

# A Powerful Theory of Causation

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## **Abstract**

Hume thought that if you believed in powers, you believed in necessary connections in nature. He was then able to argue that there were none such because anything could follow anything else. But Hume wrong-footed his opponents. A power does not necessitate its manifestations: rather, it disposes towards them in a way that is less than necessary but more than purely contingent.

In this paper a dispositional theory of causation is offered. Causes dispose towards their effects and often produce them. But a set of causes, even though they may succeed in producing an effect, cannot necessitate it since the effect could have been counteracted by some additional power. This would require a separation of our concepts of causal production and causal necessitation. The most conspicuous cases of causation are those where powers accumulate and pass a requisite threshold for an effect to occur.

We develop a model for representing powers as constituent vectors within an n-dimensional quality space, where composition of causes appears as vector addition. Even our resultant vector, however, has to be understood as having dispositional force only. This model throws new light on causal modality and cases of prevention, causation by absence and probabilistic causation.

## **1. The dispositionality of causation**

When it comes to causation, we should think less of necessity and more of dispositionality. Others have already suggested that it should be possible to get a theory of causation from an ontology of real dispositions or powers (Harré and Madden 1975, Bhaskar 1975, Cartwright 1989, Ellis 2001, Molnar 2003: ch. 12, Martin 2007: ch. 5). Such a project is far from complete but even here we find that the key point of a dispositional theory of causation has been lacking. One of the key attractions of a dispositional theory of causation should be the claim that causes dispose towards their effects. This offers us something stronger than Humeanism, in which everything is loose and separate. Unlike many opponents of the old Hume, however, we do not want dispositionality to be reduced to necessity either for that too would be to overlook what is most important about dispositionalism. Causes do not necessitate their effects: they produce them but in an irreducibly dispositional way.

Many theories of causation assume that it must involve some kind of necessity, or that the cause must be entirely sufficient for the effect.<sup>1</sup> It is, however, not always clear what necessity means in this context. It is often accepted that causal processes can be prevented or interrupted and thus that any such necessity cannot be strict. In that case it is not clear what the alleged necessity adds to the notion of causation, nor how it deserves the name.

There is, though, already an older tradition that acknowledges the dispositional nature of causation. Aquinas's philosophy of nature, according to Geach (1961), is one in which causes only tend towards their effects rather than necessitating them and the view presented in this paper is on that account neo-Aquinian.<sup>2</sup> Many contemporary treatments of causation follow from Hume, however, as he was traditionally understood prior to the 'New Hume' debate. Constant conjunction is there depicted as a necessary condition for causation having occurred. Dispositionalists have highlighted the weakness of constant conjunction, pointing out that there can be accidental cases that were not genuinely causal, and instead saw real dispositions as somehow imposing natural necessity on top of constant conjunction. We argue that a true dispositionalism, in contrast, is one in which a cause only tends towards its effect. For a general causal claim to be true, such as that smoking causes cancer, there need be no constant conjunction. And in particular causal claims, even if one cause indeed produced its effect, that doesn't mean it necessitated it. Something could have got in the way of the effect, even if it did not as a matter of fact.

## 2. Causal production

How, one might wonder, can there be causal production unless there is necessitation? Isn't necessitation required for causation because a cause has to be sufficient for its effect; in other words, it must necessitate it? On the contrary, we maintain that the most natural account of causation is one that does not require necessitation. The issue of causal production should be seen as independent from the issue of causal necessitation for, as Collins, Hall and Paul (2004: 18) say, that would be 'simply to confuse *guaranteeing* an outcome with *causing* that outcome'. Perhaps some things can be guaranteed but, if that is the case, it is not causation alone that makes the guarantee: it is something more. A cause should be understood, therefore, as something that disposes towards a certain effect or manifestation. That will suffice for general causal claims. In many particular causal claims, however, there is typically also a factive element, which states that the effect actually did/does/will occur. The dispositional theory thus says in the case of particular causal claims that a cause is something that disposes towards an effect and succeeds in producing it (at least partially).

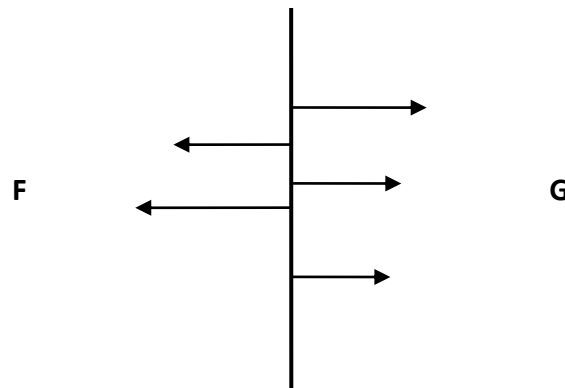
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<sup>1</sup> Examples are too numerous to list in full but for one contemporary instance see Sosa: 'What there is in common to all forms of causation is, it appears, necessitation' (Sosa: 1980: 241). Historical examples are to be found in Aristotle, *Metaphysics* Θ 5: 264, Spinoza 1677 I, ax. iii: 46, Kant 1781 book II, ch. II, sec iii, second analogy, Mill 1843: III, V, sec 6, Russell 1913: 2, Ducasse 1924: 55, Davidson 1967: 698, Popper 1972: 91 and Mackie 1980: 62.

