Powers as Causal Truthmakers

Potencias como hacedores de verdad causales

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La mayoría de las teorías de causación asumen que debe envolverse algún tipo de necesidad, o que la causa debe ser enteramente suficiente para el efecto. Otros ya han sugerido que debería de ser posible obtener una teoría de causación a partir de una teoría de poderes o disposiciones. Un proyecto tal está muy lejos de estar completo, pero incluso aquí encontramos que ha faltado el punto clave en una teoría dispositiva de causación. Este escrito intenta establecer algunos de los principios más importantes de una teoría tal, y al hacerlo inclina la discusión existente en una nueva dirección.

Disposición · Causación · Necesidad · Prevención · Determinismo · Probabilidad · Clasificación · Modalidad · Ausencias · Hume.

Most theories of causation assume that it must involve some kind of necessity, or that the cause must be entirely sufficient for the effect. Others have already suggested that it should be possible to get a theory of causation from a theory of powers or dispositions. Such a project is far from complete but even here we find that the key point in a dispositional theory of causation has been lacking. This paper attempts to establish some of the most important principles of such a theory and in so doing turn the existing discussion in a new direction.

Disposition · Causation · Necessity · Prevention · Determinism · Probability · Classification · Modality · Absences · Hume.

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ARTÍCULO

Powers as Causal Truthmakers

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§1. The dispositional character of causation

ALMOST ALL EXISTING ACCOUNTS OF CAUSATION make what we consider to be a mistake. Causes do not necessitate their effects. They dispose towards them in a way that is less than necessary but more than purely contingent. Causation has an essentially and irreducibly dispositional nature that, we argue here, is fundamental for its proper understanding and yet it has been largely ignored. The mistake, we suggest, derives largely from the Humean origins of the modern discussion of causation. Hume thought that causation involved at least a constant conjunction whereas we do not. He presumed that his opponents required necessary connections between causes and effects. While we are opponents of Hume, we do not.

This paper is an attempt to set right this misconception and take the discussion of causation away from necessity and towards dispositionality. Most theories of causation assume that it must involve some kind of necessity, or that the cause must be entirely sufficient for the effect. Others have already suggested that it should be possible to get a theory of causation from a theory of powers or dispositions (Harré and Madden 1975, Bhaskar 1975, Cartwright 1989, Ellis 2001, Molnar 2003: ch. 12, Martin 2008: ch. 5). Such a project is far from complete but even here we find that the key point in a dispositional theory of causation has not been made. This paper attempts to establish some of the most important principles of such a theory and in so doing turn the existing discussion in a new direction.

We are not the first to have argued that causation and necessitation are distinct. Anscombe did so:

> 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)

With Anscombe, we should think that whether A necessitates B would have to be some further question over and above that A causes B. The present paper attempts to build a more thorough and convincing case for this view.

   While we offer a theory of causation, we do not offer it as an analysis. The notion of a disposition, tendency or power may already be a causally-loaded notion and thus any putative analysis would be circular. There are, nevertheless, good reasons to illuminate the notion of causation via the notion of dispositionality. Dispositionality, it will be argued, involves an irreducible and *sui generis* modality the acknowledgement of which is vital for a correct understanding of causes. We see dispositionality as the fundamental modal notion, derived from experience, and at the heart of our causal hypothetical thinking. Just as a primitivist account of dispositional modality will be offered (§8, below), the account of causation that is generated should be thought of as a primitivist theory. As Cartwright (1989: ch. 2) has already suggested, if we put no causation into our theory, we will get none out. The best way to start on establishing these claims is by a consideration of prevention and exceptions.

§2. Prevention and exceptions

Causal claims can be and often are made in conditional form, such as «if you strike that match, it will light». However, if we were trying to vindicate a notion of causal necessity, we would face the snag that there will always be some context in which such a conditional is false. Traditionally, this has been regarded as a problem and there are often attempts to mend our causal claims by listing specific contexts in which they apply. We may also try to exclude the factors that would render such a conditional false and say that if a hypothetical claim is suitably bolstered, by some kind of *ceteris paribus* or *all else being equal* clause, then it will remain true. The danger of this approach is that, in attempting to preclude all the many contexts that would prevent an effect occurring, the conditional could be rendered trivially true.[1] However, our concern is not with such an attempted strategy but to point out that our inability to form a causal hypothetical statement that will remain non-trivially true in all contexts is no

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[1] An *all else being equal* clause is clearly problematic (see Lipton 1999). If the clause is replaced by a list of background conditions (if F, then G, unless H and I), then there will always be some further context in which even this conditional is false. If, instead, the clause is an automatic immunity from falsehood, then the conditional is trivial (if F, then G, unless it's not). The only worthwhile sense we see in *ceteris paribus* would be if it indicates the kind of primitive dispositional modality we advocate here.

threat to its utility but is actually indicative of the fact that it is causation we are dealing with, rather than something else.

