Causation, Nomic Subsumption, and the Concept of Event

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IN his celebrated discussion of causation Hume identified four prima facie constituents in the relation of causation. As everyone knows, they are constant conjunction, contiguity in space and time, temporal priority, and necessary connection. As ordinarily understood, the causal relation is a binary relation relating causes to their effects, and so presumably are the four relations Hume discerns in it. But what do these four relations tell us about the nature of the entities they relate?

Constant conjunction is a relation between generic events, that is, kinds or types of events; constant conjunction makes no clear or nontrivial sense when directly applied to spatiotemporally bounded individual events.[1] On the other hand, it is clear that the relation of temporal priority calls for individual, rather than generic, events as its relata; there appears to be no useful way of construing 'earlier than' as a relation between kinds or classes of events in the causal context.

What of the condition of contiguity? This condition has two parts, temporal and spatial. Temporal contiguity makes sense when applied to events; two events are contiguous in time if they temporally overlap. But spatial contiguity makes best sense when applied not to events but to objects, especially material bodies; intuitively at least, we surely understand what it is for two bodies to be in contact or to overlap. For events, however, the very notion of spatial location often becomes fuzzy and indeterminate. When Socrates expired in the prison, Xantippe became a widow and their three sons became fatherless. Exactly *where* did these latter events take place? When

* I am indebted to Richard Brandt, Alvin and Holly Goldman, and Ernest Sosa for helpful suggestions.

[1] By 'event' simpliciter I always mean individual events; when I mean generic events I shall say so.

Hume's two billiard balls collide, what obviously are in spatial contact are the two balls. Are the *motions* of the balls also in spatial contact? Reflections on these and other cases suggest that the locations of events, and hence their spatial contiguity relations, are parasitic in some intricate ways on the locations of objects.[2] As for the controversial idea of necessary connection, we are clearly more at home with this notion taken in the *de dicto* sense as applying to sentences, propositions, and the like, than when it is taken in the *de re* sense as applying directly to objects and events in the world.

Hume's four conditions, therefore, seem at first blush to call for apparently different categories of entities as relata of causal relations. We might say that the four conditions are jointly incongruous ontologically, thereby rendering the causal relation ontologically incoherent. I do not intend these remarks as criticisms of the historical Hume; I am merely pointing up the need for a greater sensitivity to ontological issues in the analysis of causation.

In this paper I want to examine some logical and ontological problems that arise when we try to give a precise characterization of Humean causation.[3] (I call "Humean" any concept of causation that includes the idea that causal relations between individual events somehow involve general regularities.) In fact, my chief concern will be focused not on the full-fledged concept of causation but rather on the concept of nomic subsumption, the idea of bringing individual events under a law, which is at the core of the Humean approach to causation. I begin with an examination of one popular modern formulation of Humean causation, "the nomic-implicational model."

I. "SUBSUMPTION UNDER A LAW"

When we try to explain the notion of subsuming events under a law, a notion of central importance to Humean causation, we immediately face a problem which turns out to be more intractable than it might at first appear: laws are sentences (or statements, propositions, etc.), but events are not. Exactly in what relation must a pair of events stand to a law if the law is to "subsume" the events? Given the categorial difference between laws and events, it would be quite senseless to say that one of the events must be "logically implied" by the other event taken together with the law. However,

[2] Zeno Vendler makes the claim that events are primarily temporal entities, whereas objects are primarily spatial, and that the attributions of temporal properties and relations to objects and of spatial properties and relations to events are derivative. See his *Linguistics in Philosophy* (Ithaca, N.Y.: Cornell, 1967), pp. 143–144.

[3] For a general discussion of Humean causation see Bernard Berofsky, *Determinism* (Princeton, N.J.: University Press, 1971), esp. chs. IV, VI, and VII.

the temptation to use logico-linguistic constructions is great, and one tries to bring events within the purview of logic by talking about their descriptions.

(1) Law L subsumes events e and e' (in that order) provided there are descriptions D and D' of e and e' respectively such that L and D jointly imply D' (without D alone implying it).[4]

Thus, according to this formulation, the law 'All copper expands upon heating' subsumes the events described by 'This piece of copper was heated at t' and 'This piece of copper expanded at t'. The basic idea is that nomic subsumption is nomic implication between appropriate event descriptions.

Here 'describe' is the key word. The crucial assumption of the nomic-implicational model as embodied in (1) is that *certain sentences describe events.* But how do we explain this notion? There are three important related problems here: (i) What types of sentences describe events? (ii) Given an event-describing sentence, what particular event does it describe? (iii) Under what conditions do two such sentences describe the same event?

Recent investigations[5] have shown that there are no simple answers to these questions and that the intuitive ideas we have about them are full of pitfalls, if not outright contradictions. Let us briefly see how a seemingly natural and promising line of approach runs quickly into a dead end.

Consider a sentence like 'This piece of copper was heated at t', which we would take as a typical event-describing sentence. We may think of the whole sentence as describing the event of this piece of copper being heated at t. An event-describing sentence in this sense has the form 'Object x has property P at time t' and affirms of a concrete object that it has a certain empirical property at a time (let us not worry about polyadic cases). Such a sentence, if true, is thought to describe the event of x's having P at t. Now, once this approach is adopted, the following development is both natural and inescapable: if object a is the very same object as object b, then the event of a's having P at t is the same event as

[4] Compare Arthur Pap: "In the scientific sense of 'cause', an event A causes an event B in the sense that there is a law, L, such that from the conjunction of L and a description of A the occurrence of B is logically deducible." *An Introduction to the Philosophy of Science* (New York: Free Press, 1962), p. 271. We shall not consider here the difficulty that, according to (1), undescribed events are not subsumable under any law and as a result cannot enter into causal relations.