<sup>2</sup> Aquinas uses the terms *inclinatio* and *appetitus*. See Geach 1961: 101.

How, then, would causal production work? We offer what can be called a *threshold account* in which an effect occurs when its causes have accumulated to reach the requisite threshold. Our preference is to outline this account in terms of powers, which we believe to be the most plausible truthmakers of causal claims, but we note that other views of the truthmakers may be able to make use of the same idea. A threshold account is consistent with causes being events or facts though we think that causation has an essentially powerful nature that sits especially well with it being understood in terms of thresholds rather than necessity.<sup>3</sup>

Causation typically involves complexity. As Molnar says (2003: 194-8), different powers accumulate polygenically and pleiotropically to produce what we would recognize as the effect of a causal process (see Mumford 2009). That these effects are polygenic means that they are typically produced by more than one power acting together. That powers are pleiotropic means that they make the same contribution to any effect of which they are a cause. The same power always makes the same contribution, when it manifests, even though the final effect may vary according to what other powers it is operating with. Among other things, this would allow us to understand the composition of powers along the lines of vector addition, as shown in figure 1. Powers can be plotted as vectors on a one-dimensional quality space with F and G as two possible effects of the accumulated powers. F could be the property of being cold and G the property of being hot, for instance. Vectors are a useful way of modeling powers because, like powers, they have a direction – the possible manifestation the power is ‘for’ – and they have a strength or intensity, indicated by the length of the vector.



*Figure 1: Powers modeled as vectors.*

The threshold account of causal production states that an effect is produced when some local aggregation of operative powers reaches the requisite threshold for that effect. In other words, an effect is caused when powers have accumulated to reach the point at which that effect is triggered. However, in reaching that point, we cannot consider simply the addition of operative powers. Other powers might be subtracting from the accumulation and tending away from the requisite threshold. In striking a match, for instance, and aiming to light it, I am doing what I think needs doing for the threshold for lighting to be met. I am using a match

<sup>3</sup> Empiricists tend to prefer events as the relata of causal relations while Mellor (1995) argues that the relata are facts. Either view is consistent with a threshold account.

that I already judge to be suitably empowered, with its flammable tip intact. I am trying to strike it in the right way, against a suitable surface and in the presence of oxygen. But I will also be conscious of the powers that could subtract from those I have accumulated. I will try, for example, to keep out of the wind precisely because I know that the wind could tend away from the match igniting. Powers compose additively and subtractively in the sort of way we would have to consider when calculating vectors. To calculate a final effect, we have to consider the strength and direction of each individual vector. The resultant vector  $R$  will be constituted by all the component vectors along the lines of vector addition (figure 2).<sup>4</sup>

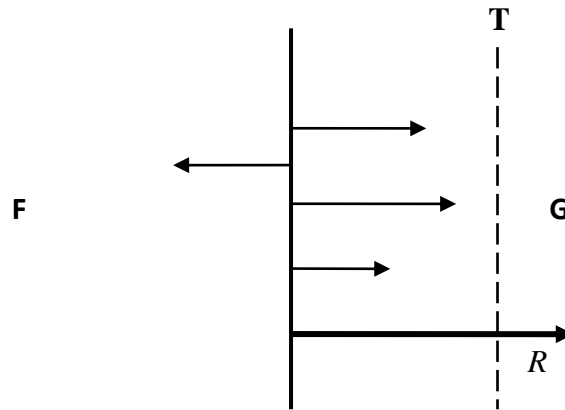


Figure 2: A resultant vector  $R$  that meets a threshold.

What, though, are these causal thresholds and how do they relate to effects? The threshold is not a real thing at all; it is only a way of understanding the point at which an effect occurs. Often thresholds are marked as particular points that interest us because they involve some significant or dramatic change. Water can become hotter and hotter, for instance, because of a variety of factors at work. There is, however, a significant threshold that can be passed when the water gets to  $100^{\circ}\text{C}$  because at that point the water turns from liquid to steam. In another case, pressure can be exerted on a vase and at some point the factors taken as a whole are enough to make the vase shatter. An effect need not be quite so dramatic, however. I may require simply that the water in my radiators reaches some point short of  $100^{\circ}$  but enough to keep my living room warm. The desired effect in this case is simply a comfortable room temperature.

