Metaphysical Causation

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Abstract: There is a systematic and suggestive analogy between grounding and causation. In my view, this analogy is no coincidence. Grounding and causation are alike because grounding is a type of causation: metaphysical causation. I defend the identification of grounding with metaphysical causation from some initial objections, drawing on the causation literature to explore systematic connections between grounding and metaphysical dependence counterfactuals. I outline a non-reductive counterfactual theory of grounding along interventionist lines, and use it to diagnose the prevalence of scepticism about grounding as deriving, at least in part, from scepticism about non-trivial counterpossible counterfactuals.

1. Introduction

> "Grounding is something like metaphysical causation."
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> Schaffer (2012) p.122

> "Ground, if you like, stands to philosophy as cause stands to science."
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> Fine (2012) p.40

> "I offer a treatment of grounding in the image of causation... "
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> Schaffer (MS) p.37

In the quotes above, I think Jonathan Schaffer and Kit Fine understate the intimacy of the connection between grounding and causation. The main thesis of this paper is that grounding *just is* a type of causation: metaphysical causation. I will refer to this claim as *G=MC*. According to G=MC, the grounding relation is a special case of the causal relation: when A grounds B, A is a (metaphysical) cause of B and B is a (metaphysical) effect of A.

Treating grounding as metaphysical causation has two major theoretical benefits:

- G=MC is ideologically parsimonious. If grounding is just metaphysical causation, then we do not need a separate theory of grounding invoking new primitive notions. Instead, our account of grounding will invoke only whatever fundamental ideology is employed by our best theory of causation[1].

- G=MC provides a straightforward explanation (or, alternatively: removes the need for any explanation) of why grounding claims are explanatory. Grounding explanations are a type of causal explanations, and we can account for their explanatory power in whatever way we usually account for the explanatory power of causal explanations.

Contemporary metaphysicians typically adopt a Quinean methodology of comparing total theories - 'systems of the world'[2]. Given such a methodology, the having of a theoretical benefit can count in favour of a principle of fundamental metaphysics. The theoretical benefits described above can accordingly form the basis of a *prima facie* case for G=MC.

The argument from theoretical virtue does not stand alone. To complete the case for G=MC, we need independent reason to think that grounding and causation are alike. This reason can be found in the systematic analogy between grounding and ordinary causation, which is explored in §2-6 of this paper. These relations[3] have the same logical properties (which can be challenged in analogous ways); they have the same connections to explanation and to counterfactuals; and the same puzzle cases and theoretical issues arise when we try to give them a counterfactual analysis[4]. The best explanation of these persistent parallels is that grounding and ordinary causation are different species of the same genus.

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[1] In this respect, my proposal resembles those of Wilson (forthcoming) and Hofweber (2009), who argue that grounding claims can be accommodated using antecedently-understood ideology such as counterfactual dependence or conceptual inclusion. Those inclined to think that 'grounds' is equivocal, as Wilson and Hofweber suggest, may still regard metaphysical causation as one of the disparate notions drawn together under the heading of grounding.

[2] See e.g. Quine (1975).

[3] Perhaps neither grounding nor causation is strictly speaking relational, but is instead best expressed with something like a sentence operator. This issue is orthogonal to my argument.

[4] Some of these parallels are also noted by Schaffer (2012, MS). The conclusion of the present paper, which was written before Schaffer (MS) became available, is significantly stronger than Schaffer's: I develop the causal-modelling conception of grounding in service of my main argument that grounding is a type of causation, whereas Schaffer's aim is the more modest one of providing a tractable formal model for grounding.