[5] See, e.g., Donald Davidson, "The Individuation of Events" in Nicholas Rescher *et al.*, eds., *Essays in Honor of Carl G. Hempel* (Dordrecht: Reidel, 1969); and my "Events and Their Descriptions: Some Considerations," *ibid.*

the event of b's having P at t. Thus, if 'a' and 'b' are coreferential, the sentences 'a has P at t' and 'b has P at t' describe the same event.[6] But now see what happens to the nomic-implicational model (1).

Let the law '$(x)(Fx \rightarrow Gx)$' subsume the two events described by 'c has F' and 'c has G' (we drop 't' for simplicity). Then, if 'b has H' is any true event-describing sentence, the law subsumes the event described by 'b has H' and the event 'c has G'; for the former event is also described by '$(Ix)(x = b \ \& \ c$ has $F)$ has H',[7] which, together with the law '$(x)(Fx \rightarrow Gx)$', but not by itself, implies 'c has G'. In fact, it can be shown that any law that subsumes, in the sense of (1), at least one pair of events subsumes every pair.

The moral of these difficulties for the nomic-implicational model is this: once the description operator 'I' is available, we can pack as much "content" as we like into any singular sentence, and this can likely be done without changing the identity of the event described. Obviously, this is bound to cause trouble for any account of causation or nomic subsumption based on the relation of logical implication, since logical implication essentially depends on the content of sentences.[8]

So far we have examined the difficulties for (1) that arise from the notion of a sentential description of an event. Let us now go on to difficulties of another type arising from the other central idea of (1): that nomic subsumption of events can be linguistically mirrored by nomic implication between their descriptions.

The obvious similarity between the so-called "covering-law model" of explanation and what we have called "the nomic-implicational model" of causation will not have escaped notice. It should then come as no surprise that difficulties for one have counterparts in the difficulties for the other; however, this fact seems not to have been fully appreciated.

A valid argument having the following properties will be called a 'D-N argument' ('D-N' for 'deductive-nomological'): (i) its premises include both laws and singular sentences and its conclusion is singular, and (ii) the argument becomes invalid upon the deletion of the laws from the premises. The covering-law model of explanation, as a first approximation, can be formulated thus: an event

[6] For more details see my "Events and Their Descriptions: Some Considerations," *ibid.*

[7] We follow Dana Scott in the use of 'I' as definite description operator. See Scott, "Existence and Description in Formal Logic," in Ralph Schoenman, ed., *Bertrand Russell: Philosopher of the Century* (Boston: Little Brown, 1967).

[8] Thus, the method favored by Davidson for handling event-describing sentences runs afoul of the same difficulties in connection with (1). See his "Causal Relations," this JOURNAL, LXIV, 21 (Nov. 9, 1967): 691–703, esp. p. 699.

is explained when a D-N argument is constructed whose conclusion describes that event. In terms of 'D-N argument', the nomic-implicational model of subsumption under a law comes to this: two events are subsumed under a law just in case there is a D-N argument whose premises are the law and a description of one of the events and whose conclusion is a description of the other event.

It is trivial to show that the notion of D-N argument as characterized cannot coincide with explanation, for the following is easily shown: for any law L and a true event-description D', there is a true singular sentence D such that 'L, D, therefore D'' is a D-N argument.[9] Thus, one law would suffice to explain any event you please. As an example: you want to explain why an object b has property F, for any b and F you choose. So you construct the following D-N argument: 'Copper is an electric conductor, b is F or b is nonconducting copper, therefore b is F'.

With regard to this and similar cases, the proponent of the nomic-implicational model might plead that the singular premise in such an argument (e.g., 'b is F, or b is nonconducting copper'), being a compound sentence of a rather artificial sort, cannot be thought of as an event-description.[10] Apart from the fact that this reply presupposes a satisfactory solution to the problem raised earlier of characterizing 'event-describing sentence', it seems to have a good deal less force against a pseudo-D-N argument like this: 'All crows are black, b is a crow, and c has the color of b. Therefore c is black'.

There is as yet no adequate formulation of the notion of 'D-N argument' that can successfully cope with these and other simple anomalous arguments; and it is unclear how examples of the second sort just described can be handled within the existing scheme of the theory of explanation. In any case, the unsettled state of the formal theory of deductive explanation implies a similar unsettled state for the nomic-implicational approach to Humean causation.

Enough has been said, I think, to justify at least a temporary shift of strategy away from the logico-descriptive approach underlying the nomic-implicational model. In the two sections to follow, we shall explore a direct "ontological approach" which dispenses with talk of descriptions and implications.

[9] For further details see Carl G. Hempel and Paul Oppenheim, "Studies in the Logic of Explanation," reprinted in Hempel, *Aspects of Scientific Explanation* (New York: Free Press, 1965) and the references given in Hempel's "Postscript" to this article.

[10] In fact, a clearer understanding of event-describing sentences is likely to help us with the problem of characterizing the structure of deductive explanation, since many counterexamples to the standard account contain singular premises which are intuitively not event-describing.

II. THE STRUCTURE OF EVENTS

Once we abandon the logico-descriptive approach, we must begin taking events seriously, since the only clear alternative to it is to define the causal relation directly for events without reliance on linguistic intermediaries. But what is an event? What sort of structures do we need as relata of causal relations? In this section I sketch an analysis of events[11] on the basis of which I shall formulate three versions of Humean causation in the next section.

We think of an event as a concrete object (or n-tuple of objects) exemplifying a property (or n-adic relation) at a time. In this sense of 'event', events include states, conditions, and the like, and not only events narrowly conceived as involving changes. Events, therefore, turn out to be complexes of objects and properties, and also time points and segments, and they have something like a propositional structure; the event that consists in the exemplification of property P by an object x at time t bears a structural similarity to the sentence 'x has P at t'. This structural isomorphism is related to the fact that we often take singular sentences of the form 'x has P at t' as referring to, describing, representing, or specifying an event; also we commonly and standardly use gerundial nominals of sentences to refer to events as in 'the sinking of the Titanic', 'this match's being struck', 'this match's lighting', and so forth.