The threshold idea of production, mixed with the idea of causes as polygenic, shows us why causal production does not require necessitation. Geach (1961: 102) provides a nice example that we can use in which the same room contains both a heating unit A, which can raise the room's temperature to  $25^{\circ}$  in an hour, but also a refrigerator unit B that can lower the room's temperature to  $10^{\circ}$  in an hour. On its own, the heater A would have enough power to raise the room temperature to  $25^{\circ}$ , and sometimes does so. But it doesn't necessitate it. It won't reach

<sup>4</sup> The understanding of causation along the lines of vector addition appears in Cartwright (1983: 59 & 1989: 163), though she rejects it on various grounds. She does not think that forces in the world, for instance, literally add. She thinks that only resultant forces are real because they can be measured. In contrast, she thinks that component forces have no separate existence because if they did there would be a systematic overdetermination. Cartwright's view, applied directly to powers, is rejected in Mumford and Anjum (forthcoming).

that temperature – won't reach the threshold – if the refrigerator is also on. If A alone is on, the room reaches 25° in an hour. But if A and B are both operating, the room reaches, let us suppose, only 15°. So even though the heater A in one context would have enough power for a certain effect, in another situation there is not overall enough for that same effect. Even though the unit A appears sufficient for this effect, because it actually succeeds in producing it in one situation, it cannot be the standard sufficiency as understood by philosophers because we can have another situation in which A operates but does not produce that effect. The example shows the way in which dispositionality, accumulation and subtraction are all in play when it comes to whether or not an effect is actually produced. The bare notions of necessity and causal sufficiency cannot do this justice.

### 3. Causes do not necessitate their effects

What is the argument for the claim that, in general, causes do not necessitate their effects? In this section, the *argument against necessity* is advanced.

Let us call a group of polygenic causes  $C_1, \dots, C_n$  and assume that there is a case in which together they produce the effect  $E$ , the match lights. Nevertheless, it can be claimed, had all of  $C_1, \dots, C_n$  occurred but also some interfering condition  $I$  been present, such as a gust of wind, then  $E$  might not have occurred. We are taking  $I$  to be a real natural or physical possibility, rather than a mere logical one. This shows that  $C_1, \dots, C_n$ , although they caused  $E$ , were nevertheless consistent with  $E$  not occurring. Therefore,  $C_1, \dots, C_n$  do not necessitate  $E$ , even if as a matter of fact they do cause  $E$ .<sup>5</sup>

It should be noted that the argument applies whether we are talking about the causes of an event as particulars or we are talking about type causal claims. We cannot say that causes of the types  $C_1, \dots, C_n$  necessitate  $E$  if there are some instances of those types that fail to produce  $E$ . But also we cannot say that particular tokens of  $C_1, \dots, C_n$  necessitated their token effect  $E$  if something could have prevented it.

The argument against necessity might immediately provoke objections. We anticipate four of them.

#### *Objection 1*

The first objection to the argument against necessity is that it works only by changing the original causal situation which, had it indeed been fully present, would after all have guaranteed the effect. Suppose, for instance, a simple case where we have just four causes of  $E$ , namely  $A, B, C$  and  $D$ .  $A$  might be that a particular match is dry,  $B$  that it is flammable,  $C$  that there is oxygen present, and  $D$  that the match is struck. In this case  $A - D$  do in fact cause

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<sup>5</sup> A precedent for the argument is to be found in Schrenk (2008). It is also deployed by Hume (1739: 161) against the powers view, though we argue in §7 that it works against powers only when they are misconceived. The argument also bears similarities to Bird's (1998) antidote case, where we could call  $I$  an antidote to the disposition(s) that would produce  $E$ .

*E*: the match lights. But suppose I now allege that *A – D* might have occurred without *E* because, in some other situation, there is also the interference *I* – that the humidity is too high – which prevents *E*. An objection to this claim would be that this new factor, *I*, is really just the taking away of *A* because the match is no longer sufficiently dry when there is high humidity. We do not then, in this second situation, have all of *A* to *D* present because *I* is effectively just not-*A* by another name and we have thus failed to show that *A* to *D* are consistent with *E* not occurring.<sup>6</sup>

This could indeed be true in this particular instance but it does not establish that all such alleged cases of prevention are equally spurious, which is what would be needed for this objection to be successful. The genuine exception cases are those where all of the causes *A* to *D*, which in some cases succeed in producing *E*, are indeed present but *E* fails. Instead of high humidity, for instance, a strong wind might prevent the match from lighting. The wind is not a factor that is incompatible with *A – D*, that stops any of them happening or being the case, but still it interferes with *A – D* such that they fail to produce *E*. Another case that we think is clearly of this kind is that of a lumberjack felling a tree by cutting a wedge out of one side and then letting gravity take hold of it. Do the wedge and the gravity necessitate that the tree falls? Evidently not. The gravitational attraction to the Earth could still have been there, and the wedge cut out of the tree, but these are consistent with a cyclone appearing above the tree and sucking it off into the air.

Using the vector model, we can see that there is a clear distinction to be drawn between what we may call subtractive and additive interference (figures 3 and 4). The argument against necessity is premised on the possibility of additive interference, which it seems hard to deny outright as a real possibility.