You strike a match and it lights. It is almost certainly true that the match lit because it was struck.[2] But was it necessary that it lit when struck? Could its lighting have been prevented? Clearly it could have been. The match may have been damp. There may have been inadequate oxygen. A gust of wind could have blown immediately after the striking. Any one of those, and many other possible factors, could have occurred and prevented the match lighting. We account for this by pointing out the essentially dispositional nature of causation. Striking the match disposes it towards lighting and being disposed towards lighting does not guarantee it. A disposition is a tendency towards a certain kind of outcome. But tending towards G by no means necessitates G, precisely because other things might get in the way. A disposition towards G might operate at exactly the same time that a disposition away from G is operating and the two dispositions cancel each other out. While this point has been widely acknowledged, its importance has been largely overlooked.[3]

Following Mill (1843: Bk III, ch. vi), Molnar (2003: 194), and others, we accept the composition of causes: that powers compose polygenically, sometimes with each other, and sometimes against each other, to produce the sort of effects we find in the world around us. The manifestation of any power, therefore, such as the flammability of a match, will be contingent upon what other powers are also operating. Dampness in the atmosphere, lack of oxygen and gusts of wind can all suppress the flame.

Cases of prevention and exception are often seen as a threat for the necessity of causation and therefore in need of some philosophical solution. On the contrary, it should be noticed that the possibility of prevention is actually an essential aspect of causality. The possibility of prevention is criterial. It is one criterion, among others, for it being a case that A causes B. A can have caused B only if there was a possibility that B could have been prevented even though A had occurred.

§3. Causes do not necessitate their effects

Appeal has been made to one particular example of causation for which

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[2] We set aside cases such as that where a wizard lights the match that you have just struck.

[3] But see Schrenk (2008) and Mumford (2004 and 2009). For instance, «This contrasts with the connection between being fragile and being broken. There is a connection between these two properties that is more than bare compatibility although it is less than necessitation» (Mumford 2004: 178).

prevention could occur. Is there any argument for the bolder claim that, in general, causes do not necessitate their effects? There is.

The argument is best understood by comparison with an argument in truthmaker theory against an alleged solution to the problem of negative truth. What makes it true that <there is no hippopotamus in this room>? One candidate solution is that all the objects that are in the room together make it true that there is no hippo in the room. The problem is, however, that according to a leading version of truthmaker theory the truthmakers are supposed to necessitate the truth of the proposition in question (Armstrong 2004: 5). And the objects in the room —a table, some chairs, a man, some books— are consistent with there being also a hippo in the room. There could be all these things in the room as well as a hippo, therefore those things cannot necessitate that <there is no hippopotamus in the room>.[4]

The question of how all the causally relevant factors, which we will henceforth refer to simply as the causes, relate to their effects will afford exactly parallel reasoning. Instead of objects in a room failing to necessitate the truth of a proposition, we can instead think of a collection of causes failing to necessitate an effect. Invoking the notion of polygeny, we say that the causes of an effect are typically complex. The match lights not just because it is struck, but also because oxygen is present, the wood was dry, the surface against which it is struck is rough, and so on. Let us call these causes $C_1, \ldots C_n$ and assume that there is a case in which together they produce the effect E, the match lights. It can be demonstrated, however, that they did not necessitate E. Had all of $C_1, \ldots C_n$ occurred but also some interfering condition I been present, such as a gust of wind, then E would not have occurred. This shows that $C_1, \ldots C_n$, although they caused E, were nevertheless consistent with E not occurring. Therefore, $C_1, \ldots C_n$ do not necessitate E, even if as a matter of fact they do cause E.

This can be called the *argument against necessity*.[5] It is a simple argument and one that might immediately provoke objections. We will try to anticipate four of them.

OBJECTION 1.— The first objection to the argument against necessity is that it

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[4] See Armstrong for this discussion (2004: 56). There are other candidates for the truthmakers of negative truths, including one from Armstrong himself, but our purpose here is only to draw an analogy with this particular argument.

[5] 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 §10 that it works only when powers are misconceived.

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, that 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 *E*: the match lights. But suppose one now alleges that *A* – *D* could still occur but *E* not occur 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.[6]

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 lightning. The wind is not some factor incompatible with *A* - *D*, 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 black hole appearing above the tree and sucking it off into space, rather than it falling to the ground.[7]

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.[8] One was that a flame would cause

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[6] Our thanks to Maria Jose Garcia Encinas for developing this line of objection.

