sigma = \{d^*, f^*, k^*\}$, e^* Σ^{**}-depends on g^* as well as a^*. Then (II′) is violated once more because g^* is a non-actual event. Thus (II′) disqualifies a^* from being a cause of e^*. Accordingly, Noordhof might argue that, since (NC) allows the counter-example depicted in Diagram 2 but (NC′) does not, the former should give way to the latter.[3]

Unfortunately, Noordhof's possible argument is a nonstarter because in fact (NC) does succeed in ruling out a^* from being a cause of e^*. Let p^* be a mereological sum of g^* and h^*. Then, for $\Sigma = \{d^*, f^*, k^*\}$, e^* probabilistically Σ-depends on p^*. For if p^* were to occur without any of the events in Σ then e^* would occur, whereas if neither p^* nor any of the events in Σ were to occur then e^* would not occur. But, p^* is a non-actual event because both g^* and h^* are non-actual events. Accordingly, (II†) is not fulfilled, so a^* does not qualify as a cause of e^* with $\Sigma = \{d^*, f^*, k^*\}$ by (NC).

Moreover, there are no other Σ-sets with which a^* qualifies as a cause of e^* by (NC). Note that e^* probabilistically Σ-depends on p^* as long as k^* is in the Σ-set and that e^* probabilistically Σ-depends on a^* only if k^* is in the Σ-set. This means that, for any Σ-set with which e^* probabilistically Σ-depends on a^*, e^* probabilistically Σ-depends on p^*. Accordingly, without violating (II†), e^* does not probabilistically Σ-depend on a^*. Thus (NC) delivers the right verdict that a^* is not a cause of e^*. As a result, Noordhof's possible motivating argument for (II′) fails.[4]

Programs in History and Philosophy of Science
Seoul National University
Sillim-dong, Kwanak-gu, Seoul 151-742, Korea
choise80@snu.ac.kr

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[3] Since the example involves only deterministic causation, if it were a genuine counter-example to (NC) then it would be a counter-example to the PCA account of causation, too. On this point I am indebted to Inkyo Chung.

[4] I thank Inkyo Chung, Paul Noordhof and Hwan Sunwoo for their helpful comments.

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Sungho Choi and the 'actual events' clause

PAUL NOORDHOF

In order to keep matters brief, I shall assume knowledge of my *Mind* paper and Sungho Choi's paper printed before this brief response (Noordhof 1999; Choi 2001). Sungho Choi claims that the example I gave to motivate my formulation of the 'actual events' clause fails to motivate it and that the formulation, in fact, contains a redundant element, namely my appeal to supersets. I think he is right that my example doesn't work. However, I think he is wrong that the actual events clause contains a redundant element. The second case he discusses provides the motivation we need.

In his discussion of the second case, Sungho Choi makes two key claims. First that e^* probabilistically Σ-depends on p^* (the mereological sum of g^* and h^*) where $\Sigma = \{d^*, f^*, k^*\}$. Second, that there are no other Σ-sets for which a* comes out a cause of e^*. I concede the second point. However, I think that he is wrong about the first. If we consider what would happen if the mereological sum of g^* and h^* did not occur, it does not follow that neither g^* nor h^* occurred, only that one didn't. In which case e^* does not probabilistically Σ-depend on p^*. If p^* did not occur, it is still possible that one of g^* or h^* did occur and hence that e^* might have occurred. Although, for the reasons given by David Lewis and implied by the similarity metric I put forward in my response to Ramachandran, I don't accept that 'x might occur' entails 'it is not the case that x would not occur', I think that, in the actual set-up he describes, it would be plausible that, if e^* might occur, it is not the case that e^* would not occur (Lewis 1986: 64–65; Noordhof 2000: 319–21). Certainly I would not want to rest a theory on insisting that the move from 'e^* might occur' to 'it is not the case that e^* would not occur' is implausible in this case. It would have better served Sungho Choi's purposes to have appealed not to the mereological sum but to the disjunction of g^* and h^*. e^* does probabilistically Σ-depend on the disjunctive event. But I still have a worry. Some might deny that there is a

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