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# Activities and Causation: The Metaphysics and Epistemology of Mechanisms

Peter Machamer

*This article deals with mechanisms conceived as composed of entities and activities. In response to many perplexities about the nature of activities, a number of arguments are developed concerning their epistemic and ontological status. Some questions concerning the relations between cause and causal explanation and mechanisms are also addressed.*

## 1. Mechanisms and Causes

For purposes of understanding and doing science, it is best to conceive of the world as being ontologically composed of entities and activities. This is the dualistic position that we first put forth in Machamer, Darden, and Craver, “Thinking about Mechanisms” (2000; hereafter, MDC 2000). At that time we said:

Mechanisms are entities and activities organized such that they are productive of regular changes<sup>1</sup> from start or set-up to finish or termination conditions ... Mechanisms are composed of both *entities* (with their properties) and *activities*. Activities are the producers of change ... Entities are the things that engage in activities. (MDC 2000, 3)

We meant thereby to distinguish our position, or way of thinking, from a substance ontology and from a process ontology, and we chose “entity” and “activity” because these terms seemed to carry fewer historical and philosophical presuppositions than “substance” or “process”. Subsequently we have made minor changes in the programme, but not major ones. About causality, we claimed to follow Elizabeth Anscombe (MDC 2000; Anscombe 1981) in thinking of “cause” as basically a generic term like “organism”.<sup>2</sup> Just as one cannot have, or does not need, a theory of organism per se and *tout court*, equally one does not need a theory of *cause*. The problem of causes is not to find a general and adequate ontological or stipulative definition, but a problem of finding out, in any given case, what are the possible, plausible, and actual

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causes at work in any given mechanism. This does not preclude saying some quite general things about causes, but I shall not elaborate or argue for this point here.

The problem of causes, in our terms, is how to discover the entities and activities that make up the mechanism. That is, scientists and often we plain regular folk seek to discover how things work by uncovering the mechanisms that make them work the way they do. Uncovering mechanisms is a process of learning about causes. Particularly, discovering activities, the “doing” or productive parts of mechanisms, is the finding of causes. My colleagues, Darden and Craver (e.g. Craver and Darden 2001; Craver 2002; Darden 2002; Darden and Craver 2002), have written at some length in various places about the strategies and processes of discovering mechanisms. Darden and Craver (2002, 21ff.) are nicely explicit about the role of activities and productive continuity in discovery.

Here I wish to make a different point. It seems clear to me that processes of, or strategies for, discovery are, if correct, epistemic principles. They direct us in how to find out about the world, particularly how to find evidence for the mechanisms by which the world works. One strategy for doing this is intervention, whereby one stops or changes a putative activity to find out what happens. Intervention is a good strategy for uncovering mechanisms or for finding causal connections. Francis Bacon and John Stuart Mill thought so too, and many versions of statistical screening-off depend on intervention to bifurcate the relevant reference classes. However, this is clearly an epistemic or methodological principle (I will not make a distinction here), and I would have thought that only ontological (or even ontic) principles or descriptions belong in a “real” definition of causality. Possible ideal interventions seem to fare no better in their claim to be fundamental ontology.<sup>3</sup> One way to see this is to note that controlled intervention is an activity of a human researcher. Yet, sometimes Nature herself brings about an intervention. However, any use of interventions in science are epistemic and come only from a human recognizing the intervention as providing knowledge about a mechanism. An intervention in experimental science is one of the techniques through which we may discover which of the possible activities and entities are really doing the work (or, if one prefers, to discover what the true cause, *vera causa*, is).

