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Dispositions, Causes, and Reduction

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Dispositionality and causation are both modal concepts which have implications not just for how things are, but for how they will be or, in some sense, must be. Some philosophers are suspicious of modal concepts and would like to make do with fewer of them.[1] But what are our reductive options, and how viable are they? In this paper, I try to shut down one option: I argue that dispositions are not reducible to causes.

In doing so, I try not to prejudice the issue by assuming a particular analysis of causation or dispositions. I make the following minimal assumptions about dispositions: they are properties of objects which have characteristic manifestations that occur in certain circumstances, and an object can have a disposition outside of the circumstances of manifestation and hence without the manifestation occurring. I think of causation primarily as a relation between events, though there can be true causal generalizations, and objects might be causes.

In Section 1, I will try to clarify what it means for one kind of thing to reduce to another. I will then argue in Section 2 that dispositions do not conceptually reduce to causes, and in Section 3 that dispositions do not metaphysically reduce to causes. In Section 4,

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1. A major motivation for reducing modal concepts is actualism, the view that everything that exists is actual (E. W. Prior 1985: 11–28).

I explore other reductive possibilities, in particular that causes reduce to dispositions.

1 Reduction

In saying "dispositions reduce to causes" one might mean any of the following:

> We can define disposition terms with causal terms.
>
> Disposition statements can be systematically replaced by causal statements.
>
> Causes explain everything dispositions explain.
>
> Dispositions can be described completely in terms of causes.
>
> Causal statements entail dispositions statements.
>
> Disposition facts are nothing over and above causal facts.

These are very different claims concerning different issues, from what our words mean, how we should talk, what explains what, to the relations between facts, what exists, and what the world is really like. It is helpful to distinguish at least three different kinds of reduction in this context:

> *Conceptual/Analytical Reduction* of *A*'s to *B*'s occurs when we can adequately define *A*'s in terms of *B*'s, or systematically replace *A*-talk with *B*-talk, etc.[2]
>
> *Epistemic/Explanatory Reduction* of *A*'s to *B*'s occurs when why-questions about *A*'s can be answered with *B*'s alone, and/or when *B*'s explain everything that *A*'s explain.[3]
>
> *Metaphysical Reduction* of *A*'s to *B*'s holds when *A*'s are nothing more than *B*'s.

If we want to rule out symmetrical reduction, we can add a "not

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2. According to Carnap 1938, "If now a certain term x is such that the conditions for its application (as used in the language of science) can be formulated with the help of the terms y, z, etc., we call such a formulation a reduction statement for x in terms of y, z, etc., and we call x reducible to y, z, etc." (397).

3. According to Garfinkel 1981, "to say that something is reducible to something else is to say that certain kinds of explanations exist" (443).

vice versa" clause to each kind of reduction, though in the case of conceptual reduction, it's not clear if definitions or systematic replacement should be asymmetrical.[4] Philosophers discuss other varieties of reduction, such as nomological or inter-theoretic reduction (E. Nagel 1961: 336–97) but since dispositions and causes are not laws or theories, these are not the kind of reduction at issue.

We can further explicate the notion of metaphysical reduction in terms of global supervenience (Kim 1993: 68–70). To say that dispositions globally supervene on causes is to say, roughly, there cannot be a difference in dispositions without a difference in causes; any possible world with the same causes must also have the same dispositions. If dispositions don't globally supervene on causes, they aren't metaphysically reducible to causes. If two worlds have all the same causes, but different dispositions, then the disposition facts are something over and above the causal facts—no metaphysical reduction.

While global supervenience might be necessary for reduction, it is not sufficient. Global supervenience is a reflexive relation; reduction is thought to be irreflexive.[5] So, while A's globally supervene on A's, A's don't reduce to A's. Furthermore, even if a set of properties A globally supervenes on a distinct set of properties B, that might not be because A's reduce to B's, but because A's and B's independently reduce to the same thing.

Though conceptual, explanatory, and metaphysical reductions are distinct, they are closely related. They all contribute to a more economical ontology, decreasing the number of fundamental concepts, explanatory hypotheses, or kinds of things thought to exist in the world. If A's reduce to B's in one way, they tend to reduce in other ways as well. If we can systematically replace A-terms with B-terms without loss, that suggests that each A-term

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4. Trout 1991 points out that the correspondence rules used for reductions typically involve identity statements, but since identity is a symmetrical relation, this won't do for intertheoretic reduction, for example (387). Putnam and Oppenheim's 1958 characterization of microreduction (reduction of kinds of things into their constituents) includes an asymmetry clause "if B_1 reduces to B_2, B_2 never reduces to B_1" (407).

5. For example, Putnam and Oppenheim 1958 stipulates that microreduction must be irreflexive as well as assymetrical (407).

and each corresponding *B*-term are both picking out the same things in the world, so *A*'s are nothing more than *B*'s. It would also seem to follow that *B*'s can explain everything that *A*'s can. But we could have metaphysical reduction without conceptual or explanatory reduction. The *B*'s to which the *A*'s reduce might be so complex and complicated that a replacement of *A*-talk with *B*-talk, or an explanation of *A*'s in terms of *B*'s, might be a distant hope or practically impossible. Molecules might be nothing over and above strings, even if we can't explain molecules in terms of strings or replace molecule-talk with string-talk. In what follows, I'll address conceptual and metaphysical reduction of dispositions to causes, and raise points about explanatory reduction along the way.

2 Conceptual reduction

Can we define dispositions in terms of causes? Not in any simple way. Clearly, "disposition" and "cause" do not have the same referent, like "water" and "H_2O." Dispositions and causes are different kinds of things: A cause is an event, causation a relation between events; a disposition is a property of an object. To see why this is a problem for simple conceptual reduction, consider a flat-footed definition of "disposition" in terms of causation:

> Def 1: What it is for an object to have a *disposition* is for one event to *cause* another.

Obviously, one can't adequately define an object having a property in terms of two events standing in a relation. A better attempt would introduce some parallelism by attributing both *having a disposition* and *being a cause* to the same thing:

> Def 2: Object *x* has a *disposition* iff *x causes* something.

Or, if you think that objects aren't causes but events are, you can say:

> Def 3: *x* has a *disposition* iff *x* is involved in an event which *causes* another event.

While these analyses are slightly more plausible, they are still inadequate. An object can have a disposition even if it neither causes anything nor is involved with any event that causes anything. For example, a match can be flammable even if it never ignites. The most obvious fix is to say:

> Def 4: *x* has a *disposition* iff *x* is *disposed to cause* something.

But this is circular and non-reductive. The same goes for "being prone to cause" "having the tendency to cause" etc. These are merely synonyms for "disposed to cause." We might try to define "being disposed to cause" as follows:

> Def 5: *x* is *disposed to cause* a type of event iff it is such that *x would cause* that type of event in certain circumstances.