We represent events by expressions of the form

$$`[(x_1, \ldots, x_n, t), P^n]'$$

An expression of this form refers to the event that consists in the ordered n-tuple of concrete objects $(x_1, \ldots, x_n)$ exemplifying the n-adic empirical attribute P^n at time t. Strictly speaking, P^n is $(n + 1)$-adic since we count 't' as an argument place; but we follow the usual procedure of reckoning, for example, redness as a property rather than a relation even though objects are red, or not red, *at a time*. (In fact, there is no reason why time should be limited to a single argument place in an attribute, but let us minimize complexities not directly relevant to our central concerns.) We shall abbreviate '$(x_1, \ldots, x_n)$' as '$(\mathbf{x}_n)$' and '$(x_1, \ldots, x_n, t)$' as '$(\mathbf{x}_n, t)$' re-

[11] This account was adumbrated in my "On the Psycho-Physical Identity Theory," *American Philosophical Quarterly*, III, 3 (July 1966): 231–232. It bears a resemblance to R. M. Martin's analysis in "Events and Descriptions of Events," in J. Margolis, ed., *Fact and Existence* (Oxford: Blackwell, 1969) and also to Alvin I. Goldman's account of action in *A Theory of Human Action* (Englewood Cliffs, N.J.: Prentice-Hall, 1970), ch. 1. Nancy Holmstrom develops a similar notion of event in her doctoral dissertation, *Identities, States, and the Mind-Body Problem*, The University of Michigan, 1970.

spectively, and drop the superscript from 'P^n'. The variable 't' ranges over time instants and intervals; when 't' denotes an interval, 'at t' is to be understood in the sense of 'throughout t'. We call P, $(\mathbf{x}_n)$, and t, respectively, the "constitutive attribute", "the constitutive objects", and "the constitutive time" of the event $[(\mathbf{x}_n, t), P]$.

We adopt the following as the condition of event existence:

Existence condition: $[(\mathbf{x}_n, t), P]$ exists if and only if the n-tuple of concrete objects $(\mathbf{x}_n)$ exemplifies the n-adic empirical attribute P at time t.

Linguistically, we can think of '$[(\mathbf{x}_n, t), P]$' as the gerundive nominalization of the sentence '$(\mathbf{x}_n)$ has P at t'. Thus, '[(Socrates, t), drinks hemlock]' can be read "Socrates' drinking hemlock at t." Notice that $[(x, t), P]$ is not the ordered triple consisting of x, t, and P; the triple exists if x, t, and P exist; the event $[(x, t), P]$ exists only if x has P at t. As property designators we may use ordinary (untensed) predicative expressions; when the order of argument places has to be made explicit we use circled numerals;[12] e.g.,

$$[(a, b, c, t), \text{② stands between ① and ③}]$$

corresponds, by the existence condition, to the sentence 'b stands between a and c at t'. The proviso that the constitutive attribute of an event be "empirical" is intended to exclude, if one so wishes, tautological, evaluative, and perhaps other kinds of properties; but we must in this paper largely leave open the question of exactly what sorts of attributes are admissible as constitutive attributes of events.

When P is a monadic attribute, that is, when only "monadic events" are considered, the following identity condition is immediate:

Identity condition I_1: $[(x, t), P] = [(y, t'), Q]$ if and only if $x = y$, $t = t'$, and $P = Q$.

Thus, Socrates' drinking hemlock at t is the same event as Xantippe's husband's drinking hemlock at t, and this liquid's turning blue at t is the same event as its turning the color of the sky at t.

Two objections might be voiced at this point. First, it might be contended that the event [(Brutus, t), stabs Caesar] is the very same event as [(Caesar, t), is stabbed by Brutus], although our identity condition pronounces them to be distinct. Our reply here is

[12] Following W. V. Quine, *Methods of Logic* (New York: Holt, Rinehart & Winston, 1950), pp. 130ff. For formal development property abstracts could be used; see, e.g., Richard Montague, "On the Nature of Certain Philosophical Entities," *Monist*, LIII, 2 (April 1969): 159–194.

that what the critic might have in mind are the dyadic events [(Brutus, Caesar, t), stabs] and [(Caesar, Brutus, t), is stabbed by], and that, according to the identity condition for dyadic events below, these events are indeed one and the same. Generally, we do not allow "mixed universals" [13] such as stabbing Caesar as constitutive attributes of events; only "pure universals" [13] are allowed as such.

Second, it might be objected that the event [(Xantippe's husband, t), dies] is identical with the event [(Xantippe, t), becomes a widow], viz., Xantippe's husband dying at t is the same event as Xantippe's becoming a widow at t, although again I_1 is not satisfied. We answer that these are indeed different events. Consider, for example, their locations: the first obviously took place in the prison in which Socrates took the poison, but it is not clear exactly where the second event occurred. We might want to locate it where Xantippe was at the moment of Socrates' death (and this is the procedure we shall adopt), but clearly not in the prison. To be sure, the two events are connected; in fact, the biconditional '[(Xantippe's husband, t), dies] exists if and only if [(Xantippe, t), becomes a widow] exists' is demonstrable from the existence condition; one might wish to say that necessarily one exists if and only if the other does. But this has no tendency to show that we have one event here and not two. One could just as well argue that since 'The husband of Socrates' wife exists if and only if Socrates' wife exists' is necessarily true, the husband of Socrates' wife is the same as Socrates' wife.