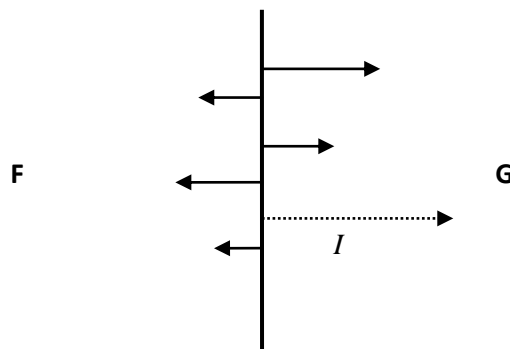


Figure 3: Subtractive interference (dotted vector is removed).

<sup>6</sup> Our thanks to Maria Jose Encinas for developing this line of objection.

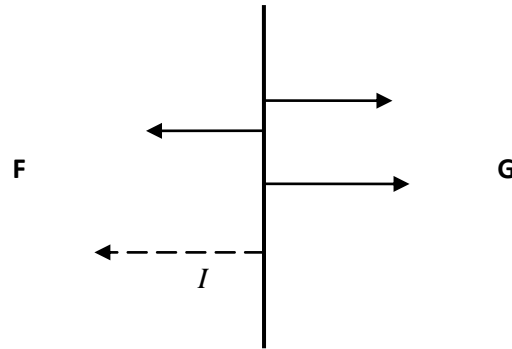


Figure 4: Additive interference (broken vector is added).

### Objection 2

A second objection to the argument against necessity is that, as a matter of fact, there are some cases of causation where it is just absolutely impossible that there be any prevention because an effect follows a particular cause with absolute uniformity. Hume alleged a couple of causal examples of inviolable constant conjunction for instance.<sup>7</sup> One was that a flame would cause us to withdraw our hand. No man could ‘put his hand into the fire, and hold it there, till it be consumed’. Another case he cites is that ‘A man who at noon leaves his purse full of gold on the pavement at Charing-Cross, may as well expect that it will fly away like a feather, as that he will find it untouched after an hour’ (both examples 1748: VIII, 20).

Contrary to Hume’s claims, however, both these cases could be prevented. Some people have a condition in which they can feel no pain and would be capable of holding their hand in the flame. And even if, as a matter of fact, there were no such condition, its very possibility is enough for us to allow that such a causal claim admits the possibility of an exception. Again in the second case, there is at least the possibility that all those who pass by Charing Cross leave alone the purse for its owner’s return.

An example from physics might be the case of gravitational attraction, which seems to be a universal phenomenon whose operation can never be prevented. Suppose one thought that gravity always resulted in a tendency to attract bodies. Gravity and this tendency are always conjoined with no possibility of prevention. Is this a counterexample to the claim that causes do not necessitate their effects? We argue not. It would be a misapprehension to think of gravity and the tendency as standing in a causal relation. On the contrary, gravity just is the tendency to attract bodies. What gravity, understood as such a tendency, actually causes (when it does) is the movement of bodies towards each other and whether it actually does so is obviously something that can be prevented by other powers and attractions. In the case of gravity, the constant conjunction between gravity and the tendency to attract is not indicative of causation at all but, it seems more plausible, identity.

<sup>7</sup> Both these examples occur when Hume tries to show that we (people) are as much subject to causation as inanimate matter. If constant conjunction could be shown for the most difficult case of persons, even with their apparent free will to resist it, then it would seem also established for inanimate matter.

In answer to objection 2, therefore, we argue that when we consider the world, it is clear that most causal cases admit the possibility of prevention. If there is a causal process for which there is no preventer, it seems the exception rather than the rule. And even then, it seems that we can countenance a possible preventer even if there is no actual one. To allow that is to accept that even this process does not involve necessity.

### *Objection 3*

Might one be able to ensure the necessity of the effect by just including more? Might it be that as well as all the positive factors in the effect, all of  $C_1, \dots, C_n$ , part of the cause is also that all the possible interfering factors are ruled out? Burks made this move in defending the sufficiency of the cause for the effect, for example, stating that ‘By “sufficient conditions” we mean a set of conditions, complete with respect to negative properties as well as positive ones (*i.e.*, counteracting causes must be explicitly mentioned)’ (1951: 368). Hence, the cause, as well as  $C_1, \dots, C_n$ , includes  $\neg I_1, \neg I_2$ , and so on. Let us call this complete set of circumstances, both positive and negative, the set  $\Sigma$ . Is it the case, as Burks supposed, that  $\Sigma$  necessitates the effect in question,  $E$ ? We can see immediately that it does not. The problem is that precisely the same argument can be applied to  $\Sigma$ . Although it may perfectly well produce  $E$  on any number of occasions, that does not mean that it necessitated  $E$ . There could have been  $\Sigma$  plus one other counteracting power,  $I_\Sigma$ , that prevents  $E$ . There is no reason to think that the possible interfering factors are of finite extent such that they could all be listed. And even if, as a matter of fact, interferers are of finite extent in actuality, to prove that  $\Sigma$  necessitates  $E$  requires that there is not even some physically *possible*  $I_\Sigma$  that can prevent  $E$ . There seems to be no plausible reason to rule out some such thing (though we will consider an attempt under the next objection). Rather, we should conclude from this that there is no  $\Sigma$  that could serve as a ‘sufficient condition’ for  $E$  even though  $\Sigma$  does indeed produce  $E$ .