[7] Thanks to Manuel de Pineda for this example.

[8] 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.

us to withdraw our hands. 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 1848: 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.

This demonstrates the general weakness of Hume's constant conjunction account. Hume thought that the idea of constant conjunction was an essential component in our idea of causation. But this means that all A-type events must be followed by B-type events, if it is to be true that an event of type-A has caused an event of type-B. This is too restrictive and not at all required in order for us to say that we have causation. There will always be the possibility of some A-type event not being followed by some B-type event even though it is the case that many particular A-type events cause B-type events and also where it is a true general claim that A causes B (or A-type events cause B-type events). In many causal claims that we make, we all acknowledge that there is less than constant conjunction, for instance when we say that smoking causes cancer or that sugar causes tooth decay. These claims are nevertheless true, despite the lack of constant conjunction, because, on the theory presented here, it is a claim that smoking disposes towards cancer, which is near universally acknowledged, and a claim that sugar disposes towards tooth decay.[9]

There might thus never have been a case of constant conjunction of the kind Hume imagined. His prime example of causation was to be found on the billiard table, «as perfect an instance of the relation of cause and effect as any which we know» (Hume 1740: 137). But even here it is doubtful that there is

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[9] A probability-raiser account also allows these consequences (e.g. Mellor 1988). Smoking may raise the probability of cancer without producing it in every instance. The problem with such an account is that there are conceivable cases where a cause is something that lowers a probability of F yet nevertheless succeeds in producing F. One such example can be taken from Nancy Cartwright (1989: 99, the original example is attributed to Hesslow) of a contraceptive pill that can cause thrombosis even though it lowers the probability of a thrombosis. A possible situation is one in which the pill lowers the probability of thrombosis by preventing pregnancy, which is an even more probable cause of a thrombosis than is the contraceptive pill itself. Nevertheless, there are many cases where the pill does indeed cause a thrombosis even though it had actually lowered the probability of one occurring. For more on probabilities, see §6, below.

constant conjunction. One ball struck by another might well have been incinerated when struck by lightening, been glued to the table as a practical joke, or have flown off the table because of some freak «kick» when one ball had chalk on it.

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 $C_1, \ldots C_n$, part of the cause is also that all the possible interfering factors are ruled out? Burks made this move, for example, in defending the sufficiency of the cause for the effect, stating explicitly 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)» (Burks 1951: 368). Hence, the cause, as well as $C_1, \ldots C_n$, includes $\neg I_1, \neg I_2$, and so on. Let us call this complete set of circumstances, both positive and negative, the set Σ. Is it the case, as Burks supposed, that Σ 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 Σ. Although it may perfectly well produce E on any number of occasions, that does not mean that it necessitated E. There could have been Σ plus one other counteracting power, I_z, that prevents E. There is no reason at all 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 Σ necessitates E requires that there is not even some *possible* I_z that can prevent E. There seems to be no plausible reason to rule out some such thing. Rather, we should conclude from this that there is no Σ that could serve as a «sufficient condition» for E even though Σ does indeed produce E.

OBJECTION 4.— Could it be said that attempting to mention all the causes of E in a finite list such as Σ is both misguided and not what we actually do when we pick out a cause of an effect? 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 in like circumstances.[10] This solution would purportedly work by

[10] Such a suggestion has been made to us by Matthew Tugby, following an idea of Alexander Bird's.

picking out an exact kind of total circumstance that is successful for the production of E and thus, it would seem, sufficient for E. Let us call such a total circumstance, Σ^*.

If this proposal is to add any more to those already discussed and dismissed, it seems it would have to include some automatic exclusion of any further preventers such as I_z. It is supposedly able to do this through the ostensive and externalist mechanisms deployed but what exactly the mechanism is does not matter for our reply.[11] Suppose such mechanisms were to work, however. Σ^* will have to be a very precise but huge set of factors that perhaps occurs only rarely and it is thus doubtful that it can be what we have in mind when we make general causal claims because it does not seem repeatable. But even if we set aside that practical consideration, would the position really have established that Σ^* necessitates E? We should be sceptical of that. How would we know even that circumstances of type Σ^* are always followed by effects of type E? To assume so would look to be simply the very assumption that we deny, that Σ^* necessitates E, and would thus be begging the question.