Why prefer the thesis that grounding is a metaphysical form of causation to the thesis that grounding and causation are distinct species of a genus of directed determination relations? This dualistic view has been defended by Jonathan Schaffer and by Kit Fine in recent work. It is tempting to dismiss a dispute on this point as terminological: for example, simply translate Schaffer's 'directed determination' as my 'causation', and Schaffer's 'causation' by my 'ordinary causation'. But there is more to the dispute than that. Fine and Schaffer posit a fundamental distinction in ideology where I posit a non-fundamental distinction between different applications of a unified ideological primitive. My reason for scepticism about the dualistic view is that the differences between grounding and ordinary causation seem too subtle to support a fundamental distinction, a distinction that would be the ideological equivalent of a distinction between ontological categories. Categorical parsimony is a notoriously vexed methodological primitive (see e.g. Quine 1968, Lowe 2006, Paul forthcoming); but in what follows, I invite you temporarily to suspend any doubts about it and to take seriously the ideological parsimony argument for G=MC.

Why prefer the thesis that grounding is a metaphysical form of causation to the thesis that causation is a physical form of grounding? Because we have plausible candidates for informative accounts of causation but we lack good candidates for informative accounts of grounding. Conceiving of causation as a type of grounding, as Karen Bennett does (Bennett 2011, MS), infects causation with the obscurity which currently surrounds grounding; but conceiving of grounding as a type of causation allows grounding theorists to make use of the concepts, distinctions and theoretical tools that have been elaborated in the extensive literature on causation. I hope that the benefits of my proposed approach will make themselves apparent over the course of this paper; of course, the proof of the pudding is in the eating.

Some signposting is in order. §2 briefly describes the target of the analysis - the grounding relation - and identifies some core examples on which to test the analysis. §3 discusses recent work on causation distinguishing causal dependence from causal production, and argues that eliding this distinction may lead to unwarranted scepticism about G=MC. In §4, I explore the fate of certain key counterfactuals associated with metaphysical causal dependence, and discuss some difficulties facing a counterfactual account of grounding. I argue that these problems are familiar from the metaphysics of causation and that they can be handled by more sophisticated counterfactual accounts of causal dependence. One interesting approach of this kind, interventionism, essentially involves the use of causal models; in §5 I present and discuss a number of metaphysical causal models that are analogues of problem cases familiar from the causation literature. §6 adds two further points of similarity,

involving challenges to transitivity and symmetry, and summarizes the systematic analogy between grounding and causation. The counterfactuals encoded in metaphysical causal models will generally include counterpossible counterfactuals; §7 explores the connection between the controversy over counterpossibles and the controversy over grounding and offers a diagnosis of the prevalence of scepticism about grounding. §8 is a conclusion.

2. Grounding and Causation

Most contemporary treatments (e.g. Rosen 2010) claim to take grounding as a primitive notion. It is not always entirely clear what this means, but, at least, it involves not giving any reductive analysis of the notion in independent terms. Friends of grounding instead typically use non-reductive methods to help non-initiates get a grip on their notion.

As a preliminary step, grounding theorists constrain the notion of grounding by specifying its formal properties. In the classification scheme of Fine (2012), here we will be initially concerned with the notion of *strict partial ground*, to be distinguished from *weak ground* (non-posteriority as opposed to priority) and from *whole ground* (a complete set of partial grounds). Thought of as a relation between facts, strict partial[5] grounding is usually taken to be a partial ordering: transitive, anti-symmetric, and irreflexive. This provides an initial plausibility check on G=MC, which it passes with no difficulty: the relation *is a cause of*[6] is likewise generally taken to be transitive, anti-symmetric, and irreflexive. We will see in §5 that these logical properties can be challenged in closely analogous ways both for grounding and for ordinary causation.

Thinking of ordinary causation and metaphysical causation as different species of the same genus - causation - has some immediate consequences for the logical relations between the two species. Assuming for the moment that the genus-level notion *is a cause of* is anti-symmetric, the holding of everyday physical causation in one direction excludes the holding of metaphysical causation in the other direction. If

[5] For the remainder of the paper, I will usually omit the qualifiers 'strict' and 'partial'.

[6] I will initially focus on this particular causal locution for simplicity, but the account presented in §4-5 generalizes to the whole of our causal discourse. We have a range of non-equivalent causal locutions - e.g. 'is a cause of', 'is the cause of', 'caused' - and being able to account flexibly for this range is one of the main advantages claimed (by, e.g., Woodward 2003) for the interventionist approach to causation. Though I will not explore the point further, I suspect that taking advantage of this variety of locutions could be of value to metaphysicians writing about grounding.