Ann Whittle espouses a similar analysis of dispositional properties in "Causal Nominalism" (this volume). The similarity is not immediately obvious, since Whittle's main proposal, that "properties could be reduced to facts about particulars and causation" doesn't mention reducing dispositions to causes. However, Whittle equates having certain causal powers with standing in certain causal relations, and so her reduction of properties to causal powers is, at the same time, a reduction of powers to causal relations. She says:

> According to causal nominalism, *a* is *F* if and only if *a* has certain causal powers. Put another way, we can say that *a* is *F* if and only if *a* would stand in certain causal relations, given certain circumstances. (this volume: *Dispositions and Causes*, Toby Handfield, ed., Oxford University Press, 2009, p. 245)

While Whittle presents the move from properties to causes as one reductive step, we can focus on the second part of that step—the reduction of causal powers to causal relations, as the one at issue in the present paper. If we think of *F* as dispositional, as it is for Whittle, her suggestion that "*a* is *F* if and only if *a* would stand in certain causal relations, given certain circumstances" is essentially that of Def 5.

This is the most plausible definition considered so far, and it isn't obviously circular. But notice that dispositional statements have not been reduced to statements about actual causes, but to conditional causal statements. In other words, dispositions haven't been defined in terms of actual causes, but in terms of "would-be" causes. If the reductionist isn't committed to any such entity as a "would-be cause," how are we to understand these conditional causal statements? What does it mean to say, not that an object caused or is causing an event, but that the object *would cause* that event in certain circumstances? One might have thought that to say "an object would cause an effect in certain circumstances" is just to say "the object has a disposition to cause that effect in those circumstances." This intuition is perhaps a consequence of the conceptual connection proposed by Def 5 between having a disposition and being something that would cause an effect. Though the definition isn't blatantly circular, it seems reasonable to expect that the reductionist should have something to say about the relation of actual causes to would-be causes, a task which seems quite similar to that of saying something about the relation of causes to dispositions. The analysis is not complete without some account of conditional causal statements.

Similar remarks pertain to slightly more complex analyses which construe a disposition as a property of having some property or other that meets a certain causal specification. According to a "secondary property" account of dispositions:

> Def 6: *x* is disposed to cause a type of event iff *x* has a property *F* which is such that *F* would cause (or would be causally relevant to) that type of event in certain circumstances.[6]

Again, what does it mean to say that a property is such that it "would cause" or "would be causally relevant" to some event? These expressions suggest that the property has some causal

6. A similar account is discussed by Johnston 1992: 229.

power, which would seem to make the property dispositional in some sense. If this is right, being disposed is defined in terms of having a dispositional property, which makes the definition more circular than it first appears.

On the other hand, one may argue that saying that a property "would cause" or "would be causally relevant to" something is not to say that it has causal powers, but rather that it is subsumable under some causal law. This idea of how to think about conditional causal statements suggests another definition of "disposition":

> Def 7: x is disposed to cause an event of type G iff x has some property F and there is a causal law that F's in circumstances C are necessarily followed by G's.

This is similar to Armstrong's position (in Armstrong, Martin and Place 1996). Disposition ascriptions are not reduced to singular causal statements, but to "categorical" (non-dispositional) properties and general causal laws. This avoids the suspicion of circularity, but introduces a new modal notion into the analysans, causal laws. I will discuss the metaphysical reduction of dispositions to non-dispositional properties and laws in Section 3.

2.1 Dispositions, causes, and conditionals

Notice that definitions 5 and 6 employ conditionals in their causal analyses of dispositions. Of course, using conditionals to analyze disposition ascriptions is nothing new (Carnap 1936: 444–5; Ryle 1949: 43; Dummett 1978: 50). According to a familiar conditional analysis of dispositions:

> Def 8: x has a *disposition* iff if x were in certain circumstances, x would exhibit a certain manifestation.

Since causal statements have often been analyzed in terms of conditionals as well, it may be helpful to consider how conditional analyses of causation and conditional analyses of dispo-

sitions are related. Consider a counterfactual analysis of causal dependence:

> Def 9: *e* causally depends on *c* iff:
>   (*i*) *c* and *e* both occur,
>   (*ii*) *c* and *e* are distinct, and
>   (*iii*) if *c* hadn't occurred, *e* would not have occurred
>   (Lewis 1973a: 165–7).

There are three important differences between definitions 8 and 9. Def 8 is about a relation between an object and a property, while Def 9 is about a relation between two events. It is also significant that Def 8 employs a subjunctive conditional where Def 9 employs a specifically counterfactual subjunctive conditional. This is because, in the analysis of "disposition," the antecedent of the conditional is not necessarily contrary to fact since the circumstance of manifestation can obtain whilst the object has the disposition, but the antecedent of (*iii*) is necessarily contrary to fact since, if it were true that *c* had not occurred, there could be no causal dependence of *e* on *c*. Relatedly, no equivalent of clause (*i*) occurs in Def 8, since no such condition is necessary for an object to have a disposition: A thing might have a disposition to cause an effect even if that effect never occurs. Despite these differences, there are certain similarities, which can be summarized as follows: To accept conditional analyses of both causes and dispositions is to hold that disposition facts are a matter of certain conditionals being true about objects, while causal facts are a matter of certain conditionals with false antecedents and consequents being true about events.

So, why not reduce dispositions to conditionals? Some philosophers, such as Martin (1994), Johnston (1992), and Lewis (1997), claim that simple conditional analyses of dispositions have been conclusively refuted by a number of counterexamples. One such counterexample is "masking." Imagine a fragile glass that is packed so that it has internal supports that would prevent the glass from warping and therefore from shattering when struck. This glass has a host of intrinsic duplicates which are unprotected, and which are occasionally struck and broken. If you

struck the packed glass, it would not shatter. The ascription of the disposition is true—the glass is fragile—but the counterfactual claim is false.

Another purported counterexample to the conditional analysis is "finkish" dispositions. Lewis 1997 critiques the following simple conditional analysis of dispositions:

(SCA) (A) x is disposed at t to give response R to stimulus S iff (B) if x were to be subject to S at t, x would give R.