Now for dyadic events: if we want the identity '[(Brutus, Caesar, t), stabs] = [(Caesar, Brutus, t), is stabbed by]', we obviously cannot simply repeat I_1 for dyadic events. But what we should say is equally obvious. For any dyadic relation R, let R^* be its converse. We then have:

Identity condition I_2: $[(x, y, t), R] = [(u, v, t'), Q]$ if and only if either (i) $(x, y) = (u, v)$, $t = t'$, and $R = Q$, or (ii) $(x, y) = (v, u)$, $t = t'$, and $R = Q^*$.

For the general case of n-adic events, we need to generalize the concept of converse to n-adic relations. Any n-termed sequence can be permuted in $n!$ different ways (including the identity permutation). If k is a permutation on n-termed sequences (note that k is a *scheme* of permutation, not a particular permuted sequence), then by '$k(\mathbf{x}_n)$' we denote the sequence resulting from permuting the

[13] For a possible explanation of these terms, see Arthur W. Burks, "Ontological Categories and Language," *Visva-Bharati Journal of Philosophy*, III (1967): 25–46, esp. pp. 28–29.

sequence $(\mathbf{x}_n)$ by k. The $n!$ permutations on n-termed sequences form a group, and for each permutation k there exists an inverse k^{-1} such that $k^{-1}(k(\mathbf{x}_n)) = (\mathbf{x}_n)$. If k is a permutation on n-termed sequences and R is an n-adic relation, $k(R)$ is to be the n-adic relation such that, for every $(\mathbf{x}_n)$, $(\mathbf{x}_n)$ has $k(R)$ if and only if $k^{-1}(\mathbf{x}_n)$ has R.[14] It follows that, for each k, $k(\mathbf{x}_n)$ has $k(R)$ if and only if $(\mathbf{x}_n)$ has R. The $n!$ permutations of an n-adic relation R can be thought of as the converses of R. Just as the converse of a dyadic relation may be identical with the relation itself (that is, the relation is symmetric), some of the converses of an n-adic relation may in fact be identical.

We now state the identity condition for the general case:

> Identity condition I_n: $[(\mathbf{x}_n, t), P] = [(\mathbf{y}_m, t'), Q]$ if and only if there exists a permutation k on m-termed sequences such that $(\mathbf{x}_n) = k(\mathbf{y}_m)$, $t = t'$, and $P = k(Q)$.

Obviously, I_n entails I_1 and I_2 for $n = 1, 2$. We can say, for example, that $[(a, b, c, t)$, ① gives ② to ③$] = [(c, b, a, t)$, ① receives ② from ③$]$. The permutation involved here is (13) (2), i.e., the permutation whereby the first element is replaced by the third, the second by itself, and the third by the first.

This completes the presentation of what is admittedly a sketchy account of events. And it is only a beginning; many interesting problems remain. First of all, there is the problem of characterizing more precisely the syntactical and semantical properties of the operator '[ ]'. According to our identity condition, Socrates' dying is a different event from Xantippe's becoming a widow. What then is the relationship between the two? What is the relationship between my firing the gun and my killing Jones?[15] How are such notions as "complex events," "compound events," "part-whole" (for events), etc. to be explained? And above all, there is the problem of how the notion of "property" (generally, that of "attribute") is best construed for the purposes of an event theory of this kind,

[14] This is not intended as a definition, but only an informal explanation, of '$k(R)$'. As a definition it would likely be construed as presupposing an extensional interpretation of attributes (whether in the possible-world semantics or in some other scheme), whereas I prefer to be silent on this issue here. It may be useful, however, to point out that we are as much entitled to this informal explanation of '$k(R)$' as we are to the usual informal explanation of the notion of 'converse' of a binary relation.

[15] This problem is extensively discussed in Goldman, *A Theory of Human Action.* See also the APA Symposium on "The Individuation of Action" by Goldman, Judith Jarvis Thomson, and Irving Thalberg, this JOURNAL, LXVIII, 21 (Nov. 4, 1971): 761–787.

and in particular how those properties which can be constitutive properties of events (these properties can be called "generic events") should be characterized. It seems to me that the resolution of these problems about events depends on a satisfactory general account of properties; in fact, many interesting problems about events are likely to remain unresolved until such an account is at hand. In any case, we shall be alluding below to some of these further problems.

III. CAUSATION REVISITED

There appears to be a general agreement that the requirement of constant conjunction for causal relations for individual events is best explained in terms of lawlike correlations between generic events. Constant conjunction obviously makes better sense for repeatedly instantiable universals than for spatiotemporally bounded particulars. But, given a particular causal relation between two individual events, precisely which generic events must be lawfully correlated in order to sustain it?

Our account of events gives a quick answer. Every event has a unique constitutive property (generally, attribute), namely the property an exemplification of which by an object at a time is that event. And, for us, these constitutive properties of events are generic events. It follows that each event falls under exactly one generic event, and that once a particular cause-effect pair is fixed, the generic event that must satisfy the constant conjunction requirement is uniquely fixed. It is important to notice the distinction drawn by our analysis between properties *constitutive of* events and properties *exemplified* by them. An example should make this clear: the property of dying is a constitutive property of the event [(Socrates, t), dying], i.e., Socrates' dying at t, but not a property exemplified by it; the property of occurring in a prison is a property this event exemplifies, but is not constitutive of it. Under our account, then, if Socrates' drinking hemlock (at t) was the cause of his dying (at t'), the two generic events, drinking hemlock and dying, must fulfill the requirement of lawlike constant conjunction.

This procedure, therefore, is in sharp contrast with the procedure in which the inner structure of events is not analyzed and which, as a result, does not associate with each event a unique constitutive property. On that approach no distinction is made between properties constitutive of events and properties exemplified by them; and an individual event is usually thought to fall under many, in fact an indefinite number of, generic events; for example, one and the same event can be the moving of a finger, the pressing of the trigger of a gun, a shooting, and a mercy killing.[16] How, on that view, might one answer the question raised at the outset of this section? Evidently, it would be too strong to require that every generic event under which the cause event falls be lawfully related to every generic event under which the effect event falls. A more reasonable proposal, which seems to be what many have in mind, would be to say that two causally related events are such that there are at least two lawfully correlated generic events under which they respectively fall. Thus, two events, e and e', satisfy the constant-conjunction requirement just in case there are generic events F and G such that e is an F-event, e' is a G-event, and F-events are constantly conjoined with G-events.