But the major reason this approach should be dismissed is that it «works», if at all, by excluding one of the few things that could convince us of the presence of necessity. The ostensive and externalist framework tries to exclude any difference at all between a previously experienced successful case of causal production and further cases of causation to which we refer. It tries to automatically rule out that anything could be added to the successful causal set up of Σ^* 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 is not something that is not otherwise the case, 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 a man, 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 a man and ϕ, then x is mortal» remains true for any ϕ. Therefore, it would only be non-question begging to say that Σ^* necessitates E if we could add something else, I^*,

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[11] Here are two other possibilities. One might be some sort of «screening off» in which our laboratory set-up somehow creates a closed environment to which nothing could possibly be added (see Cartwright 1999: ch. 3). A second case would be where we add to the cause a totality fact (Armstrong 2004: 57f.), which is a higher-order fact that there are no more first-order facts than those already listed as the causes of E.

to Σ* and still get *E*. But this is the very move that is supposed to be ruled out by this position as a way of avoiding the argument that this *I** could prevent *E*.

§4. How can there be production without necessitation?

We come to the question of where this leaves our account of causation. 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 rightly be seen as independent from the issue of causal necessitation. 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 enough to have reached 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.[12]

The world contains vast complexity in that there will be many powers (events or facts) that sometimes work together and sometimes against each other to produce the events and changes that go on around us. As Molnar says (2003: 194-8), different powers accumulate polygenically and pleiotropically to produce what we would recognise 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 different types of effects, whenever they manifest.

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 sufficiently to reach the point at which that effect is triggered. However, in reaching that point, we cannot consider simply the addition of

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[12] 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.

operative powers. Other powers might be subtracting from the accumulation and tending away from the requisite threshold. In striking a match, for instance, you are aiming to light it. You are doing what you think needs doing for the threshold for lighting to be met. You are using a match that you have already seen to be adequately empowered, with its flammable tip intact. You are trying to strike it in the right way, against a suitable surface and, naturally, in the presence of oxygen. But you will also be conscious of the powers that could subtract from those you have accumulated. You will try, for example, to keep out of the wind precisely because you know that the wind could tend away from the match igniting.

This idea, of there being what we call a causal threshold, explains why causal production does not entail causal necessitation. In one context, the aggregate of causes $C_1, \ldots C_n$ may be enough to reach the appropriate threshold for an effect E. But in another situation, we could have all of $C_1, \ldots C_n$ present, just as before, and E not occur. This is because there is some further factor I present, which we take to be a causal power that tends away from E, and I subtracts from accumulation such that the threshold for E is not reached. Because we could have $C_1, \ldots C_n$ without E, this means that $C_1, \ldots C_n$, even in the cases where they do indeed cause E, cannot be taken as in themselves a sufficient condition for E. And since $C_1, \ldots C_n$ is not sufficient for E, the contrapositive, $\leftarrow E \rightarrow \leftarrow (C_1, \ldots C_n)$, does not hold either. There is, therefore, causal production without necessitation, and the cause should not be taken as sufficient for its effect.

What, though, are these causal thresholds and how do they relate to effects? Does the threshold, once met, then itself necessitate the effect? If it does so, then shouldn't the threshold be seen as the real cause and one which did, after all, necessitate its effect? But this is not the way we are asking for the notion of a threshold to be understood. In a sense, the threshold is not a real thing at all, it is only a way of understanding the point at which an effect occurs. It is nothing more than a way of saying that an effect is triggered when there is enough to trigger it, taking into account the overall accumulation of additive and subtractive powers. There may be some cases where we can quantify exactly how much is required for an effect to be triggered and the threshold thus be given a numerical value. It may, for instance, be possible to specify a numerical value of a force at which a rock will move. But in many other cases, such as your attempt to light a match, it seems that the threshold cannot be considered numerically. We can still understand the case in terms of the accumulation of powers, even where we cannot quantify the contribution of each, and nor do we rule out the

possibility of an eventual explanation of the striking of a match that is in terms of quantities rather than qualities, as those who believe in reductionism to fundamental properties might testify.[13]

§5. What if determinism is true?

It may be objected to our account that we are assuming too much in an essentially a priori consideration of causation. In particular, are we assuming in our theory that 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.[14]

This criticism is not effective, however, because in saying that causes do not necessitate their effects, we pass no judgement at all on the question of determinism. It might be true or it might be false and the account leaves that open. Our opponents should also leave it open and not, for instance, have a notion of causation that declares indeterministic causation to be self-contradictory.