Once we note that things can acquire or lose dispositions, we can generate counterexamples by supposing that dispositional changes occur at inopportune times and ways. Lewis's example of a finkish disposition is the fragility of a glass which is protected by a wizard who will immediately render it non-fragile if it is ever struck. A real-world example of a finkish disposition is the instability of the DNA molecule. DNA is susceptible to breaking up due to forces such as radiation and heat. However, forces which would break the molecule also trigger mechanisms within the cell nucleus that maintain the molecule's structure (Tornaletti and Pfeiffer 1996). An object has a "finkish disposition" if that object has a disposition which it loses in what would otherwise be the circumstances of manifestation. In other words, the same S that would cause x to elicit R instead causes x to lose its disposition D before it can elicit R. In this case, (A) is true: The thing does have the disposition. But (B) is false: If x were to undergo S, it would not give R. So, the analysis fails to state a necessary condition for x's having a disposition.

Johnston (1992) considers a similar type of counterexample he calls "altering." A glass swan is fragile, but a vigilant monitor is equipped with a laser beam and will rapidly melt the swan the moment it would be struck. The conditional is false, but the swan is fragile. Another example is the shy, but intuitive chameleon (Johnston 1992: 231). The chameleon is green and thus disposed to look green, but before anyone can turn on the light and look at it, it blushes red. In both these cases, the conditions of manifestation are such that, if they were realized, the object would "alter" and lose its disposition.

A related case is a finkish lack of a disposition. When green, the chameleon does not have the disposition to appear red, but when the circumstances of manifestation occur, the chameleon acquires that disposition. In this case, an x which doesn't have D gains D when exposed to S, and subsequently gives R. Arguably, (A) is false: x does not have the disposition. However, (B) is true: if x were to be subject to S at t, x would give R. This shows that the analysis fails to state a sufficient condition for x's having a disposition.

If both disposition ascriptions and causal statements could be analyzed in terms of conditionals, then they would have similar, but different reduction bases: Dispositions would reduce to subjunctive conditionals about objects, and causes would reduce to counterfactual conditionals about events. This would not go to show that dispositions reduce to causes, but it may satisfy the urge to reduce modal concepts in whatever way works. But it's far from clear that this way will work. Both conditional analyses of dispositions and causation continue to gain critics.[7]

What about defining dispositions in terms of both conditionals *and causes* as definitions 5 and 6 do? Well, if a conditional analysis of dispositions were adequate, there would be no need to add causes. And if finks and masks show that a conditional analysis cannot work, adding causes will not help. The counterexamples work just as well against *causal* conditional analyses as they do against the simple conditional analysis. For example, according to Def 5, what it is for a glass to be disposed to break is for the glass to be such that it would causally contribute to a breaking event in the circumstances of striking. But when the glass is well-padded, or protected by the wizard, the glass doesn't causally contribute to breaking when it's struck, since it doesn't break at all.

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7. For critics of conditional analyses of dispositions, see Bird 1998; Mumford 2001; Choi 2003. For a survey of objections and replies to counterfactual analyses of causation, see Collins, Hall, and Paul 2004.

Lewis's revised conditional analysis (RCA) is a causal conditional analysis that was specifically designed to overcome finks. A slightly simplified version of the account (1997: 157) goes as follows:

> (RCA) x has a disposition at time t to give response m to circumstances C iff x has intrinsic property B, and if x were to be in C at time t and retain B, then B and C would cause event m.

According to RCA, the activating conditions and an intrinsic property of the bearer of the disposition jointly cause the manifestation of a disposition. In a finkish case, something causes the object to lose the relevant intrinsic property, and subsequently to lose the disposition. The condition that the object retains the intrinsic property is not satisfied by objects with finkish dispositions, and so they pose no counterexample to RCA. The condition that the object must have the intrinsic property is not met by the reverse finks, so that counterexample is defeated as well.

RCA reduces dispositions to counterfactuals and causes. Lewis's analysans also features would-be causes, but Lewis has resources for explaining them (1973a, 1986b). The basic form of a conditional causal statement is:

> If x were to occur, x would cause y.

Using possible-worlds semantics for counterfactuals, this becomes:

> In the closest possible world where x occurs, x causes y.[8]

Employing the counterfactual analysis of causation, you get: In the closest possible world where x occurs (call it W), y occurs, and if x didn't occur in W, y wouldn't have occurred in W.[9]

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8. I am simplifying here. More accurately, on Lewis's view, the sentence would get analyzed as "Either there is no close enough world where x occurs, or there are close enough worlds where x occurs, and in all of the closest possible worlds where x occurs, x causes y" (1973b: 16). I continue with my simpler Stalnaker (1968) semantics below, since nothing hangs on these details.

9. I am simplifying here as well, since the counterfactual analyzes causal dependence, and causation is the ancestral of causal dependence (Lewis 1973a: 167).

Applying possible-worlds semantics for counterfactuals again, we derive:

> In the closest possible world where x occurs (call it W), y occurs, and in the closest possible world to W where x does not occur, y does not occur.

So, RCA comes to:

> x has disposition D at time t to give response m to circumstances C in world W iff
>
> > (*i*) x has intrinsic property B, and
> > (*ii*) in W^+ (the closest possible world to W where C obtains at t and x has B at t) m occurs, and
> > (*iii*) in the closest possible world to W^+ where C does not obtain at t or x does not have B at t, m does not occur.

In other words, Lewis can reduce disposition statements to counterfactual causal statements, then to purely counterfactual statements, and ultimately to statements about events in and similarity relations among possible worlds. Though Lewis can ultimately reduce causes and dispositions to categorical properties in possible worlds, he reduces disposition statements to causal statements along the way, and thus his view is one of the targets of this paper.

Though Lewis has an account of conditional causal statements and an answer to the finkish counterexample, the analysis can be contested on at least three grounds: (1) It assumes that all dispositions have causal bases and (2) that these causal bases are intrinsic; and (3) it does not address the masking counterexamples.

Taking up the second objection first, I have argued elsewhere that dispositions are not necessarily intrinsic to the objects that have them (2003a). Contrary to Lewis, perfect duplicates could differ with respect to having certain dispositions; a thing can lose or acquire dispositions without changing intrinsically. Weight may be dispositional, but it's not intrinsic. The weight of an object is relative to the object's gravitational field. According to RCA, weight would be defined as follows:

> An object weighs 100 lbs, i.e., has a disposition at time t to give a reading of 100 lbs in circumstances of standing on a standard scale iff it has an intrinsic property B, and if it were to stand on a standard scale at t and retain B, then B and standing on the scale would cause a 100 lbs reading.

But if the object stood on the scale on the moon at t, its intrinsic properties plus standing on a scale would not cause a 100 lb. reading.

One might object that being subject to a certain gravitational field is part of the circumstances of manifestation of weighing 100 lbs. However, this is not in accord with the meaning of "weight," if ordinary usage is any guide. A visit to the "Your Weight on Other Worlds" website amply demonstrates this.[10] The site asks "Ever wonder what you might weigh on Mars or the Moon? Here's your chance to find out." If the circumstances of manifestation of your weight included being in the Earth's gravitational field, there would be no cause to wonder what you weigh on the moon.