Given the considerable freedom permitted by this formula in the choice of the generic events to which the two events belong, the requirement of constant conjunction as stated turns out to be too easy to satisfy. If any grouping of events is allowed as a generic event—or if any property exemplifiable by events is taken as one—then the requirement thus interpreted becomes quite useless; it can be shown that every event satisfies this requirement with respect to any event that satisfies it with respect to at least one event. For let e_1 and e_2 satisfy the requirement in virtue of the constant conjunction between F-events and G-events; that is, e_1 is of kind F, e_2 is of kind G, and whenever an F-event occurs there occurs a corresponding G-event. Let e_3 be any arbitrary event and let R be any relation such that $R(e_3,e_1)$. We explain 'H' to be true of any event e just in case $(\exists f)(R(e,f)\ \&\ F(f))$. Then clearly e_3 belongs to the generic event H, and H-events are constantly conjoined with G-events, from which it follows that e_3 and e_2 satisfy the requirement of constant conjunction. This plainly is a result we want to avoid.[17]

In comparison, our procedure will make it a good deal more difficult—too difficult, some will say—to satisfy the constant-conjunction requirement because, as we noted, once cause and effect are fixed, the generic events that must lawfully correlate are also fixed. There may be a way of framing a reasonable condition of constant conjunction without associating a unique generic event with each event, but it is hard to see what it could be. In any case I

[16] Compare Donald Davidson: "I flip the switch, turn on the light, and illuminate the room. Unbeknownst to me I also alert a prowler to the fact that I am home. Here I do not do four things, but only one, of which four descriptions have been given." "Actions, Reasons, and Causes," this JOURNAL, LX, 23 (Nov. 7, 1963): 685–700, p. 686.

[17] This has been adapted from an argument given by J. A. Foster in "Psychophysical Causal Relations," *American Philosophical Quarterly*, V, 1 (January 1968): 65–66.

do not wish to suggest that the foregoing considerations tilt the the balance decisively in favor of our procedure; as we shall shortly see, there is a difficulty of a somewhat similar nature for our procedure as well.

What does it mean to say that two generic events are constantly conjoined or lawfully correlated? It clearly is not enough to repeat the usual formula that the occurrence of an event of one kind is always followed by the occurrence of an event of the other kind. We need to make more specific the relation between the given event of the first kind and *the* event of the second kind that is to be associated with it. As an example, the heating of a metallic object and the expansion of a metallic object would be constantly conjoined, according to this formula, provided only that whenever a metallic object is heated, *some* metallic object *somewhere* expands. In this particular case, what we have in mind is that whenever a metallic object is heated *it* expands. But this cannot be made into a general requirement, since we must allow causal relations between events whose constitutive objects are different. A similar sort of indeterminacy besets the expression 'whenever' in the above formula; we do not want to say that a given event of kind F and the particular event of kind G that follows it must be simultaneous; but to leave this indefinite ("each F-event is followed by a G-event at some time or other") is to render the requirement vacuous.

What seems needed, then, is a way of relating a particular F-event to that particular G-event with which it is associated by the constant conjunction of F-events with G-events. Such a relation would also be useful for correctly pairing a cause with *its* effect and an effect with *its* cause. If two rifles are fired simultaneously, resulting in two simultaneous deaths, we need a relation of that kind to pair each rifle shot with the death it causes and not with the other.[18] Notice, by the way, that those who would allow for each event a multiplicity of generic events are faced with the same pairing problem.

If x's being F at t is causally related to y's being G at t', this must be so in virtue of some relation R holding for x, t, y, and t'. How else could the following two facts be explained? First, given that x is F at t, there are objects other than y that are not G at t'; and there are times other than t' at which the object y is not G. Second, again given that x is F at t and this event causes y's being G at t', there can be (and usually would be) other individual events of kind G

[18] Haskell Fain raises a similar problem in "Some Problems of Causal Explanation," *Mind*, LXXII, 288 (October 1963): pp. 519–532.

occurring at t' that are causally unrelated to x's being F at t. Now it seems that there are three different ways in which such a relation could be worked into an analysis of Humean causation: (A) we look for a single "pairing relation" for all cases of constant conjunction (or Humean causal relations); (B) we let the choice of a suitable pairing relation depend on the specific generic events F and G to be correlated (and perhaps the choice may also depend on the specific individual events to be causally related); (C) we build such a pairing relation into the cause event so that the cause is not the event of x's being F at t, but rather the "complex event" of x's being F and also being in relation R to y at t.

In what follows we explore these three possibilities. In addition to their individual strengths and shortcomings, all three will be seen to be subject to one important difficulty. But a close examination and discussion of the comparative merits and faults of these three approaches cannot be attempted here, although of course I shall be making remarks relevant to a comparative evaluation of them. The order in which the three approaches will be considered is this: first (B), then (A), and finally (C).

An analysis of the causal relation that falls under (B) is the following definition of 'causal sufficiency' offered by J. A. Foster (*op. cit.*, p. 67):

a's being F is causally sufficient for b's being G if and only if there exists a relation R such that

(i) $F(a)$, $G(b)$, and $R(a,b)$

(ii) $(x)(F(x) \rightarrow (\exists y)(G(y) \ \& \ R(x,y)))$ [19]

(iii) $(x)(F(x) \ \& \ R(x,b) \supset x = a) \ \& \ (x)(G(x) \ \& \ R(a,x) \supset x = b)$

The condition (ii) of course is the constant-conjunction requirement; and the condition (iii) states that the pairing relation R must be such that at most one thing that is F, namely a, bears R to b and that a bears R to at most one thing that is G, namely b. The choice of R depends not only on F and G but also on a and b.