It can also be noted here that if strictly there are no sufficient conditions for an effect then there are no INUS conditions either. Mackie famously characterized a cause as ‘an *insufficient* but *necessary* part of a condition which is itself *unnecessary* but *sufficient* for the result’ (1965: 34). No matter how big and complex the total cause is, it would never be sufficient for its effect in the sense that it is impossible to have  $\Sigma$  without  $E$ .

### *Objection 4*

Could it be said that attempting to mention all the causes of  $E$  in a finite list such as  $\Sigma$  is both misguided and not what we actually do when we pick out a cause of an effect? Isn’t it the case that when we identify a cause of some effect, we automatically rule out any additional factors that might interfere with it?

There are a number of mechanisms for doing so. One would be idealized models where we abstract away from interfering factors and consider the causal process in isolation. But this, of course, can be no more than an abstraction and should not be mistaken for the actual causal scenarios as they play out in the world. There is, however, a real world correlate to abstraction, which is the case of ‘screening off’ (Cartwright 1999: ch. 3), where in some



carefully controlled experiment we put up barriers to possible interferers. Armstrong's totality facts (2004: 57f.) would also serve this purpose as they are the higher-order facts that there are no more first-order facts. These could be used to stop the addition of anything further to  $\Sigma$ . Another suggestion might be that because we are surrounded by successful cases, where some particular set of causes does indeed produce an effect, we are able to refer to that cause, complex though it may be, ostensively. Employing externalist semantics, we might then always have this kind of causal situation in mind and thus as the reference of future causal attributions.<sup>8</sup> Finally, there would be a Lewisian kind of constraint (Lewis 1973, 1986) that in assessing causal claims we should consider only the closest possible worlds, which are worlds in which interferers such as  $I$  are ruled out as gratuitous differences from the actual world. All these solutions would purportedly work by picking out an exact kind of total circumstance, to which nothing could be added, that is successful for the production of  $E$  and thus, it would seem, sufficient for  $E$ . Let us call such a total circumstance,  $\Sigma^*$ .

If this kind of proposal is to add any more to those already discussed and dismissed, it is because it would have some automatic exclusion of any further preventers such as  $I_\Sigma$ . But then would the proposal really have established that  $\Sigma^*$  necessitates  $E$ ? We should be skeptical of that. How would we know that circumstances of type  $\Sigma^*$  necessitate  $E$ ? That would have to mean at least that every case of  $\Sigma^*$ , both actual and possible, is followed by  $E$ . How would we know that  $E$  always does follow? To say so is to assume the very thesis that we deny, that  $\Sigma^*$  necessitates  $E$ , and would thus be begging the question.  $\Sigma^*$  thus has no power to defeat the argument against necessity. It merely denies it.

The major reason this approach ultimately fails is that it 'works' by excluding one of the few things that could convince us of the presence of necessity. The 'solution' tries to automatically rule out anything being added to the successful causal set up of  $\Sigma$  that might block  $E$ . But then it automatically excludes one of the most reliable, this-worldly tests we have of necessity, namely, antecedent strengthening. When we want to know whether  $A$  necessitates  $B$ , where  $B$  on its own is not already necessary, one plausible test is to consider whether  $B$  would still be the case, given  $A$ , no matter what else happens. So if  $A$  is followed by  $B$ , *even if*  $C$ ,  $D$ , and no matter what else, then that is a good reason to believe that  $A$  necessitates  $B$ . For example, we might think it necessary that 'if  $x$  is human, then  $x$  is mortal' because we could strengthen the antecedent in any way we wanted and we would still get a true conditional. 'If  $x$  is human and  $\phi$ , then  $x$  is mortal' remains true for any  $\phi$ . Therefore, it would only be non-question begging to say that  $\Sigma^*$  necessitates  $E$  if we could add something else,  $I^*$ , to  $\Sigma^*$  and still get  $E$ . But this is the very move that is supposed to be ruled out by this strategy as a way of avoiding the argument that this  $I^*$  could prevent  $E$ .

#### 4. What if determinism is true?

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<sup>8</sup> Such a suggestion has been made to us by Matthew Tugby, following an idea of Alexander Bird's.

It may be objected to the account that we are assuming too much in an essentially a priori consideration of causation. In particular, are we assuming in our theory that causal determinism is false and thereby deciding a priori on a thesis that may be an a posteriori matter? What, for instance, if physics were to tell us eventually that the whole history of the universe was determined? If the truth or falsity of determinism is an a posteriori matter, then no philosophical account of causation should rule it out.<sup>9</sup> How should we respond?

In the first place, it should be noted that causal necessitarianism – the thesis that causes necessitate their effects – is not the same thing as determinism. One could accept that all causes necessitated their effects without being a determinist simply if one accepted that some events are uncaused. Determinism would require, therefore, that not only do all causes necessitate their effects but also that all events are caused. This shows that causal necessitarianism does not entail determinism.