I have also argued elsewhere that dispositions do not necessarily have causal bases; there can be ungrounded or "bare" dispositions (2003b). RCA fails to extend to such dispositions. I argue that it neither follows from the concept of a disposition nor from the idea that disposition claims must have truth-makers that dispositions necessarily have causal bases. Others such as Molnar (2003) and Mumford (2005a) attempt to identify a class of ungrounded dispositions in the fundamental properties of subatomic particles. Molnar argues that the nature of these particles is exhausted by their dispositionality, and extensive experimentation has revealed no deeper structure to serve as the intrinsic properties to ground these dispositions (131–2). RCA would seem, therefore, to be inapplicable to the most fundamental properties of the physical world.

10. http://www.exploratorium.edu/ronh/weight/

In addition, RCA still faces the problem of masking. Consider the glass that is carefully packed. According to RCA, to say the glass is fragile is to say that it has some intrinsic property B, and if it were to be in circumstances of striking at time t and retain B, then B and striking would cause breaking. However, the carefully packed glass retains its intrinsic properties, but its intrinsic properties and the striking do not cause the glass to break.

I haven't considered every attempt to conceptually reduce dispositions to causes, but some lessons seem to be emerging: A straightforward definition of dispositions in terms of actual causes is a non-starter. Definitions that do justice to dispositional concepts rely on dispositional or other modal concepts, such as counterfactuals, in addition to causation. But when theorists add conditionals to a causal analysis, they inherit the well-known problems which plague conditional analyses.

3 Metaphysical reduction

So, what about metaphysical reduction of dispositions to causes? We've already seen that dispositions and causes are different kinds of things, so it is not plausible to say that disposition are "nothing but" causes. But perhaps once you have all the causes in the world, you don't have to add anything else to get the dispositions. Recall that, in order for dispositions to be metaphysically reducible to causes, dispositions must globally supervene on causes.

So, do dispositions globally supervene on causes? Here are some reasons to think they might. Consider the question: "when, if ever, is one warranted in making a disposition claim?" To begin to answer that question, you might reason as follows. We are entitled to say that something has a disposition before, and even if it never manifests that disposition. The glass doesn't have to break in order for us to be justified in claiming that it is fragile. We are correct to say the match is flammable before we strike it. So we don't have to base our disposition claims on what a thing has caused, or does cause. In those cases, we reason from other

similar cases: Things of this type have acted like that in these circumstances in the past; therefore, this thing is disposed to act like that in these circumstances.[11] So, if we live in a world in which a type of thing has never acted in a particular way, it is hard to see how we could ever be entitled to believe that something of that type is disposed to act in that way. Different causal sequences will warrant different disposition claims and identical histories will warrant the same disposition claims. This suggests that possible worlds which agree on causal facts must agree on disposition facts; global supervenience, a necessary condition for reduction, seems to hold.

However, while this line of reasoning might justify explanatory reduction, it is a bit out of place in arguing for metaphysical reduction. The question of which disposition claims we are justified in believing is different from the question of which disposition claims are true—which dispositions things have. Things in this world have not been subject to every possible circumstance. We can, at best, imagine what some of these circumstances would be like, and the way familiar things would behave in these circumstances. We have few if any justified beliefs about these dispositions, yet it seems reasonable to say that things have dispositions we don't know about. If these dispositions have never been triggered, then perhaps there is a possible world with the same history as ours, in which these latent dispositions are different. That would be a case of two worlds agreeing on the causes, yet disagreeing on dispositions—a counterexample to global supervenience, and thus reduction.

The reductionist might reply that he can establish global supervenience without taking the route through justification that provoked my objection. He might appeal to Humean supervenience, claiming that the things that make causal statements true are arrangements of local matters of fact, sequences of events, or pat-

11. Quine 1969 makes much the same point when arguing that disposition ascriptions require a prior conception of similarity (166).

terns—*A*'s always being followed by *B*'s, regular succession in space and time.[12] Furthermore, the reductionist may claim, these are the very same things that determine which dispositions things have. Thus it would be impossible for two worlds to agree on causal facts but disagree on disposition facts. A necessary condition for reduction, global supervenience, is met.

This is a more direct defense of metaphysical reduction of dispositions, but reduction to what? Notice, the metaphysical picture which supports global supervenience of dispositions on causes is not that of reducing dispositions to causes, but one of reducing both dispositions and causes to something else. Again, a reductionist might be happy with this result, but that is not the thesis at issue here.

Furthermore, there's reason for thinking that dispositions don't globally supervene on causes at all. Intuitively, we can describe different possible words which agree on causes, but disagree on dispositions. Our world and the one like it with different latent dispositions were two such worlds. Or, consider two worlds, one containing, among other things, a certain particle, the other nearly identical world containing another version of the particle in that world. But one of the particles has a certain disposition that the other lacks. Suppose the two worlds are exactly similar with respect to causes and effects. In particular, they are alike in that the particles never find themselves in the circumstances of manifestation for the disposition in question. (They may find themselves in many other circumstances and do many things, but they are never in the circumstances that trigger this particular disposition.) These worlds agree on the causal facts, but disagree on the disposition facts.[13] The same feature of dispo-

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12. As Lewis puts it, "Humean supervenience is named in honor of the great denier of necessary connections. It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another" (1986c: ix). See also Loewer 1996.

13. This example is similar to one used in Tooley 1977 to support the idea that there could be underived, uninstantiated laws. He imagines "the universe containing two types of particles that never meet" which nevertheless have laws that would govern their interaction (671). I would add that these particles would also have unmanifested dispositions.

sitions that caused a problem for conceptual reduction causes a problem here: an object can have a disposition even if that disposition never gets triggered. So, disposition facts don't globally supervene on causal facts.

But perhaps dispositions supervene on singular causes *plus* nondispositional properties. In that case, worlds which agree on the distribution of non-dispositional properties and causes necessarily agree on dispositions.

But that would be true if dispositions supervene on nondispositional properties alone. Whatever you think of causation, if you think dispositions reduce to non-dispositional properties, you're going to think worlds with the same non-dispositional properties have the same dispositions. A fortiori, you're going to think that worlds with the same non-dispositional properties *and causes* have the same dispositions. Showing that dispositions supervene on causes plus non-dispositional properties does not show that dispositions reduce to causes.

Secondly, if, as I and others have argued, ungrounded dispositions are possible, then there are possible worlds which agree on non-dispositional properties but disagree about dispositions. These worlds could have the same causal history and instantiate the same non-dispositional properties, but differ with respect to a particular instantiation of some latent disposition.