## 2. The Metaphysics of Activities

But let’s turn back to activities and ask about their metaphysical status. I am often unsure how to do metaphysics in ways that keeps it apart from epistemics. But I would assume that any metaphysics that purports to get at ontology, or at some thing’s ontic status, must answer questions about what are the criteria for identification for the “thing” in question and about how reference to that kind of “thing” succeeds. Further, I presume something must be said about the relations the “thing” has to other “things” that are in one’s ontology, and specifically one must say something about the epistemic status of such things and why and how they are important or necessary for knowledge and explanation. Moreover, the history of metaphysics, from Aristotle onwards, has most often sought the basic explanatory principles (or categories)

through which we may (or must) understand the world. Very often this project has been couched in the language of the passive or potential vs. the active or actualizing. (Here I think of Descartes's troubles with passive matter and the answers to them provided by Spinoza and Leibniz.) These may not be all the proper questions that a metaphysician should ask, but if they are not some then I do not know what metaphysics is, and my readings of the history of philosophy are severely impoverished.

Activities have criteria that can be given for their identification. We know how to pick out activities such as running, bonding, flowing, etc. But these identification criteria are specific to kinds of activity that a group, at a time and in a discipline, takes to be fundamental in the sense that they do not feel any need to question their truth or usefulness. One might try to do something more general by giving the conditions for all productive changes, but then one would have to find out what all *producings* have in common and by what are they differentiated from *non-producings*. It is not clear that they all have any one thing in common or are similar in any significant way, but neither commonality nor similarity are necessary conditions for an adequate category.

We can make some general claims about the properties that producings or activities have. Darden and Craver (2002) mention finding out about such things as "rate, duration, strength, and sphere of influence". From the fact that activities have measures that may be applied to them, and from the fact that they may be identified independently of any particular entities that are acting, we might infer that they have some independent status as referents. This is presumably what we need in order to attribute ontological status. Nevertheless, such general characterizations do not begin to come close to a definition.

We could say that activities are the happenings that, singularly or in concert with other activities, produce changes in or bring into existence other entities and/or activities (where the entity may be the entity that is acting or the one acted upon or both, or some set of other entities and activities).<sup>4</sup> Again, we might say that activities are ways of acting, processes, or behaviours; they are active rather than passive; dynamic rather than static. However, even this way of talking, while maybe helpful, seems a far distance from providing necessary or sufficient conditions or from definitionally characterizing activities in terms of things even more generically ontological.

Entities are perhaps ontically asymmetric with activities in one sense. Entities, most often, are the things that act. This may be taken to imply that there is no activity without an entity. However, this is not to say that activities belong to entities in the same way structural properties belong to entities: running does not belong to Lisa in the same way that her nose does. It is to say that activities are how entities express themselves. Activities show how entities are not just static (or passive) and in what ways they act as causal agents. It is because of this feature of activities that some philosophers want to treat activities as dispositions or propensities. Yet even granting an entity-activity asymmetry in most cases, it is not clear even that all activities are necessarily the activity of some entity, or, less strongly, that one always can or needs to identify an entity to which an activity belongs. It is unclear to me that forces, fields, or

energy are entities and not, as it were, “substantial” activities, or that the process or activities of equilibrating or reaching stasis need entities in order to be understood. More complex and far-reaching is a point about differential equations. For example, the first law of thermodynamics says  $dU=dQ - dW$ , where  $dU$  is the internal energy change. So it is the change itself that is “substantial”.<sup>5</sup> This may be the case for all differential equations in so far as they are supposed to describe or refer to continuous processes.

I’ll mention one more short point that I won’t elaborate here. Activities can be abstracted and referred to and identified independently of any particular entity, and sometimes even without reference to any entity at all. So, at least, activities existing as abstract objects exist independently. I, of course, want to go further and claim that their existence as abstract objects depends upon experiencing their existence as particulars.

Process philosophers would have us redefine all entities in terms of combining processes, but this seems a bit too strange. Therefore, we (MDC 2000) decided to be dualist.