What should be said instead is that, if determinism is true, its truth is not grounded in the nature of causation alone. Determinism would be some supplementary thesis over and above the modal force involved in causal claims. Determinism is a thesis about all the facts of a world's history being fixed, which they could be even if the world contained nothing more than constant conjunctions. If there can be determinism without any proper causal production at all, then there certainly can be determinism if there is causal production without causal necessitation. This remains the case even if one articulates determinism as the thesis that the history of the world to time t fixes its history for any time after t. One might then be able to say that if determinism is true it could consist in it always being determined what causes what, which is not the same as saying that causes necessitate their effects. It is not the notion of causation that is doing the deterministic work here. It is the idea of everything being fixed, including which powers succeed in producing their effects.

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[13] The difference between these two cases is that, in the former, we are dealing with quantitative magnitudes while, in the latter case, we have only qualities. There is, however, a naturalistic view that science will be able to cash all qualities out in quantitative terms and if that were the case then all cases of causation would indeed involve quantifiable thresholds.

[14] Thanks to Stephen Barker for raising this point.

The present account of causation in fact judges that determinism and causal necessitationism are independent theses. We could have determinism without causes necessitating their effects, as has just been argued. But we could also perfectly well have causal necessitation without determinism, for instance if some events are uncaused.

§6. Probabilistic causation

The thesis that causes do not necessitate their effects has thus far been independent, it has just been claimed, 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 causation 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 genuinely probabilistic coin that when tossed has a 50:50 chance of landing heads or tails. Real coin tosses are unlikely to be indeterministic in nature but we are here simply assuming that they are as our only purpose is to provide a model for probabilistic causation. Our preference would be the 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 powers ontology, any truths about what is most likely for a whole group of coin tosses would ultimately be determined by the powers of the individual coins.

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.

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. Here we find an important confirmation of the present theory because it looks clear that the dispositional view makes the best sense of the case. Our indeterministic 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 trails 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 distribution 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 half of the time, a tendency which manifests itself over a sequence of trails. 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 trails.

The case of probabilistically constrained causation thus offers an exemplary corroboration of 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.

§7. Causation, classification, identity

Although causation does not involve necessity, there is still some generality involved in causal claims for which we need to account. But in order to distinguish the nature of genuine causal claims from others, such as classificatory and identity claims, we follow Kant in drawing a logical distinction between the categorical and hypothetical (1781: 106-10).[15] This is in contrast to Frege (1879), who made no such distinction and effectively treated categorical and hypothetical claims as logically equivalent,[16] interpreting the general categorical «All Fs are Gs» as a universally quantified conditional: «For all *x*, if F*x* then G*x*». The reason for denying this equivalence is that it fails to acknowledge an important difference between the pairs of statements under (1) and (2):

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[15] Our gratitude to Johan Arnt Myrstad for impressing this Kantian distinction on us.

[16] «The distinction of judgments into categorical, hypothetical and disjunctive seems to me to have a merely grammatical significance.» Frege (1879: 4).

1.   a) All iron bars expand if heated.

       b) If an iron bar is heated, it will expand.

2.   a) All men are mortal.

       b) If *x* is a man, then *x* is mortal.

The statements under (1) are hypothetical claims, while the statements under (2) are genuinely categorical. Causal claims are essentially hypothetical and non-categorical. Given the preceding account, there are good reasons for this. First of all, claims like «All men are mortal» and «All even numbers are divisible by 2» are not subject to exception and prevention. This is, in the first place, because they are classificatory: stating that all Fs are Gs because F is a subclass of G. Hence there are no circumstances under which something will be an F but not a G, which means that contextual elements like changes in background conditions are not relevant. This is the reason that such claims will be robust under antecedent strengthening (see above, §3, objection 4). In the second place, there are questions of induction. Because we accept the truth of the categorical claim as a truth of classification, and there is no possibility of exception or prevention, the generalisation involved in the classificatory claim is not a result of any inductive inference. Hence no problem of induction occurs for such claims. On the contrary, if something were found that were immortal, then rather than being seen as a counterexample to the classification, the response would be instead to say that this thing was not a man: perhaps instead a god or an angel.

For causal claims the case is different as they are essentially subject to cases of exception and prevention. Thus contextual factors such as possible changes in background conditions must be considered as causally relevant as they could affect the outcome of the causal process. Heated iron bars might not expand if, for instance, they are held firmly in a vice-like grip. In such a case, they could instead bend or become denser. There is, thus, no absolute necessity in this case, and we cannot say that *C* causes *E* independently of everything else. This means that, in contrast to the case of classificatory claims, a question of inductive warrant may meaningfully be asked.

To sum up the distinction between causal and classificatory claims, they relate differently to logical matters such as counterexamples, induction, and necessity.