Perhaps a more plausible reductionist view is not that dispositions supervene on actual causal sequences, but on causal regularities or laws. Causal laws might be a more promising reduction base for dispositions than singular causal facts are, if, like dispositions, laws might be latent, without manifestations. This harkens back to an earlier suggestion:

> Def 7: x disposed to cause an event of type G iff x has some property F and there is a causal law that F's in circumstances C are necessarily followed by G's.

To put this idea in terms of metaphysical rather than conceptual reduction, the proposal entails that, if worlds have the same laws, they have the same dispositions. Given this suggestion, one may

argue that the two particle worlds must have different causal laws if one particle is disposed and the other isn't. So even if the worlds have the same events occurring, they don't have the same causal laws. In that case, there's no dispositional difference without a causal law difference.

One way dispositions and laws might coincide is if statements of law that are true at a world summarize the disposition facts instantiated in that world. If it's true that all *F*'s in *C* are followed by *G*'s, that might be *because* all *F*'s have the power to produce *G*-events in *C*, rather than it being the case that *F*'s have that disposition because of the law. If the truth of law statements depends on which dispositions are instantiated, then there will be no difference in *laws* without a difference in *dispositions*. However, the current question is whether there can be a difference in *dispositions* without a difference in *laws*. If the same law statements could adequately summarize different distributions of dispositional properties, then the relation between laws and dispositions suggested above is consistent with there being worlds with the same laws but different dispositions.

Returning to the two particle worlds, the suggestion that dispositions supervene on laws entails that these worlds must have different causal laws. But must they? Perhaps not, if they are both worlds in which it is a law that all *F*'s in *C* are followed by *G*'s, but while one particle is *F*, its counterpart is not *F* and hence is nondisposed. It's plausible that worlds with the same laws could differ with respect to a certain particle having a certain feature, either because of different initial conditions in each world, or because the laws in these worlds are indeterministic. These worlds would agree on the causal laws, but differ with respect to dispositions.

However, this reply is not true to the reduction suggested by Def. 7, since *x* having its dispositions to produce a *G*-event depends not just on there being a law that all *F*'s in *C* are followed by *G*'s, but on the fact that *x* has property *F*. If dispositions are really being reduced on this picture, *F* must be non-dispositional. So, a better formulation of this idea is that disposition

facts supervene on causal laws plus the distribution of non-dispositional properties.

The plausibility of this view depends on the idea that all dispositions, even those of fundamental entities, have a non-dispositional causal basis. The metaphysical picture, on this view, is one in which all metaphysically possible worlds are populated by objects which are inert in themselves, and only become active because they are governed by over-arching laws which push them around.[14] But if there is a possible world in which a particle has a power which has no non-dispositional causal basis, then there could be worlds which agree on non-dispositional facts and laws, but disagree with respect to dispositions.

I will now consider some objections to this counterexample.

3.1 Objection 1: Causal theories of persistence

On some views of persistence, what makes a three-dimensional object at t_1 the same persisting object as a three-dimensional object at t_2 is a causal connection between the two (Tooley 1984). In other words, each time-stage of an object stands in a causal relation to its next stage. In the counterexample, one world contains an *F*-particle; the other world contains a *non-F*-particle. In the first world, an *F*-particle stage causes the next *F*-particle stage, and in the second world, a *non-F*-particle stage causes the next *non-F*-particle stage. So, one may argue, if the particles have different properties, then the two worlds would have different causal sequences after all, and so this is not an example of a difference in dispositions without a difference in causes.

Two sorts of replies come to mind. One is to deny this theory of persistence. Though we are not assuming a particular theory of causation, an intuition one many have about causation is that it is a relation between events that essentially involves change. Kant, for example, conceived of causation as a relation between two sets of objective sequences of appearances, perceived as

14. Stephen Mumford has argued against this view (*Laws in Nature*, 2004).

events (*Critique of Pure Reason*, B234). On some views, a world without change would be a world without causation and perhaps without time as well. Unless something is out to destroy it, an object just sitting there doesn't have to do anything to remain in existence. Causation essentially involves doing, making something happen. A different challenge to the causal theory of persistence is four-dimensionalism according to which, for an object with three spatial dimensions to persist is for it to be part of a larger object with a fourth, temporal dimension. It makes no more sense to say that one time-slice of a four-dimensional object causes a future time slice of itself than it does to say that the right half of the three-dimensional object causes its left half. If the relation between one stage of a thing and a later stage is not that of cause and effect, there is no causal difference between the two worlds.

An alternative reply is to concede this account of persistence, but argue that the stages of a persisting thing could have stood in the same causal relations even if that thing had been slightly different. In other words, sequences of events do not need to be qualitatively identical in order for them to be alike causally, as long as they have all of the same causally relevant properties. Compare one causal sequence, Oswald shooting Kennedy wearing blue socks, with one in which Oswald shoots Kennedy wearing black socks. Arguably, the pairs of events, (*Oswald shooting, Kennedy getting shot*), are alike causally despite this trivial difference.

Now, compare two particle stages each causing a subsequent particle stage. The only difference is that one of the particles has a certain latent disposition which has no effects. In both worlds, a particle existing at t_1 causes a particle to exist at t_2. To this extent, the causal theory of persistence is preserved.

Admittedly, "the particle's being F at t_1 causes it to be F at t_2" is not true at both worlds. But it's not clear to me that this claim is essential to a causal theory of persistence of objects. If it were true that a time slice of an instantiation of a property causes the next time slice of the instantiation of that property, then any worlds with any duration that differ at all would differ causally. That way of getting no dispositional difference without a

causal difference also gets you no categorical difference without a causal difference. If this goes to show that dispositions reduce to causes, it equally goes to show that non-dispositional properties reduce to causes. I don't think the proponent of reducing modalities would want to go there.

So, even if the causal theory of persistence is correct, it could be that the *F*-particle world and the *non-F* particle world have the same causal relations, but different dispositions; the counterexample to global supervenience of dispositions on causes stands.

3.2 Objection 2: Causally relevant properties are essential properties

The counterexample proposes that the particle might have lacked a certain causally relevant property—one that figures in causal laws and grounds its dispositions. But perhaps the property *F* is essential to the particle. For example, the properties *being an electron*, *having negative charge*, or *having a certain mass* may be essential to the particles that have them. Indeed, it might generally be the case that a thing's causally relevant properties are essential to it. David Braun (1995) argues that causally relevant properties are essential properties of the cause. Braun's Natural Essentialist Analysis (458) of causal relevance goes as follows:

> (NEA) If *c* and *e* are events, and *F* is a property, then *c*'s being *F* is causally relevant to *e* iff:
> *c* is a cause of *e*,
> *c* is essentially *F*, and
> *F* is a natural property.