Further, activities are better off ontologically than some people’s ontic commitments to capacities, dispositions, tendencies, propensities, powers, or endeavours. All these concepts are derivative from activities. One can’t specify a tendency or a capacity without having some way to identify what the capacity does when it is actualized or exercised. However, being able to recognize what a capacity does when actualized or the activity that constitutes it presupposes having the concept of the activity. Having the concept of the activity entails that one may use it in the identification of instances of that activity. This means that one needs to know how to fix the referent for that activity. Without such conceptual abilities, there is no possibility, even ideally, of defining capacities, endeavours, etc. Put more tendentiously, the active exercise of a capacity has to be ontologically prior to any mysterious property called “the ability to exercise that capacity”. This does not entail anything about the fact that structural properties of entities are sometimes necessary for exercising capabilities.

I need to have experienced things that break and things breaking before I can understand *breakable*. One might think I can have *breakable* by having the concept *broken*, where *broken* just picks out a state that contrasts, say, the state of the split-apart object with the state when the object was whole. However, this would be a very limited concept, for when we have the concept of *breakable* at least part of what we need are the ideas that are formed as we watched the glass shattering and flying into a thousand pieces. In this latter sense we understand that *breakable* means *capable of shattering and flying apart in a thousand pieces*. Once again, activity must precede potentiality.

### 3. Necessity

Let me briefly talk now about another grand metaphysical term, “necessity”. Necessity, as the great metaphysician Leibniz saw, comes by foreclosing possibilities. The only sense of necessity that relates to causality, that most factitious of all concepts,

should be some sort of physical necessity (and whatever that means, it ought not to mean the necessity of logic or temporal determinism). It was this sense of “necessity” that William Kneale (1949) tried to explain, and C. J. Ducasse (1924) too. I think the necessity that attaches to cause is an epistemic necessity and not an ontological kind. Indeed, I doubt that there are any ontological necessities. Epistemically or methodologically, by experimentation or other means, one rules out possibilities that are at first promising or could be thought to be the cause in order to find out what cause or causes are more probable. One may hope, then, that after enough work one may discover what the actual cause is. In this scenario, the actual cause is necessary, but only in the sense that since we have ruled out all other possibilities, then this *must* be the case. If we have ruled out everything that is possible, the only thing that is left must be necessary. (I here paraphrase Sherlock Holmes and Leibniz.) Of course, we can make mistakes in thinking we have found the actual cause.

Metaphysically, activities are what do the ruling out, by connecting one entity through its actions to another entity or activity or by producing a change in another entity. In this way activities function as selective processes: they are explanations of the arrows in the cartoon diagrams, and spell out how the previous stage or situation produces this certain result rather than some other. In other words, among all the changes that might have occurred at the next stage, this one did occur because of the activity that produced it.

Those philosophers who search for a general metaphysical definition of causality would have us ground natural necessity by somehow adding restrictive conditions (constraints) on correlations or by varying correlations. In this way they would show that the correlation is not accidental. Yet it is well known that no degree of correlation, even constant conjunction, between two entities will give rise to any form of necessity. In the face of this, they try to capture necessity by adding of other kinds of conditions, like supporting counterfactuals or isolating the variables that co-vary in their values, as if these somehow would be sufficient to warrant some sort of necessity. In the case of counterfactuals, the modality of the subjunctive contrast is somehow supposed to warrant the necessity of the actual causal case. But even if this were true, and I am not sure it is, there still would be no explanation, for they would still have forsaken the process of production by which these certain entities and activities produced such and such changes, which was what was to be explained.

In a final point about ontology (or in older Wittgensteinian terms, grammar) let me remark that activities are necessary for natural language descriptions of the world. Natural languages need verbs (or verb surrogates), and some verbs refer to causes or activities. In formal languages, verbs may be eliminable in some sense (in favour of functions). Canonical logical form eliminates verbs and treats them as strange predicates or properties of objects. This seems to be equivalent to turning all verbs into property-like capacities, and I have argued above against the sufficiency of wantonly nominalizing everything. Moreover, taking functions as ontologically basic would yield an even weirder ontology than countenancing activities. Logic then would have become metaphysics.