But does determinism entail causal necessitarianism? We have argued that causes should be understood as disposing towards their effects and that because dispositions can be prevented from manifesting, they should therefore be understood as not necessitating their effects. If causal determinism is true, however, everything that happens is causally fixed by what has happened earlier. But this would still be consistent with the possibility that any individual causal process can be prevented, and in that sense the argument against the necessity of effects stands. There is still a very real sense in which any causal process can be naturally prevented. The determinist, however, would then have to say that where an individual, token causal process is prevented, it was determined that it was so prevented. What did the preventing, according to the powers theorist, will always be a countervailing power. What has been said of necessity applies also to this countervailing power. Although its actual effect is to prevent a certain process, our countervailing power could itself have been prevented from operating and in that sense did not necessitate its effect. The causal determinist again will say that whether or not it does so – whether or not something else prevents it – is an entirely determined matter.

If this kind of determinism is true, then everything that happens naturally is fixed, including which causal processes are prevented and which are not. This brings necessity in the sense that nothing could have been different. It is a very strong claim, however. There would be no probabilistic causation at all. Were we to be told on a posteriori grounds that the world is indeed this way, we would beat a tactical retreat to a position in which the possibility that things could have been different would be either purely logical, metaphysical or epistemic. It could no longer count as a natural possibility. Yet there would also be enough of our core argument that remained. Any individual causal process could still have been prevented had things been different and by our lights is thus not necessary. In that sense, causation is not necessary. What brings the necessity is the fixity of everything else: all the background conditions and processes are set so that it is determined what causes what. With Anscombe, it cannot be derived simply from the concept of causation that the world is like that.

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<sup>9</sup> Thanks to Stephen Barker for raising this point.

If *A* comes from *B*, this does not imply that every *A*-like thing comes from some *B*-like thing or set-up or that every *B*-like thing or set-up has an *A*-like thing coming from it; or that given *B*, *A* had to come from it, or that given *A*, there had to be *B* for it to come from. Any of these may be true, but if any is, that will be an additional fact, not comprised in *A*'s coming from *B*. (Anscombe 1971: 136)

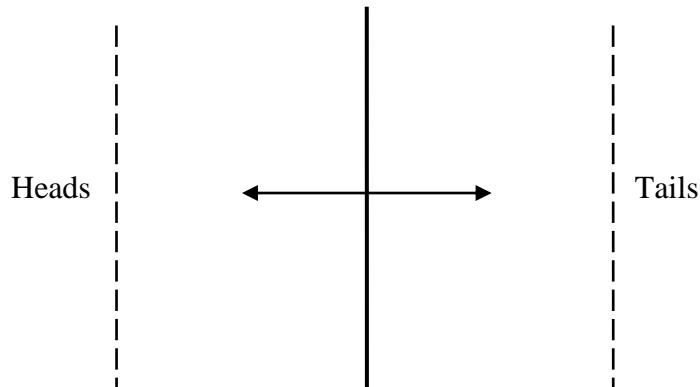
The deterministic assumption has to be added and cannot be derived merely from the notion of causal production alone. The notion of causal production developed in section 2 is consistent both with determinism and indeterminism and it seems quite correct that any theory of causation should be likewise open to both possibilities.

## 5. Probabilistic causation

The thesis that causes do not necessitate their effects has thus far been independent of an assumption of indeterminism and also of probabilistic causation. The thesis does not rest on such things. Nevertheless, probabilistic causation has to be acknowledged as a possible kind of causation that may indeed occur and even be widespread according to some theories. It is relatively easy to understand probabilistic cases once one accepts the essentially dispositional nature of causation.

By probabilistic causation we do not mean completely random chance events, which may best be described as uncaused. Rather, we mean causation that is chancy yet probabilistically constrained. Let us assume, as a model of such causation, a coin that when tossed has a 50:50 chance of landing heads or tails. Not all probabilistic causes of course have only two outcomes: a dice roll has six. And not all probabilities are equal: a loaded coin may have a disposition to land heads more frequently than tails. The simplest case, however – two outcomes with equal probability – contains all the features we need.

Our preference would be a propensity interpretation of this kind of probabilistic chance (see Mellor 1971). The propensity interpretation makes it sensible to ascribe a chance to an individual coin toss instead of talking about frequencies but also, according to the dispositional ontology, any truths about what is most likely for a whole group of coin tosses would ultimately rest on the dispositions of the individual coins. A probabilistic disposition could be plotted as a single double-headed vector, disposing partly towards *F* and partly towards *G* (see figure 5). A 50:50 propensity will point to both in equal measure but other propensities could point more towards one outcome than another.