It seems to me that Foster's (ii) is not the most useful way of stating the lawlike correlation of F and G; there appears to be no simple way of accommodating such mundane examples of causal relations as a's firing a rifle and b's dying, a's having such-and-such mass and b's accelerating with such-and-such rate of acceleration

[19] We use the arrow '$\rightarrow$' to denote whatever type of implication the reader deems appropriate for stating laws in something like this form (this in effect is also Foster's practice). We do not consider here the question of precisely what sort of "nomic force" if any, should be carried by a statement of a constant conjunction. For various possible interpretations of causal or nomological implication, see Arthur W. Burks, *Cause, Chance, and Reason* (forthcoming).

(toward a by gravitational attraction), and so on. The problem is simply that the laws in question do not entail a statement of the form (ii) to the effect that if any object has property F *there exists at least one object y* fulfilling the consequent of (ii). (Foster restricts his definition so that a, b, and objects in the range of 'x', 'y', ..., are "momentary particulars" without temporal duration, but this doesn't affect the problem.) It would seem that (ii) is more usefully stated thus: $(x)(y)(F(x) \; \& \; R(x,y) \rightarrow G(y))$.

In any case, let us turn to another problem. Let us assume, as Foster does, that, for any spatiotemporal objects a and b, their exact spatiotemporal relation R satisfies the condition (iii), regardless of what F and G may be; this assumption holds if the identity of spatiotemporal objects is determined completely by their spatiotemporal location. With this assumption at hand we can show the following: If a's being F is causally sufficient for b's being G, then for any object c there exists a property H such that c's being H is causally sufficient for b's being G. For let R_1 be the spatiotemporal relation between c and a, and let R_2 be the spatiotemporal relation between c and b. And we set H to be the property denoted by the expression '$(\exists y)(F(y) \; \& \; R_1(x,y))$'. Then, the law '$(x)(H(x) \rightarrow (\exists y)(G(y) \; \& \; R_2(x, y)))$' holds; and the other conditions are obviously satisfied. To make this more concrete, consider this case: the object b's being heated is causally sufficient for its expanding (here $a = b$ and the relation R can be taken as identity). Let c be an object exactly 50 miles due north of the object that is being heated. The property H in this case is the property an object has in virtue of there being another object 50 miles due south that is being heated. Morevoer, given the law that all objects expand when heated, we have the law that for any object x if x has the property H, then there exists an object 50 miles due south which is expanding. From this it follows that c's having property H is causally sufficient for b's expanding.[17]

Cases like this need not be regarded as necessarily objectionable for Foster's definition, which defines causal sufficiency, not causation. However, they would be clearly objectionable if the relation defined were that of causation. It would be absurd to say that object c's having H caused object a to expand, or that c causally influenced or interacted with a. Notice that Foster's definition can be directly mirrored in our framework of events, since the entities related by his causal sufficiency, a's being F, b's being G, etc., are close analogues of our $[(a, t), F]$, $[(b, t), G]$, etc. The implication of the above example then is that, under a definition of the causal relation similar to Foster's definition of 'causal sufficiency' (notice here that the possible alteration of the condition (ii) does not materially affect the difficulty), if an event is caused by another, then every object is the constituent object in some event which is a cause of the first; that is, there would be no object "causally independent" of that event.

As we shall see, the two remaining ways of handling the pairing problem are open to difficulties of a similar sort. The gist of the difficulties is this: when there is a constant conjunction between F and G, then, for any object you please, we can pick a property H such that the object has H, and H is constantly conjoined with G. Thus, this spurious constant conjunction rides piggyback, so to speak, on the genuine correlation between F and G; we may call this problem "the problem of parasitic constant conjunctions."

We may, I think, question whether the artificially concocted property H can in general be regarded as a constitutive property of an event. A negative answer seems plausible, although a plausible defense of it would be a subtle and difficult matter. We feel that for an object to have this sort of property (recall the special case of H above) is not always for it to undergo, or be disposed to undergo, a "real change"; my being 50 miles east of a burning barn is hardly an event that happens to me.[20] But it would be a mistake to ban all such properties; my being in spatial contact with a burning barn is very much an event that happens to me. Whether a clear distinction between these two kinds of cases can be made that does not beg the question by using causal concepts is an interesting question to which I know of no completely satisfying answer. This is a special case of the more general problem alluded to earlier, namely that of characterizing the properties whose exemplification by an object at a time is an event, i.e., generic events.

We now turn to the approach (A) to the pairing problem. One feature of the event $[(c, t), H]$ which enters into an unwanted causal relation with the event $[(b, t), G]$ is the fact that its constitutive object c, need not be in spatial contact with the constitutive object b, of $[(b, t), G]$. In fact, Hume's condition of spatial contiguity is not mentioned at all in Foster's definition of 'causal sufficiency'. Thus, if we are willing to go along with Hume here, the contiguity relation presents itself as a natural candidate for the pairing relation. This manner of handling the pairing problem differs from the one we have just considered in that there would be a single uniform

[20] In this connection see Peter Geach's interesting remarks on "Cambridge changes" in *God and the Soul* (London: Routledge & Kegan Paul, 1969), pp. 71–72.

relation doing the job for all causal relations independent of the particular cause and effect events.

As Hume was aware, however, direct contiguity cannot be generally required for causal relations; following Hume's own suggestion,[21] we shall try first to explain 'direct contiguous causation' and then explain 'causation' as a "chain" of direct contiguous causal relations. Thus, the analysis of causation that follows is not only "Humean"; it is also Hume's.