There is also an epistemological argument which, I would purport, has metaphysical consequences, not unlike those just sketched. J. J. Gibson has argued that change or activity in the world is necessary for the functioning of our perceptual systems (Gibson 1966; Machamer 1975). The necessity of change for perception or of perceiving activities is that if anything is truly static, and neither perceiver nor entity is moving, then perception is impossible. Perception does not occur when retinal images become stabilized. It is only by moving signals across the retinal cells that the cells become activated. No activity, no cellular activation, no perception.<sup>6</sup> In other words, change is the cause even of seeing stable objects.

#### 4. Epistemology of Activities

We should talk now about the epistemology of activities. People learn to pick out and categorize activities as well as they do entities, and independently. All language users need to learn what verbs mean by using verbs to attribute activities to entities (Tomasello 1992). Referents of verbs (activities or, often, human actions) are taken by young children as being categories in very much the same way objects are. People, including children, categorize the world into running, breaking, and boozing just as they do into flowers, bears, and bootstraps (cf. Machamer 2000). The asymmetry point spoken of above is relevant here again. In most cases, it is some *thing* that is involved in an activity, whereby some people assume that it is sufficient just to pick out things. However, activities, since they may be exemplified in many different individual entities and often across kinds of entities, must be identifiable independently of the individual entities that are acting. The upshot of this view of verb learning is that learning verbs is independent of learning nouns, and each must be treated distinctly. This, then, is epistemic independence.

One argument for epistemic priority might be given by arguing that object permanence is learned only through grasping and manipulating objects. So the very idea of a static, permanent object is dependent upon sensorimotor skills, which are in themselves activities. Therefore, a child must first develop the requisite sensorimotor skills before acquiring any concept of object permanence (cf. Piaget 1930). Further, in developing these sensorimotor skills the child is developing knowledge of what activities are. This aspect of activity learning is in part procedural learning, where what is learned is how to do something or how to act properly or effectively. Much sensorimotor knowledge is of this form. There is no nominalized (propositional) version of this type of knowledge. In fact, very often the structure of this form of knowledge is not available to consciousness and cannot be given explicitly in any verbal form (Cohen and Eichenbaum 1993). Seemingly contrary to this hypothesis, Elizabeth S. Spelke, Ann Phillips, and Amanda L. Woodward (1995) argue that from very early on infants have an idea of objects as cohesive in that objects maintain connectedness and boundaries as they move freely. This they take to show that infants have an idea of a coherent object long before Piaget and others thought. What the results of Spelke and co-workers show is that infants can pick out objects and have expectations about some of their behaviour or activities before they have the ideas of

object permanence. But having expectations about what a particular object will do presupposes they have a concept of, at least, that activity.

Further, children often learn what objects do before they learn what objects are. That is, in the early stages of development, children develop sensorimotor skills by engaging in activities with objects and in so doing they gain some knowledge of cause and effect relations. They learn what objects do. Some of this learning is prior to their learning a language. To borrow a classic example from Piaget, infants learn to play a form of peekaboo noticing the activity of covering up an object, or hiding it, before they have any expectation that the object persists. They recognize the parent's intent to play peekaboo by having their attention drawn to the covering up act, and then become delightfully surprised when the act of removing the cover reveals the unexpected object.

Perception of activities is as fundamental (if not more so) as perception of objects or entities. Perception of causality is a good example. Gibson (1966, 1979; following Michotte 1963) and more recently Scholl and Tremoulet (2000) have argued that people perceive events more fundamentally than objects. In their review article, Scholl and Tremoulet (2000, 306) argue that there is strong evidence to show that what are often taken to be interpretations of causality and intentionality resulting from perceptions really are themselves perceptual phenomena that are brought about by perceptual module innate in the human visual system. They conclude:

The phenomena of perceptual causality and animacy might indeed reflect some specialized processing that is not "easily penetrated" by higher-level cognition. In this sense, such phenomena are of interest in that they lie at the intersection of perception and cognitive processing, where simple schematic displays are parsed via perceptual systems in causal, animate or even intentional terms ... (Scholl and Tremoulet 2000, 307)

What this suggests is that schemata or categories of productive activity are fundamental to how human perception works. Stressing their perceptual nature is supposed to distinguish them from inferences or from higher-level cognition. The fundamental claim stresses how they are in fact the way humans epistemologically access and make sense of the world.