*Figure 5: A probabilistic case with two possible, equally likely, outcomes.*

It is important that this be a single, probabilistic disposition rather than two distinct dispositions. This would explain, for instance, why the combined probabilities must always add up to one. It would be a disposition for a certain distribution between possible outcomes, where all such outcomes comprise a single whole. The single, double-headed vector also distinguishes this kind of power from a regular, non-probabilistic one. Once a probabilistic power is involved, the rules of the game for vector addition are changed. A resultant can still be calculated, but now more than ever it needs to be understood that the resultant only disposes towards that outcome. If at least one probabilistic power is involved, then there remains a chance of other possible outcomes.

Understanding irreducibly probabilistically constrained causation is not easy unless one accepts that it involves a dispositional connection that is neither entirely necessary nor entirely contingent. Our coin tends towards a 50:50 distribution, but in a sequence of trials there could be any distribution of heads and tails. We know that an actual 50:50 distribution is unlikely, especially when the number of trials is low. But we also know that if the number of trials is high then a distribution wildly at odds with an equal distribution is highly unlikely. There is a principle of probabilistic distribution that, applied to this case, says that the proportion of heads and tails will tend to 50:50 as the number of tosses tends to infinity; or, the higher the number of tosses then the closer to 50:50 the distribution is likely to be. This principle is appealing and yet we might wonder why it is true. Is it just some brute fact about the world or does it have a truthmaker? The powers theory offers a truthmaker for the principle. The coin has a tendency to land heads and tails with equal chance, a tendency which manifests itself over a sequence of trials. But this is ‘only’ a disposition towards such a distribution. It does not necessitate it, as we know when we acknowledge that any actual distribution is possible for any sequence of tosses. Yet the distribution is not entirely contingent either, as we know when we acknowledge that distributions at variance widely from 50:50 are unlikely, proportionate to the number of trials.

The case of probabilistically constrained causation thus corroborates our account. It is noteworthy in so far as the account seems to accord entirely with what we already accept pre-theoretically to be the data of chancy causes.

## 6. Causation by absence?

A theory in which causation is essentially dispositional suggests the ontological reality of powers and that causation occurs when powers manifest themselves. In that case, causation could look like the passing around of powers (see Mumford 2009). There is an objection to this, and to many similar theories of causation, that sometimes causes are absences, such as when lack of water causes a plant to die or the lack of a nail causes a horseshoe to come loose (see Schaffer 2004). Were there to be causation by genuine absences, that is, by nothing at all, then it would indeed seem to create a problem for the present account. Absences are nothing and how can *nothing* have causal powers?<sup>10</sup> Powers, like properties, must be instantiated by something.

It is not, however, necessary to invoke absences as real causes. Why they are sometimes invoked as such can be explained and justified by the powers theory. The solution we offer to this difficulty resembles that of Dowe (2001) though with powers at its centre. The claim would be that all cases of genuine causation involve the manifestations of dispositions. Where an absence is invoked, what we have in mind is a counterfactual that the effect would not have occurred had the removed or absent power been present. In figure 6, for instance, power *b* is removed, such as when I stop watering my plant. When *b* was present, the plant was in balance, disposing overall neither to death by drowning (F) nor death by dehydration (G). Once we remove the water, it now disposes towards death by dehydration, but note that what kills the plant is the remaining powers, *c* and *d*. The surrounding atmosphere had the power, for instance, to suck moisture out of the roots, soil and leaves. This power is operative on the plant and leads to its death. The absent water does nothing. The thesis that all causation involves the exercise of powers could therefore still remain. Considering the vector model, however, we can see that had the water been present, the plant would not have dehydrated, which is why its absence is explanatorily useful.

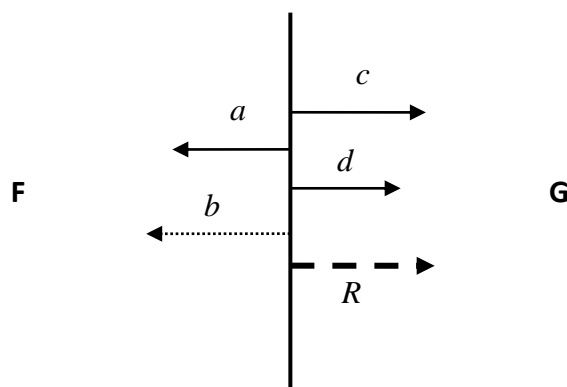


Figure 6: Causation 'by absence'

<sup>10</sup> One might of course try to defend the line that an absence can have causal powers. David Lewis's (2004) deadly void, for instance, might have a causal power to kill, but we do not think it is necessary to make this move to account for such cases.

## 7. Where Hume really went wrong

Hume's account of causation has proved immensely seductive to such an extent that even those who would refute him have nevertheless accepted many of his starting assumptions. Hume produced an objection for his opponents, to those who believed that there were real causal powers and that causation was something more than constant conjunction. They, Hume insisted, were people who believed in a 'necessary connexion' (1739: 77). This move was made with little ceremony as follows:

... we must be able to place this power in some particular being, and conceive that being as endow'd with a real force or energy, by which such a particular effect necessarily results from its operation. We must distinctly and particularly conceive the connexion betwixt the cause and effect, and be able to pronounce, from a simple view of the one, that it must be follow'd or preceded by the other. (1739: 161)

But he was then able to argue that 'Such a connexion wou'd amount to a demonstration, and wou'd imply the absolute impossibility for the one object not to follow, or to be conceiv'd not to follow upon the other' (1739: 161-2). There was no such thing, he concluded.