We first need the contiguity relation for events. It would seem that this relation must be explained in terms of the contiguity relation for objects and times of events (an object is contiguous with another at a time). Thus, if $[(a, T), P]$ is contiguous with $[(b, T'), Q]$, this must be so in virtue of a contiguity relation holding for a, b, T, and T'; and the relevant aspect of the objects a and b is their spatial location at the indicated times. Let '$\mathrm{loc}(x,t)$' denote the spatiotemporal location of x at time t (where x exists at t); where t is an interval, $\mathrm{loc}(x,t)$ will be a spatiotemporal volume. In order not to complicate our problems excessively we consider here only monadic events.

We say that two events $[(a,T), P]$ and $[(b,T'), Q]$ are contiguous just in case $\mathrm{loc}(a,T)$ is contiguous with $\mathrm{loc}(b,T')$—we assume of course that the two events exist. How contiguity for spatiotemporal location is to be explained is a question that depends on the properties of the space-time involved; since nothing in this paper hinges on the exact explanation of this notion, we leave it unanalyzed. We now define 'direct contiguous causation' as follows (we abbreviate 'contiguous with' as 'Ct'):

$[(a, T), P]$ is a *direct contiguous cause of* $[(b, T'), Q]$ provided:

(i) $[(a, T), P]$ is contiguous with $[(b, T'), Q]$.

(ii) If $a = b$: $(x)(t)(t')([(x, t), P] \text{ exists } \& \ \mathrm{Ct}(\mathrm{loc}(x, t), \mathrm{loc}(x, t')) \rightarrow [(x, t'), Q] \text{ exists})$.

If $a \neq b$: $(x)(y)(t)(t')([(x, t), P] \text{ exists } \& \ \mathrm{Ct}(\mathrm{loc}(x, t), \mathrm{loc}(y, t')) \rightarrow [(y, t'), Q] \text{ exists})$.

We define 'contiguous cause' in terms of the ancestral of direct contiguous causation:

e is a contiguous cause of e' if and only if $e \neq e'$ and e bears to e' the ancestral of the relation of direct contiguous causation—that

[21] Hume writes: "Tho' distant objects may sometimes seem productive of each other, they are commonly found upon examination to be link'd by a chain of causes, which are contiguous among themselves, and to the distant objects; and when in any particular instance we cannot discover this connexion, we still presume it to exist." *Treatise of Human Nature*, bk. I, pt. III, sec. II.

is to say, $(S)(e' \in S \ \& \ (f)(g)(f \in S \ \& \ g$ is a direct contiguous cause of $f \supset g \in S) \supset e \in S)$.

Whether contiguity in this sense ought to be required of causal relations as a matter of definition is a debatable issue; in particular, the verification of the existence of a causal chain of the required sort may in practice be an impossible task in many areas of science in which causal attributions are regularly made; and the belief that such a chain must exist may be only metaphysical faith. But these are the questions we must leave aside.[22] Let us now turn to the last of the three ways of dealing with the pairing problem distinguished earlier.

Recall the example of two rifle shots causing two simultaneous deaths. We raised the question how each shot is to be paired with the death it causes. Causal chains will probably help us here, but there seems to be another, perhaps more natural and simpler, way of handling it. It may be said that the cause of a death here is not a rifle shot simpliciter, but rather the rifle shot cum the event (state) of the rifle's being in such-and-such spatiotemporal relationship to the man whose death it causes. Thus, the cause of the man's death is the set of events: the rifle's being fired and its being in a certain relation R to the man (at the time it was fired); we could perhaps speak of a single "compound" or "composite event" of the rifle's being fired and being in relation R to the man. In either case, the man, who is the constitutive object in the effect event, figures in the cause as a constitutive object. Again restricting ourselves essentially to monadic cases, we may capture this idea as follows:

The set of events, $[(a, T), F]$ and $[(a, b, T), R]$, is a cause of the event $[(b, T'), G]$ provided:

(i) $[(a, T), F]$, $[(a, b, T), R]$, and $[(b, T'), G]$ exist, and

(ii) $(x)(y)(t)([(x, t), F]$ exists & $[(x, y, t), R]$ exists $\rightarrow [(y, t + \Delta t), G]$ exists), where $\Delta t = T' - T$.

(iii) The law in (ii) does not hold if one or the other of its antecedent clauses is deleted.

We should be wary of speaking of "composite events" before a precise characterization of them is at hand. But at least we can say this: if $[(a,T), P]$ and $[(a,b,T), R]$ exist, then, by the existence condition, the event $[(a,b,T), R^*]$ exists, where $R^*(x,y)$ at t just in case $P(x)$ at t & $R(x,y)$ at t, on the assumption that R^* is a generic event. Also, conversely, if this dyadic event exists, the two former

[22] For a brief discussion of these problems see Patrick Suppes, *A Probabilistic Theory of Causality* (Amsterdam: North Holland, 1970), pp. 30–32, 82–91.

events exist. This is the intuitive content of the concept of "conjunctive event" in a simple case of this kind; but a general formulation of this concept is yet to be worked out. In any case, if we allow ourselves conjunctive events of at least this simple sort, we can simplify the preceding formulation of Humean causation:

$[(a, b, T), P]$ is a cause of $[(b, T'), Q]$ provided:
(i) $[(a, b, T), P]$ and $[(b, T'), Q]$ exist, and
(ii) $(x)(y)(t)([(x, y, t), P]$ exists $\rightarrow [(y, t + \Delta t), Q]$ exists), where $\Delta t = T' - T$.