While classificatory claims do not allow counterexamples, causal claims do. And while classificatory claims are context-insensitive and therefore immune to the problem of induction and antecedent strengthening, causal claims are context-sensitive and admit exceptions. Furthermore, while the classification itself warrants the necessity of all Fs being Gs, no such necessity is part of a causal claim as the effect can always be prevented by some interfering factor. This allows us to distinguish bona fide cases of causation from other phenomena that are only spuriously causal. «If today is Tuesday, tomorrow is Wednesday» has a consequential nature but is not genuinely causal; nor is «If this apple is red, then it is coloured».[17] What has been said of classificatory claims can also be extended to identity statements, such as that water is H_2O. This claim, if true, is also immune to exceptions and questions of induction.

The hypotheticality of causal claims points to their conditional character as predictive, subjunctive and context-sensitive. What we need, therefore, is a theory of causation that accounts for the distinct features of our causal claims without a reduction of the hypotheticality expressed by 'if'. Hypotheticality is a distinctive feature of language while potentiality is a distinctive feature of the world that we think has to be accounted for in terms of powers. There is a close enough correspondence between the two that we think of potentiality as the most likely worldly candidate to be the truthmaker of true hypothetical claims. Our proposed theory of powers as truthmakers of causal claims provides the primitive modality of potentiality that we need in order to account for the hypotheticality of causal claims, as will be explained in the next section.

With powers as the causal truthmakers, we also avoid referring to other possible worlds in order to account for the truths of causation, contrary to the strategy of Lewis (1975). Potentiality lies in the powers themselves *in this world*, and this is what makes true our purely hypothetical claims about causal relations. Take the example: if a body were not subject to any net external force, it would continue in a uniform movement or stay at rest (Newton 1687: axioms). Even if there were no instantiation of this apparently causal claim, it would nevertheless have a this-worldly truthmaker in the potentiality of the powers. Acknowledging the real potentiality of powers we get a unified account of all causal claims in terms of their hypotheticality, whether or not their antecedents are true. Hence no logical distinction is needed between factual and counterfactual conditionals, as the question of instantiation is irrelevant for

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[17] This last example comes from Sosa (1980: 240) to illustrate what he calls consequentialist causation. We hope to have given convincing reasons why it is not properly causation at all.

the truth of general causal claim.

§8. Dispositional modality

We have shown that causal claims are of a distinct class, indicated by their different relation to issues such as prevention and induction. The reason they relate differently, however, stems ultimately from the distinctive modality we claim is involved with dispositions and thus causation understood as always involving a disposition, power or tendency towards an effect. Dispositional modality, it has been said, is neither pure necessity nor pure contingency. Nor does it appear possible to express the distinct modality involved in a dispositional claim using any combination of the two existing modal operators together with standard non-modal logic. At this point, some may claim to have no understanding of what this intermediate modal value could be.

To remedy this situation, one could introduce a third modal value, that is neither necessity nor pure contingency, and reducible to neither. This third modal value might be thought to wreak havoc with our modal thinking, as reflected in standard two-valued modal logic. To an extent this is true. Nevertheless, any modal logic that is required for accurate thinking about causation requires this serious revision to contain a *sui generis* yet ubiquitous third modal value. Once this value is included, however, a number of acceptable modal inferences will be expressible, as we will have at our disposal a new system of modal logic. This will allay the fears of some over the coherence of the idea of there being a distinct dispositional modality.

For the case in hand, our concern is primarily with the modality of statements such as Fa because causal modal talk will ultimately be about the possibility of a particular a bearing a property F, where we take Fa to be the effect of a causal process. The question of this paper concerns the modality of Fa if Fa is an effect of a cause. We would start, therefore, by adding our third modal value to our existing two operators:

Def. 1 $\Box$Fa ≡ it is necessary that a is F[18]

Def. 2 $\Diamond$Fa ≡ it is possible that a is F

Def. 3   DFa ≡ a is disposed to F

[18] Our preference would be to express Def. 1 as «a is necessarily F» except that this might be mistaken by some as making an explicitly *de re* or essentialist claim as opposed to a *de dicto* one. As it happens, we intend to remain entirely neutral on this matter. The same caveat applies to Def. 2.

   Def. 1 and Def. 2 are, of course, inter-definable with the addition of negation, but we claim that Def. 3 is irreducible and indispensable if one wants to talk about the causal modality. The idea would then be that we add to the axioms of standard logic and standard two-valued modal logic some further axioms of what could be called system P.[19] These axioms show some interesting ways in which dispositional modality relates to the more familiar modalities, though they do not of course completely define, limit or characterise it. As is usual with any logical system, the axioms and theorems admit more that one interpretation.