Perception results from changing interactions between the activities of the perceiver and the activities in the environment. Continuous reciprocal activity is basic for our ability to know the world and to act in that world. We have too long been misled by passive pictures regarding the fundamental epistemic processes of perception and, one might add, cognition. Even knowledge, it might be well argued though I shall not do this here, is not passive: knowledge representations are not static traces deposited by incoming signals, but active representations that must include activities on the part of the knower (as fundamental and ineliminable) (Machamer and Osbeck 2002, 2003). That is, acting is a major part of knowing. Further, perceivers' most fundamental abilities are those determined by the ecologically salient categories that they learn to discriminate by acting in the world (Gibson 1979).

There is another argument that is based on the epistemic salience of linguistic causal structures. Verbal structures, especially causal verbal structures, are as



important as nominalizations, if not more important, for learning and comprehension. Kintsch's studies of reading comprehension tasks have shown that readers attend to causal verbs in the passages they read, which they then use to construct their internal (situation) model of what happened (Kintsch 1986, 1992). This model is subsequently accessed during recall, which are the data used to test comprehension. Interestingly, it has been noted that how well (accurately) a reader recalls a text depends upon the coherence of the situation model constructed, and this is measured by how well the causal connections in the text are represented in the model. Specifically, the syntax of the written sentence, particularly the syntax involving verbal structures, provides cues to the reader as to what are the important causal relations in a text (Kintsch 1986, 2). Readers use active knowledge-based schemata as the basis for constructing situation models about what they read. Specific people, events or names usually play a secondary role and are filled in only when the causal schema is recalled.

Similarly in learning, studies on children's learning of history texts show they tend to recall what they have learned better when the text is written using active causal verbs than when the same events are described by relevantly similar adjectives and the verb "to be". In both cases, active causal verbs are more effective and important for learning and recall than are nouns that might do the "same descriptive jobs". Causal verbs are used to construct schemata or frames, which are then used to access prior knowledge representations of similar situations. Causal verb schemata are what we have been calling types of activities. This suggests again that people attend, identify, and categorize activities in a fundamental way.

Finally, there is psychological evidence from Ahn and Kalish (2000) that people frame beliefs about mechanisms as ways to learn about causes, and that it is these beliefs about operating mechanisms that allow people to discover and use causal knowledge. In this work, what Ahn and Kalish mean by mechanism is "a system of connected parts that operate or interact to make or force an outcome to occur" (Ahn and Kalish 2000, 201). Another such characterization, again contrasting with a regularity or correlation view, is given by Renee Baillargeon, Laura Kotovsky, and Amy Needham (1995): "we might take causality to mean something far more specific associated with the formation of sequences in which one event is understood to bring about another event through the transmission of force or some other generative process" (Baillargeon, Kotovsky, and Needham 1995, 79). This group goes on to examine the regularity view, which is more easily conducive to a clean experimental paradigm. The upshot is that there is a psychological sense in which people, including children, use "mechanism concepts" to understand the causal happenings of the world. Moreover, in all these views what differentiates the mechanism idea from the regularities idea is productive relations, generative processes, or making or forcing an outcome; in short, what differentiates is activities. What is strange, however, and may be explained by the experimental design problem mentioned above, is that activities are not the focus of research of those who hold that people learn and discover by mechanisms. This seems a mistake.