Braun's account targets properties of events, but he says that properties of objects can be considered causally relevant on his view, since an event can have the property of involving an object with a certain property (449). If Braun's account is right, perhaps my counterexample is flawed. I proposed an *F*-particle, in a world where it is a law that all *F*'s in *C* are *G*'s, has a counterpart which is subject to the same laws, but which is not *F*. But if the particle's

causally relevant properties are essential to it, then it is not true that the particle might not have been *F*; the particle has no counterpart that is not *F*.

But is Braun right? Intuitively, NEA does not seem to give either necessary or sufficient conditions for causal relevance. Consider the claim: "My birth caused my mother's joy." Perhaps my birth essentially involves me, a creature with my genetic code and innate characteristics. Was being the birth of a creature with my genetic code causally relevant to causing my mother joy? That's unclear. Anything within the range of normal human, male or female, would probably have done just as well. So, the NEA hasn't given a sufficient condition for causal relevance. Nor has the NEA given a necessary condition. Suppose I pick up a fire poker from a fireplace. It happens to be very hot, and it burns my hand. Being very hot is not an essential property of the poker, and does not seem to be an essential property of the event that consists of my grabbing the poker. The poker could have been cool when I grabbed it. However, the temperature of the poker is surely causally relevant to my burn. So, it seems like accidental properties can be causally relevant.

Braun defends his account against such objections with subtle moves regarding event individuation. In a footnote, Braun says "Some apparent counterexamples to the Essentialist Analysis can be 'turned aside' if we keep in mind that two events with different essential properties can occur in the same place at the same time" (470). On Braun's view, many different events occur in same space/time region, each with different essential properties. When I slam the door, it is thought that at least two events occur at the same place and time, one that is essentially a slamming and one that is accidentally a slamming. The event that is essentially a slamming startles Sara. The event that is accidentally a slamming blocks the draft. Being a slamming is causally relevant to startling Sara, but not to blocking the draft (Lewis 1986c: 255).

Perhaps these kinds of moves can get around the counterexamples offered above. However, these moves raise prior ques-

tions about causation and essential properties. Which among the co-occurring events is the cause of e? Braun uses counterfactuals to answer such questions. According to Braun, our counterfactual judgments support the conclusion that at least two non-identical events occurring in the same region of space/time that have different effects (455). If the event that was essentially a slamming had not occurred, the draft still would have been blocked, since the door would have been merely shut instead. However, if the event that was essentially a shutting of the door had not occurred, the draft would not have been blocked. This is supposed to persuade us that the slamming and the shutting are different events with different essential properties and different effects.

These moves suggest that even if Braun is right, NEA poses no challenge to my counterexample. As it turns out, a potentially causally relevant property might not be essential to some of the events occurring in a certain region of space-time. Suppose being a slamming is a potentially causally relevant property which figures in causal laws relating it to loud noises and startlings. According to Braun's view, the event which blocks the draft is not essentially a slamming. So, despite the potential causal relevance of being a slamming, that property is not essential to all of the events which instantiate it. Only the properties which are causally relevant to a certain effect are essential, and furthermore, they are essential only to the cause of that effect and to not the other events that occur at the same place and time as the cause. So, returning to my counterexample to the global supervenience of dispositions on causal laws, even if the particle's F-ness is a potentially causally relevant property, an event which involved the particle might not have been an event which involved an F. So, for all Braun says, the particle might not have been F. In other words, it can have a counterpart that is not F.

If causally relevant properties were essential to the objects that bear them, then it would be harder, if not impossible, to generate an example of a difference in dispositions without a differ-

ence in causal laws: If two particles differed dispositionally, they would differ with respect to a causally relevant property, and hence couldn't be counterparts of the same particle. There are reasons to reject Braun's view that an event's causally relevant properties are essential to it. But even on Braun's view, a thing can have a potentially causally relevant property non-essentially, and that's all *F*-ness is in the counterexample: potentially causally relevant. So NEA presents no barrier to generating a counterexample to the supervenience of dispositions on causal laws. That's not to say there are no other barriers. One might think that the causal properties of fundamental entities are essential to them. However, there's no need to assume that the particles in the counterexample are fundamental particles. Consideration of Braun's view supports the idea that a thing can have non-essential (potentially) causally relevant properties, including non-essential dispositions.

3.3 Objection 3: Other metaphysical assumptions

Perhaps I am assuming a certain account of events. According to some accounts, an event is a particular instantiating a property at a time (Kim 1976). So, events can be individuated by specifying a triple consisting of a particular, a property, and a time. On this account, the event that occurs in one of the particle worlds consists of the triple ($particle_1$, F, t). The corresponding event in the other world, ($particle_2$, P, t), is not an instantiation of F, so the corresponding events are different events.[15] If this account of events is correct, the two worlds do not include the same event. Arguably, this difference between events can lead to a causal difference. If these two different events have any causes or effects, then there is a causal difference between

15. If particle 1 and particle 2 are different particulars, the corresponding events already cannot be identical. In order to apply Kim's account to trans-world identity of events, we have to allow that one particular can exist in different possible worlds, or that a counterpart relation of the particular constituent of an event is sufficient sameness of event.

the two worlds in which they occur. For example, if an event in the first world caused *particle*$_1$ to be F at t, but in the second world, no event caused *particle*$_2$ to be F at t, then the two worlds seem to differ causally.

This objection is similar to Objection 1, and my reply is similar as well. One option is to reject this account of events. One problem with it is that it makes an event's property and time of occurrence essential to it. So, the event of a top spinning couldn't have been any faster or any later, since the triple (*top, spinning at 50 rpm, t*) is not identical to the triple (*top, spinning at 51 rpm, t*$_{+e}$). Another way to reply is to say that this account of events is consistent with the two worlds agreeing causally. It's possible that t and consequently the particles' being F or *non-F* spans the duration of each world, and that these events don't have any causes or effects, so there is no causal difference between the worlds despite a difference in events. These worlds might be very short-lived, so that many potentialities go unrealized. If these seem like uncommon worlds, that is merely a function of that fact that, given certain metaphysical assumptions, the metaphysically possible worlds in which the example obtains are fewer. However, the fact that the example obtains in any of these worlds goes to show that I am not making the contrary metaphysical assumption.

It may also be objected that I am assuming that there can be a world with no F's in it, in which it is a law that all F's in C are followed by G's. That seems to entail some sort of Platonism about the existence of properties. However, that might be acceptable. There could be laws governing emergent properties in worlds where those properties do not emerge (Tooley 1977: 695). But more to the point, I am making no such assumption. I assume there is a possible world in which one particle is not F. That could be a world in which other particles are F, some of which find themselves in C and are followed by G's, and others that don't. I also assume there is a possible world in which a particle is F, but never in C. That could be a world in which there are other F particles which wind up in C and are followed G's.