   Axiom 1 $DFa \rightarrow \Diamond Fa$

If a is disposed towards F then it is possible that a be F. But note that it would not conversely hold that if it is possible that a be F, then a is disposed towards F. Thus we have:

   Axiom 2 $\neg (\Diamond Fa \rightarrow DFa)$

Hence, it is possible that when I strike this match, it turns into a chicken but it is not at all disposed to do so. In the probabilistic case, it is possible that when I toss this coin 1,000 times, it lands heads on 999 occasions, but the coin is not disposed to do so. This makes clear the sense of a distinction that is sometimes drawn between logical and natural possibility. We are here assuming that possibility *simpliciter* is logical possibility. The sense we would have of natural possibility thus concerns what things are disposed to do, that is, with DFa. Hence Axioms 1 and 2 already establish a modal basis for natural possibility, namely what is potentially the case according to given dispositional potentialities.

   Axiom 3 $DFa \rightarrow \neg \Box Fa$

Axiom 3 is just the claim that we have made in §2, and following, that if a is

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[19] We have serious reservations about both standard logic and standard modal logic, which we set aside here.

disposed towards F then *a* is not necessitated to be F. This axiom should not, therefore, be a surprise to anyone who has read thus far. But Theorem 1 might look surprising to anyone familiar with standard modal logic.

Theorem 1 $\qquad \Box \mathrm{F}a \rightarrow \neg \mathrm{DF}a \qquad$ (from Axiom 3, contraposition)

This looks surprising because of the axiom of standard modal logic that $\Box \mathrm{F}a \rightarrow \Diamond \mathrm{F}a$. But no similar inference can be drawn in the case of $\mathrm{DF}a$ because we have argued that for causation there is always the possibility of interference, which would prevent *a* from being F. If it is necessary that *a* is F, therefore, then we take this as criterial of *a* not being disposed to F. As we said above, we would take the necessity of F*a* as being something non-dispositional and non-causal, such as truths of identity (necessarily, water is H_2O) or essential properties (necessarily, men are mortal). We should not, however, be misled by the mixed case of a kind having dispositional essential properties where it is necessary that any kind member have such a property but not, of course, necessary that it manifests it.

The idea of there being a modal value that is not entirely necessary and not entirely contingent might have seemed puzzling. We might have wondered what exactly this notion of a dispositional connection is. The axioms of system P are an attempt to show some of the nature of this dispositional connection in so far as it relates to other standard modal operators, that we already profess to understand. Seeing the relevant entailments between $\Box \mathrm{F}a$, $\Diamond \mathrm{F}a$ and $\mathrm{DF}a$, allows us to gain what we might call a structural understanding of $\mathrm{DF}a$. However, in addition to this we concur with Armstrong (1978: 164) and others that because we ourselves are both causal agents and causal patients, we gain direct experiential knowledge of causation. We also concur with Schrenk (2008) that we gain direct experiential knowledge of the dispositional nature of causation.[20] What this suggests is that our understanding of $\mathrm{DF}a$ should not be seen as posterior to our prior ideas of $\Box \mathrm{F}a$ and $\Diamond \mathrm{F}a$. Our understanding of causal possibility, $\mathrm{DF}a$, we would actually take as our core modal notion, familiar to us all through experience, and from which the other two standard modal operators draw their sense as being limiting cases on a spectrum. We have an idea of the match being disposed towards lighting. It is disposed if struck to

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[20] Indeed, we would be satisfied if we could say merely that our experience shows us the dispositional nature of causation without the stronger claim that causation itself can be experienced.

light and not to turn into a chicken. But we can get an idea of ever more distant possibilities, of which turning into a chicken is at the far end of the spectrum. When struck, it should light, but in successively unlikely cases it could fail to light, break, fly off into your eye, and so on. Eventually we reach the idea of a pure contingency. Likewise, we can gain an idea of what dependably happens with hardly any exceptions from which the idea of necessity occurs, though again as an extrapolation from our core modal notion of what is disposed to happen. The extrapolations to what is impossible would be very similar. It is satisfying that this is a very this-worldly account of possibility and necessity and is effectively a combinatorialism by extrapolation.[21]

It is worth noting that attempts to produce a logic for causal claims have been made before. They have been inadequate, however, where they have been built immediately on the false assumption that causation requires some kind of natural necessity. A. W. Burks (1955), for example, allows in his system that $\Box Fa \rightarrow CFa$ and that $CFa \rightarrow Fa$, where the operator C concerns causal necessity. Such a system is possible, of course, but if causation does not involve this kind of necessity, then it is of no useful application.