## 5. Disconnected Causes

Finally, let me look at a case Jim Woodward (2002) says shows the insufficiency of the MDC approach, and presumably the insufficiency of using activities to talk about causality. This is a case where the inducer, allolactase, initiates transcription by interfering with the operation of an agent that prevents transcription. Woodward claims that MDC cannot “capture the idea that there is an overall productive relationship [...] without explicitly invoking the idea of counterfactual dependence” (2002, S372). Further, he says, we cannot plausibly claim that the overall relationship is spelled out by showing that the “relationship between X and Y is productive if X is connected to Y via a series of intermediate steps each of which correspond to an activity on MDC’s list” (2002, S372–73). The reason it is implausible, he says, is that “causation (and production) are not transitive” (2002, S373, n. 2).

But who ever said that activities that make up the transitions between steps obey the laws of transitivity? Many, if not most, transitive verbs are not logically transitive. What one wants to do in establishing and displaying mechanism is to show how one stage produces the next, and so on. The activities with their associated entities are what do the producing. The causality lies in the production. The steps are the activities that connect the stages; the activities are what do the producing. These need not be transitive.

Now, sometimes we speak about activities that do not occur, and we ascribe causal roles to such non-occurrences. Genes are expressed or fail to be expressed. A protein binding to DNA, in some cases, will not allow transcription to proceed. Remove the protein, and transcription is unblocked. Killing and letting die are different. Mechanisms are sometimes described by things that are absent, are not done, or fail to occur. Clearly, many examples that people use to talk about causation (and/or explanation) seem to rely on non-occurrence. These all would seem to be cases where causality is attributed not via an activity, but by virtue of a non-activity.

The failure of Fergus to arrive at the party sent Tara into a funk, whereupon, somewhat later in the evening, she sold the ring that Fergus had bought her, bought a gun, went to Fergus’s home and shot him dead. So shall we say there is mechanism that explains why Fergus’s absence caused Fergus’s death? The tale I just told explains how his failure to appear is connected to his death. However, from this it does not follow that we wish to call his absence part of the multiple mechanisms that produced his death. Yet, mechanism schemata abound in this small story. They are the mechanisms that explain why people act the way they do, and why Tara funked, sold, bought, and shot. However, notice that Tara’s “trigger” is a disrupted mechanism. An active originating partial cause of Fergus’s death is Tara’s expectation that Fergus will show up, continue their relation as usual, etc. This expectation was thwarted and so brought the mental mechanism of revenge into play. Fergus’s non-appearance is not really a cause, though we often talk that way, and may talk that way if we wish. But the intelligibility of such talk need not be taken as a constraint on our metaphysics.

Non-existent activities cannot cause anything. But they can, when other mechanisms are in place, be used to explain why a given mechanism did not work as it

normally would, and why some other mechanism became active. Failures and absences can be used to explain why another mechanism, if it had been in operation, would have disrupted the mechanism that actually was operating. Maybe we should draw a distinction and say they are *causally relevant* rather than *causally efficacious*.<sup>7</sup> They are not, to use an old phrase, *true causes*.

Notice also that such cases may well be described by a perfectly good use of a counterfactual. In all I have said above I have not ruled out that using subjunctive locutions may be explanatory. I only asserted they were not getting at anything metaphysically or epistemologically basic. In the absence of other mechanisms becoming or remaining active, the non-occurrence of an event will cause nothing. Yet, there need be nothing counter-intuitive about attributing causal status to a lack of activity. The physician who stands by and lets a patient die, when he could have acted to save her, may be culpable. (Much depends on the circumstances, but these are not relevant here.) The physician just let the mechanisms of death work, though he might have intervened and thereby changed the mechanisms in operation. In this sense, we say he was the cause of her death or, better, that his inaction was causally relevant to her death, even though he did nothing. Similarly, stopping or disrupting a mechanism from working often does have effects (Schaffer 2000). Think about stopping any homeostatic mechanism, when the whole system goes out of equilibrium as a result. But my intuition here is that disconnection is not a cause directly: it is just what allows something else to do its work.<sup>8</sup> It does not seem difficult in such cases to explain why we normally use causal language, since these other events are causally relevant to what mechanism actually brings about the causal effect.