3.4 Objection 4: Conceptual, not metaphysical

One may object that my example trades heavily on conceptual possibility, and does not clearly speak to the issue of metaphysical possibility. The examples derive claims about what is possible from what is conceivable. What one takes to be conceivable in these instances is partially determined by one's concepts. Though I claim to not be presupposing particular accounts of dispositions, I am perhaps tacitly appealing to some conception of dispositions that is driving my intuitions. I might thereby be begging the question in favor of a certain non-reductive approach to understanding dispositional concepts. Perhaps on some metaphysical views of dispositions, the possibilities I conceive of are mere pseudo-possibilities.

This line of objection opens deep methodological questions. Perhaps I fall prey to the paradox of inquiry here, whereby I cannot search for an appropriate account of dispositions unless I already know what I'm looking for. Though I am not assuming a particular analysis or definition of "disposition," I cannot proceed as if the term holds no meaning for me. I must have some idea of what a disposition is, some concept of a disposition. If I am doing something more than critiquing conceptual analyses, I take my concept to be picking out a kind of thing in the world, which may be given better or worse descriptions by the analyses. However, I don't think I was tacitly making any illegitimate conceptual assumptions, for no leading conceptual analysis of dispositions contradicts my intuitions.

Consider the view that dispositions are irreducible powers. Particle$_1$ has a latent, irreducible power that particle$_2$ lacks. That would be a dispositional difference without a causal difference. What if dispositions are secondary properties along the lines of Def 6? Particle$_1$ has a property F that would cause the manifestation where particle$_2$ lacks that property, and hence they differ dispositionally. If I am right that there is no causal difference, there is a failure of global supervenience. What if having a disposition was a matter of a certain conditional statement being true? The condi-

tional "if C were to obtain, it would exhibit m" is true of particle$_1$, but not particle$_2$. If that's consistent with the two worlds having the same causal sequences, then there's a dispositional difference without a causal difference. What if having a disposition were a matter of having some non-dispositional property that is subsumed by some causal law? We've already considered the possibility that particle$_1$ is F, subject to the law that all F's in C are necessarily followed by G's. I argued that particle$_2$ could be *non-F*, and hence non-disposed, without there being any causal difference in the worlds. It makes no difference which particular analysis of "disposition" is assumed.

How is it that conceptual analyses of dispositions in terms of causes are consistent with there being a dispositional difference without a causal difference? Because every analysis of "disposition" that has any plausibility does not analyze disposition ascriptions in terms of statements that a cause occurred, but in terms of would-be causes or conditional causal statements. Perhaps there is some concept of a disposition that is inconsistent with my intuitions. For example, if what it is for an object to have a disposition is for that object to be a cause of some effect, then there would be no dispositional difference without a causal difference. But as we have seen, that is an inadequate conception of a disposition. One need not assume a specific analysis of "disposition" to preserve this essential feature of the concept—dispositions can be latent, or unmanifested. This is the key difference between dispositions and causes that my example plays on. As long as one is working with a concept of "disposition" that has this feature, which I would argue one must unless one is to change the subject, then the counter-examples can be generated.

4 Other reductive possibilities

In response to the proposal that dispositions globally supervene on causal laws, I suggested that the F-particle world and the non-

F-particle world could have the same laws and causal sequences if the difference in *F*-ness were part of the initial conditions of those worlds. If this is right, perhaps dispositions globally supervene on causal laws plus initial conditions. Perhaps two worlds with the same laws and initial conditions necessarily have the same dispositions. However, these laws would have to be deterministic, since two possible worlds with the same probabilistic laws and initial conditions could diverge and subsequently instantiate different dispositional properties.

If dispositions globally supervene on causal laws, or causal laws plus conditions, that still leaves the question: where do these causal laws come from? Perhaps they are derived from (supervene on, reduce to) particular sequences of events, patterns of kinds of things in succession in space and time. Possibly, these are the same kinds of things that make disposition claims true. So, again, even if disposition facts globally supervene on causal laws, that might not be because dispositions reduce to causal laws, but because both dispositions and causal laws reduce to something else.

There is some reason to think that the world cannot contain both unreduced dispositions and laws (McKitrick 2005; Mumford 2005b). If the world were law-governed, then what objects do would be determined by the laws that govern them. Their dispositions could be nothing over and above their acting in accordance with laws. On the other hand, if objects had genuine powers, then causal laws would be, at most, generalizations about the kinds of powers things have. If causal laws are necessary for causation, then there's a tension between having both dispositions and causes in the world without reducing one to the other. Since generalist theories of causation which take causal laws as fundamental clash with unreduced dispositions, a singularist view of causation is most compatible with unreduced dispositions and causes. A singularist view of causation takes singular causal facts as fundamental, and causal generalization as derivative (Sosa and Tooley 1993: 17–19). There is no obvious incoherence in imagining objects having irreducible dispositions, and events standing in irreducible causal relations. However, we may

want to be more conservative in the number of irreducible entities, properties, and relations we postulate.

4.1 Reducing causes to dispositions

How might one define causes in terms of dispositions?[16] One idea is that causation is a matter of a disposition manifesting. The view could be put roughly like this:

> Def 11: *a* causes *b* iff *a* has a disposition to produce *b* in circumstance *C*, and *C* obtains.

Without going through successive permutations, let me point out several difficulties for this approach. First of all, if *a* and *b* are names of events, it's not clear that events are the bearers of dispositions rather than objects, and it is not clear that anything can have a disposition to produce a particular event rather than a type of event. Secondly, it is possible that *a* has a disposition to produce *b* in *C*, *C* obtains, and yet *b* does not occur. The counterexamples of masks and finks work here as well. (The fragile glass is disposed to break when struck, but it is packed with Styrofoam, or protected by a wizard, so that when it is struck, it doesn't break.) And if *b* does not occur, *a* did not cause *b*, so the definition does not give a sufficient condition for causation. Thirdly, it seems conceptually possible that *a* causes *b* even though *a* didn't have a disposition to produce *b*. A fall from a flying airplane isn't disposed to cause one to get up and walk away, yet it has happened. Fourthly, "to produce" is a synonym for "to cause." So, "cause" has essentially been defined in terms of a disposition to cause, which is not reductive. This circularity cannot be easily avoided. What is a disposition a disposition for, but for causing the manifestation? Most expressions for the relationship between a disposition and its manifestation are causal, such as "produce," or "elicit." If causation is presupposed as part of the concept of a disposition, then a definition of causation in terms of dispositions is not reductive.