§9. Absences are not causes though they are reasonably invoked

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?[22] 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, however, 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

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[21] See Armstrong 1989 for a basic combinatorial theory.

[22] 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.

genuine causation involve the manifestations of dispositions. Where an absence is invoked, what we have in mind is not a literal cause but a conditional the truthmaker of which is a causal power. Some examples will illustrate this.

Everyone in the room but you drinks poison and dies. Did you survive because of an absence of poison in your body? Not literally. What caused your current health was a good diet, plenty of exercise and sleep. But in the case of your survival, while all your companions died, what we have in mind is the conditional that «If you had drunk the poison, you would have died». This conditional is made true by the disposition of the poison to kill. That the absence of poison caused your survival is not literally true because it attributes causal potency to an absence. But it is easily gained from the relevant conditional through a transposition. The relevant transposition gets from a true conditional of the form If *F*, then not-*G* to a claim that not-*F* explains *G*. But it only quasi-causally explains. To illustrate with another example, an absent umbrella does not make you wet. The rain makes you wet. The umbrella does nothing to you as it is sat at home in the umbrella stand. But because you know that the umbrella has the power to deflect raindrops, you could well claim that you got wet because you forgot your umbrella, or some such quasi-causal claim. While this last example sounds absurd, it is not different in any significant metaphysical sense from a commonly made medical claim that type-1 diabetes is caused by a lack of insulin. A lack of insulin cannot be literally what makes someone unwell. If one gets unwell, it is sugar that makes you so. Sugar is harmless to most people as their body produces insulin that has the power to break it down. This causal power of insulin is what therefore makes it explanatorily useful to cite its lack as an explanation of illness. An absence of oxygen causing asphyxiation is clearly also to be understood in the same way.

Note that powers are understood to be things that exist in the world, whether or not we know about them, and that they would thus make many hypothetical claims true. It is true also that «If there had been a hungry tiger in the room, you would have died», because of the disposition of hungry tigers to kill and eat. But we can see easily why it is reasonable to explain your survival through absence of poison rather than absence of a hungry tiger. Explanation often works through comparison and contrast. If everyone but you has ingested poison and died, the absence of poison in you is the most relevant difference that explains your survival in this particular situation. Similarly, if most other people can produce insulin and you can't, then its absence may also be explanatorily useful.

§10. 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.

But it would be a mistake to accept Hume's understanding of powers. Those who believe in real causal powers should not at all accept that they involve necessary connections between events. Hume has 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, such as 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, namely necessitation. Anti-Humeans should instead believe in modal 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.[23] 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, 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 exception cases 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 motivated, it would seem, by nothing more that 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 or 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 the *inferior* degrees. Where it is not inferior, we argue the union is not causal at all but rather something else such as classification or identity. The assumption that

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[23] 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, however.

there is always a concealed constant union at work in causation therefore looks under-motivated.

§11. Conclusion

We have argued that when *C* causes *E*, it does so without *C* necessitating *E*. That *E* is necessitated, on the contrary, tells us that *E* was not caused as causation would always admit of exceptions. If determinism is true, and a certain event is determined necessarily to be the case, we argue further that it is not causation that does the determining work.

While it can be admitted that threshold and accumulative accounts of causation can be given in other terms, we also think that they show that a cause should best be thought of as a tendency or disposition towards a certain effect. When we truly make a general causal claim that *A* causes *B*, such as that smoking causes cancer, or a token causal claim such as that the striking of one billiard ball with another caused it to move, this cannot mean anything modally stronger than that the one thing disposes or was disposed towards another. Any such causation is consistent with prevention of its effect. If we are to admit the dispositional character of causation, we think this a compelling reason why an ontology with powers —real dispositions— as its bedrock looks promising. It has been shown also in this paper that probabilistic causation has to be understood dispositionally as it seems that the only accurate conceptualisation is one in which there is a tendency towards a certain distribution, rather than the necessity of one or of unconstrained contingency.

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. We have shown that the possibility of preventions and exceptions is not something that has to be explained away but something that should be accepted as essential to the nature of causation. A pay-off is that we are able to distinguish our causal claims from claims that are often articulated in the same way, classifications and identity statements. Causal claims relate differently to induction, exception and necessity than do these other claims. We have also shown how causation by absence can be explained by a dispositional theory. We have argued, however, that standard two-valued modal logic is inadequate to articulate the modality involved in causal claims. There is, nevertheless, the

possibility of a richer modal logic along the lines of system P, introduced in §8.[24]
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* This paper dates from 2008 and was the first that was co-written by Mumford and Anjum. It contains many of the ideas that they have developed in their subsequent work. It is published here for the first time.

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