We have used the same argument as Hume but against the claim that causal production entails causal necessitarianism. However, it would be a mistake to acquiesce in Hume's characterisation of powers. Those who believe in real causal powers should not at all accept that they involve necessary connections between events. Hume has effectively wrong-footed his opponents, saddling them with a position they should never and need never adopt. Realists about dispositions have long rejected the so-called conditional analysis of dispositions (see especially Martin 1994). But they have not yet been as ready to reject a necessitarian version of the same view: that a disposition ascription means that if a certain stimulus occurs then a certain effect will be necessitated. Just as much, this is an attempt to reduce the dispositional to something else, supposedly more familiar. Anti-Humeans should instead believe in causal connections that are short of necessity, yet more than contingent. This connection is anti-Humean enough, but we should not be misled by his talk of necessity to go further than we ought. The main point is that dispositionality has an important, real and irreducible modal force of its own. Any attempt to replace it with something non-dispositional will miss the most important thing about dispositionality and, as we argue here, causation.

Indeed, we think that Hume was also incorrect to think that constant conjunction was a part of the notion of causation.<sup>11</sup> That we experience the kind of constant conjunction that Hume had in mind is a dubious claim. Even in his perfect instance of causation, the billiard table (1740:

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<sup>11</sup> We believe that Hume's condition of temporal priority was also a mistake. We do not think that causes precede their effects but that they are simultaneous with them. We have not the space to discuss this claim in detail here, however.

137), it is implausible that an absolute constant conjunction is really to be found. The object ball that is struck, he claims, always moves away across the table towards the pocket. It never flies into the air, he protests. But we know that there are cases where it does precisely that: where there is an unexpected 'kick' of the kind feared by professional snooker players.

The possibility of exceptions is something that Hume admits when he considers cases where there are only 'inferior degrees of evidence' (1739: 403) of causation. But of cases where there is a less than constant conjunction he surmises that

supposing that the usual contrariety proceeds from the operation of contrary and conceal'd causes, we conclude, that the chance or indifference lies only in our judgement on account of our imperfect knowledge, not in the things themselves, which are in every case equally necessary, tho' to appearance not equally constant or certain. (1739: 403-4)

Such cases, we argue, are the norm, not the exception. What they show is that constant conjunction, contrary to what Hume elsewhere routinely claims, is not a part of our immediate experience. Instead, constant conjunction is something that is inferred from our experience of less than constant conjunction. And as the passage above quoted reveals, that inference is of a highly theoretical nature. It would seem that it is motivated by nothing more than an assumption that wherever there is an exception to a constant conjunction it is because there is some other constant conjunction at work, of which we are ignorant. Having made that assumption, Hume then immediately goes back to his usual claim that the idea of cause and effect arise from 'the experience and the observation of their constant union' (1739: 405). We urge that a true consideration of the situation shows that *constant union* is not something that confronts our experience of causation. The union, we argue, is always less than constant and is instead of what Hume calls *inferior* degrees. Where it is not inferior, we argue the union is most likely not causal but rather something else such as classification, essence or identity. The assumption that there is always a concealed constant union at work in causation therefore looks under-motivated.

## 8. Conclusion

We hope to have shown in this paper that causal production is not the same as causal necessitation. This claim should be no threat to our pre-existing causal thinking. All that has been advanced should be consistent with common sense. The idea that causes dispose towards their effects is natural and makes sense of certain phenomena that by other theories will be philosophically problematic. The dispositional theory of causation shows that the possibility of preventions and exceptions is not something that has to be explained away but something that should be accepted as central to the nature of causation, showing its essentially dispositional character.

A cause can then be understood as a disposition towards an effect, where causal powers are doing their work and manifesting themselves. This is what we think should be basic to a dispositional theory of causation and we take to be a promising this-worldly alternative to Lewis counterfactual dependence account of causation. Assessing whether this or the counterfactual dependence account is the best theory of causation could be done only after careful consideration of the relative merits of each and while we are optimistic about how the dispositional theory would come out of such a consideration, we will leave that work for elsewhere.<sup>12</sup>

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<sup>12</sup> Earlier versions of this paper were presented at the *Metaphysics of Science* workshop in Münster, Germany, the *Powers, Causation & Laws* conference at Durham University, the Nottingham dispositions group, the University of Köln, the University of Athens, Bogazici University, the *Powers, Dispositions and Singular Causation* conference in Buffalo and the University of Warsaw. We thank all who gave comments. This research was conducted with the financial support of the AHRC-funded *Metaphysics of Science* project and the Norwegian Research Council (NFR). We also thank Manuel de Pineda and Markus Schrenk, Matthew Tugby and Charlotte Matheson for helpful support and criticism.



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