16. Suggestions appear in Cartwright 1999: 67; Harré 1970: 97.

To avoid the circularity, one might try to rid the characterization of "disposition" of causal notions by defining it in terms of a conditional. So, if disposition statements were reducible to conditionals, we could reduce causal statements to disposition statements and then reduce disposition statements to counterfactuals. It's not clear if this will work given the different kinds of conditionals traditionally involved in analyzing dispositions and causes, and the problems involved with such analyses discussed in Section 2.1. But if it did, it's not clear what, if anything, would be gained by letting dispositions playing the middle man in a counterfactual analysis of causation.

What about metaphysical reduction of causes to dispositions? Do causal facts globally supervene on disposition facts? We can use the same sorts of thought experiments used against the reduction of dispositions to causes to try to answer this question. Suppose a rubber band is stretched and resumes its former shape in one world, but in a very similar world, the rubber band has yet to be stretched. In the first world, a causal sequence has occurred which has no counterpart in the second world. However, it seems possible that the same disposition claims are true at both worlds—in both worlds the rubber band is elastic. So, there's a difference in causes without a difference in dispositions, a failure of global supervenience, and hence no reduction.

The dispositions-to-causes reductionist might argue that effects are manifestations of dispositions, so a world never has a difference in effects without a difference in the dispositions of causes. He might insist that there must be a dispositional difference between these two worlds. If someone stretched the rubber band in the first world, he had the disposition to stretch it, and that disposition was lacking in the second world. Or, if the rubber band stretched on its own accord, it had the disposition to stretch that the other rubber band lacked.

In response, the example can be elaborated as follows. In both worlds, at time t_1, the rubber band is in the hands of someone with a disposition to stretch it. In W_1, the rubber band is stretched at t_2;

in W_2, the rubber band isn't stretched until t_3. So, at t_2, the worlds differ causally, but not dispositionally.

The reductionist may counter by saying at t_1, the two worlds must have differed dispositionally in order for their futures to diverge. Perhaps the person in W_1 had a more powerful and urgent disposition to stretch the rubber band, or the person in W_2 had a disposition to attend to his itchy elbow first.

However, such a response won't work for probabilistic dispositions. Suppose two worlds each contain a lump of uranium that has a disposition to emit particles 50% of the time under certain circumstances. One lump emits a particle, but the other doesn't. To insist that there must be a dispositional difference between the two lumps of uranium is to deny the possibility of probabilistic dispositions.

I can anticipate one further, and perhaps decisive, rejoinder on behalf of the causation-to-dispositions reductionist. In W_1 in which the rubber band is stretched at t_2, the stretched rubber band has a number of dispositions at t_3: it is disposed to break if pulled a little harder; it is disposed to make a "twang" sound if it is plucked; and it is disposed to shoot across the room if one of its ends is released, etc. The flaccid rubber band in W_2 at best has the disposition to acquire these dispositions if stretched. So, the two worlds disagree dispositionally after all. The possibility of probabilistic dispositions makes no difference here. The world where a lump of uranium emits a particle then has a particle flying around in it, which is disposed to trigger a Geiger counter, to bombard other uranium atoms, and so forth. This world differs dispositionally from the world in which no particle is emitted. So, after the manifestation occurs, the worlds differ dispositionally as well as causally.

This feels like something of a cheat, but what can the antireductionist say? In order to maintain her position, she must insist that there is a point at which the two words differ causally but not dispositionally. But this most recent objection shows, as soon as the effect or manifestation starts to occur, the two worlds start to dif-

fer dispositionally. So, perhaps there's a crucial moment after the cause occurs but before the effect starts to occur. Since no cause occurs in the other world, the two worlds would disagree causally at that point.

But how could a cause be occurring in one world and not the other without the two worlds differing dispositionally? For example, suppose that prior to emitting a particle, an event which is the cause of the particle emission occurs in the lump of uranium. While the uranium lumps might have agreed dispositionally earlier, at the moment when the cause of the emission has occurred but the emission has yet to occur, the two lumps differ dispositionally as well as causally. One lump is disposed to emit a particle in the next micro-second, the other is not.

So, it seems that we cannot describe two worlds that agree disposition-wise, but disagree cause-wise. If causal facts globally supervene on disposition facts, a necessary condition for the metaphysical reduction of dispositions to causes is met. Is this because dispositions and causes reduce to the same thing? I think not. If both causes and dispositions reduced to the same thing, we should not be able to describe worlds which agree causally but disagree dispositionally. However, unless all dispositions necessarily have a non-dispositional causal basis, it seems that we can describe worlds which agree about causes and non-dispositional properties, but disagree about dispositions, as I argued in Section 3. So, this suggests it is not the case that global supervenience of causes on dispositions holds because both causes and dispositions reduce to the same thing, but because causes reduce to dispositions.

Another possibility for causal to dispositional reduction is a reduction of causal laws to dispositions. Assume that objects have inherent powers, which are activated in various circumstances. We may be able to generalize about what kinds of things have what kinds of powers in which circumstances: Protons have the power to attract electrons at certain distances and velocities; massive objects have the power to attract other massive objects, etc. Such generalizations would be our causal laws.

One may object that it is metaphysically possible that no such generalizations are true. A world in which no causal generalizations are true would be a world in which the powers are too chaotic to have any causal laws. However, if that is indeed a possibility, it is no objection to the reduction of laws to dispositions. Chaotic worlds would merely be worlds with no laws to reduce. If causal laws are generalizations about powers, then worlds which agree on dispositions will agree on causal laws—whether they have them and what they are.

However, not all worlds that agree on causal laws will agree on which dispositions are instantiated, since true generalizations underdetermine particular patterns of instantiation of dispositions. For example, the generalization "All F's in C become G's" could be true in a world with twenty F's in C that become G, a world with five F's in C that become G and six F's not in C, a world in which F's are never in C, and infinitely many others. So, there would be global supervenience of causal laws on dispositions, but not dispositions on causal laws.

5 Conclusion

There are several options regarding dispositions, causation, and reduction. My main objective was to argue against reduction of dispositions to causes. The general problem for a reductive relationship between causes and dispositions comes to this: Causes are active; dispositions are potentially latent. Reducing one to the other threatens to obscure this crucial difference. The best arguments for global supervenience of dispositions on causes, a necessary condition for reduction, proceed by providing a common reduction base for dispositions and causes. Since causal laws are possibly uninstantiated, they are a better reductive fit with dispositions. But in which direction? Recall that a reduction of dispositions to causal laws plus conditions requires deterministic laws. If we want to allow for the possibility of probabilistic laws, then reducing causal laws to dispositions is a better prospect. However,

my inability to provide a convincing example of a causal difference without a dispositional difference raises the intriguing possibility that causes reduce to dispositions.[17]

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