In MDC (2000), we said that mechanisms (and functions) are sought after in a context. That is, they have a teleological component, and usually (but not always) the scientist knows what it is that wants to be explained. Relevant mechanisms for doing the explaining will be different depending on the purpose for which the explanation is sought. The identification of mechanisms is purpose relative. It may be relative to the event, state, or termination conditions, or it may have larger context dependence: for example, the scientist's conception of science must be useful to humans. This purpose relativity is a broadening of van Fraassen's contrast classes. If a biologist or another scientist is interested in control or manipulation, and many of them are, then this is an epistemic goal for that biologist doing science. It is an important goal, and it is important to learn how to intervene and manipulate in experimental settings. Much scientific training and subsequent practice involves pursuing that goal. Having these as goals for one's science and scientific practice is not the same as finding a mechanism, nor is it the same as explaining things by mechanisms. In fact, controlling is not explaining at all.

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essay, though Carl prodded me with quizzical queries on a draft of this article. Jim Tabery also provided very useful comments and suggestions, some of which I adopted. An early version of this article was given at a PSA 2002 workshop. I am grateful to those who challenged me there. Part of the “Epistemology and Activities” section came from the paper that I am working on with Jackie Sullivan, “Leveling Reduction”, which is posted on the *Archives for Philosophy of Science* website.

### Note on Contributor

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### Notes

- [1] I think “regular” should be dropped from the definition. Jim Bogen has argued forcefully that there might be mechanisms that operate only once in a while or even one that works only once.
- [2] I still wonder what the best analogy with “cause” is. I first thought “cause” was syncategorematic, like “good” (cf. Lycan and Machamer 1973). Later I thought it maybe was closer to other philosophical categories, like “being” or “justice”. However, people write large books about such concepts, though they also write about *cause* and even about *good*. Maybe all such books fail in the same way books about *cause* must fail. John Norton (2004) directly argues that particular instances of causes in physics are all right, but that cause, in general, is incoherent. I think he and I agree on many things. I am here following Jim Bogen who tried to persuade me that “cause” is just a genus term, like “organism”.
- [3] The reference here is primarily to Jim Woodward’s work, though others have followed his lead.
- [4] Jim Tabery has argued that we should also talk about *interaction* as well as activity. Here, and in MDC (2000), it may have been unclear that activity is meant to include activities that are mutually effective and affected. There is no dispute about interaction if the “action” part is taken to refer to activities (so they’ll be interactivities), and not as is usually done to refer to relations that exist among static states.
- [5] Halliday and Resnik (1986, 396) write interestingly in a footnote describing the first law of thermodynamics: “Here  $dQ$  and  $dW$ , unlike  $dU$ , are not real differentials. There are, for example, no such functions as  $Q(p, v)$  or  $W(p, v)$  because  $Q$  and  $W$  refer to transitions between states of system and not to the states themselves.  $dQ$  and  $dW$  are called *inexact differentials* ...”
- [6] There may be a deep point to be made here. It may be that productive change or activity is both epistemically and ontologically fundamental to our knowledge. This could parallel what was said about fundamental equations being differentials that describe dynamic continuous processes. In its turn, this could be used as basis for an argument that *becoming*, the active, precedes *being*, the passive. This idea certainly is too ponderous to lift here.
- [7] Wayne Wu suggested this terminology to me. It seems to me a good case where one might follow Wilfrid Sellars’s advice and solve a putative philosophical problem by drawing a distinction.
- [8] Jonathan Schaffer (2000) makes a case for disconnection as a cause that is quite compelling. Reading along with him, one almost wants to agree until finding out that this leads to a Humean conditions approach to causation. Here my intuitions boil because of the

inactivity of the cause. But then one person's *reductio* is another's proof. I think, however, we may have it both ways with the causally relevant causally efficacious (or, true cause) distinction.

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