(There is of course no simple way of stating (iii) of the preceding formulation; but when the definition is stated for composite events, (iii) doesn't seem needed.) In special cases, $a = b$, and the cause event as well as the effect event would be monadic. But generally the cause event will be a dyadic or higher-place event involving, as one of its constitutive objects, the constitutive object of the effect event; and the first term of a constant conjunction will in general be a relational generic event rather than a monadic one.[23]

Let us briefly note here how the problem of parasitic constant conjunctions arises for direct contiguous causation as formulated above. What happens is this: suppose $[(a,t), F]$ is a direct contiguous cause of $[(b,t), G]$, where for simplicity we have assumed $t = t'$. Let c be any object such that b is the only object with which c is contiguous (for simplicity we drop t) and b is the only object with which both a and c are contiguous. We can then construct a property H such that c has H and $[(c,t), H]$ is a direct contiguous cause of $[(b,t), G]$; letting R be some relation such that $R(c,a)$, we can let H be the property that belongs to an object x just in case $(\exists w)(R(x,w)$ & $F(w)$ & $(\exists !z)(\text{Cont}(x,z))$ & $(\exists !z)(\text{Cont}(x,z)$ & $\text{Cont}(w,z)))$, where again for simplicity we have deleted reference to time and where 'Cont' is used as a contiguity predicate applicable to objects simpliciter. But notice that the conditions on the object c here are severer than for Foster's definition; and there seems to be no general argument to show that our definition of 'contiguous causation' succumbs generally to this sort of difficulty. In this way, the dif-

[23] The causal relation defined here is, in many respects, weaker than the relation of contiguous causation earlier defined, and is open to the following sort of difficulty. Jones has terminal cancer, and there is a law that any human being having cancer (of the kind and stage Jones has) is dead within two years. And in two years Jones is dead. However, Jones actually died in a traffic accident. The present definition of the causal relation will erroneously certify Jones's cancer as a cause of his being dead, whereas contiguous causation avoids cases of this sort in a natural way.

ficulty of parasitic constant conjunctions is somewhat mitigated for the relation of contiguous causation.

It is easily seen that our last formulation of Humean causation is also open to the difficulty of parasitic constant conjunctions; however, we omit the details.

Apart from this difficulty of parasitic constant conjunctions, I find the preceding two accounts of Humean causation (contiguous causation and the account that takes cause as essentially a relational event) attractive; on the other hand, the first account borrowed from Foster is somewhat unintuitive, and, even with the suggested alteration of the condition (ii), the last condition (iii) on the pairing relation appears somewhat ad hoc. In any event, various refinements can be attempted on these definitions. In particular, there is the problem of building temporal asymmetry into them, if this is desired. Also, according to these definitions, all correlated properties in the same object, e.g., thermal and electrical conductivity in metals (at constant temperature), turn out to be symmetrically related by the causal relation. (I assume that we would not want to attribute a causal relation directly between electrical and thermal conductivity; the correlation is to be explained by reference to the microstructure of metals.) It seems likely that clues to a correct account of these cases will be found not at the level of analysis in this paper but at a deeper metaphysical level involving such concepts as substance, power, and accident, or at a pragmatic level involving the concept of controlling one parameter by controlling another.[24]

These refinements, as well as others which are necessary to account for some of the well-known difficulties for Humean causation,[25] are beyond the scope of the present paper and must await another occasion. It is best, therefore, to look upon the tentative accounts of Humean causation in this section not as full-fledged analyses of causation, but rather as approximations to the broader notion of subsumption of events under a law, an idea that forms the foundation of the Humean, or nomological, approach to causation. In any event, my aim here has been to outline a uniform and coherent

[24] Georg H. von Wright has recently worked-out an account of causation on the basis of the concept of an agent's bringing about some state of affairs by doing a certain action, in *Explanation and Understanding* (Ithaca, N.Y.: Cornell, 1971).

[25] One such refinement would consist in taking account of the common observation that what we ordinarily take as a cause is seldom by itself a necessary or sufficient condition for the event it is said to have caused. For a plausible treatment of this problem, see J. L. Mackie, "Causes and Conditions," *American Philosophical Quarterly*, II, 4 (October 1965): 245–264; and my "Causes and Events: Mackie on Causation," this JOURNAL, LXVIII, 14 (July 22, 1971): 426–441.

For an interesting treatment of other important problems, see Ernest Sosa, "On Causation," forthcoming.

ontological framework of events adequate for formulation of Humean causation rather than to resolve substantive issues traditionally associated with the Humean approach. These issues must of course ultimately be handled within the suggested framework if it is to prove its worth. It is hoped, however, that we have at least made a modest beginning and that we now have a clearer perception of the directions in which to explore and the problems and promises to be expected along the way.

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BOOK REVIEWS

Facts, Words and Beliefs. TIMOTHY L. S. SPRIGGE. New York: Humanities Press, 1970. viii, 351 p. $13.50.

A man who believes something will not usually say, "I believe that such and such," because this form of words has special connotations that go beyond the fact that a man believes what he does. So a man will not ordinarily say "I believe" of what he knows, not because he does not believe what he knows, but because "believe" would suggest some uncertainty, or suggest that the matter at hand is one on which well-informed men may differ, or suggest that in saying what he does the speaker is taking a stand toward something that is not wholly a matter of truth or evidence. In keeping with this sort of reflection, T. L. S. Sprigge gives an account of the concept of belief that makes no effort to cohere with or to explicate the ordinary use of the word 'believe'. For Sprigge, "The concept in question is that of believing something to be the case, where this refers to an event in consciousness which takes place at a certain time" (319). By way of analysis, Sprigge develops a sequence of theories of belief culminating in "Imagist-Mentalism," which seems to be accepted with the reservation that certain believings may take a form that cannot be grasped within the scope of the theory presented. According to Imagist-Mentalism, "A fully realized belief experience in a certain kind of fact will be an experience of images which exemplify universals similar to those which would occur in a fact of that kind, together with an experience in response to this experience which would have been a standard response to an experience of a fact of the kind said to be believed in" (231). The idiom here is rather opaque and technical. The idea is that, if I experience a mental image of a student's paper on my desk and this prompts another experience, for instance, the