A is the everyday physical cause of B, then B cannot ground A, and vice versa. This principle seems a plausible one, and it is predicted by G=MC. In the absence of counterexamples or of other explanations of the principle[7], its plausibility provides some defeasible support for G=MC.

Logical considerations do not take us all that far in understanding grounding. (Divisibility is a partial order on the natural numbers, but it is not the same relation as strict partial ground.) Our grip on grounding is supposed to come in two other main ways: through the connection with explanation, and through examples.

Explanation provides a significant parallel between causation and grounding. The two notions stand in the same distinctive relation to our practice of explanation: causal relations and relations of ground each figure in explanations, without being literally identical to those explanations. When we want to explain why the bottle broke, we cite the causes of its breaking; and when we want to explain why Singleton Socrates exists, we cite the existence of Socrates. This sort of distinction between causation and causal explanation is familiar from the philosophy of science.

As Schaffer (MS) points out, causation and grounding also bear similar relations to a range of metaphysical notions connected with explanation. We naturally think of particular cases of token grounding as supported by general metaphysical principles, analogously to how particular cases of token causation are supported by general laws of nature. Trogdon (2013a) discusses various formulations of the connection between grounding and necessitation, and Schaffer (MS, fn.7) endorses a global supervenience principle of effects/grounded facts on causes/grounding facts for both (deterministic) causation and grounding. And under the right conditions we can be justified in inferring the effect/grounded fact from the cause/grounding fact. The exact formulation of these connections, though, is business for another occasion.

Some grounding theorists distinguish the "worldly relation of grounding from the metaphysical relations between facts that it backs" (Schaffer 2012 p. 124). A similar distinction is possible with respect to ordinary causation: we can distinguish 'worldly' relations of causation holding between concrete physical events from 'metaphysical' relations of causation holding between facts about those events. My proposal depends on the coherence of causal/grounding relations between facts, and it allows for (but does not require) 'worldly' relations in addition.

[7] Karen Bennett's view (set out in Bennett MS) that causation and grounding are both types of 'building relation' provides an alternative explanation of the requirement; my reasons for not going down this route were described in §1.

Thus far we have found nothing to distinguish ordinary causation from grounding: they have the same general logical features and they bear the same general connections to explanation, to necessity and to inference. Further explication of grounding tends to go by way of example, and the recent literature contains a rich and diverse diet of proposed examples. Here is a representative sample[8]:

Singleton: The existence of Socrates grounds the existence of singleton Socrates.

Double-negation: The truth of P grounds the truth of ¬¬P.

Disjunction: The truth of P grounds the truth of P∨Q.

Conjunction: The truth of P grounds the truth of P&Q.

Truthmaking: The existence of Socrates grounds the truth of 'Socrates exists'.

Mind/body: My being in brain state B grounds my being in mental state M.

Part/whole: The existence of my head grounds my existence.

Consequentialism: Act A's having the best consequences grounds A's being right.

Euthyphro: God's desiring that P grounds its being good that P.

Noether: The symmetry of the laws of nature under time-translation grounds the fact that energy is a conserved quantity.

Since these cases are so different from one another, there is plenty of scope to deny that they are all genuine instances of grounding. We could follow Ramsey (1927) in thinking ¬¬P just a notational variant on P, and deny Double-negation. Identity theorists deny Mind/Body. And of course, deontologists deny Consequentialism and non-theists deny Euthyphro. Accordingly, it isn't necessary (or desirable) that a theory of grounding should entail that each one of these examples is

[8] Too much should not be read into the names of these examples. As we are dealing here with the notion of strict partial ground, these true grounding claims may not fully characterize the metaphysics of the grounded entity. For example, a proper formulation of the moral theory of consequentialism would presumably need to specify that there can be no *other* grounds for the rightness of an act in addition to its consequences.

a genuine case of grounding. But a theory of grounding ought to underwrite these grounding claims at least in the context of the background assumptions which have typically motivated their defenders; otherwise, the theory could reasonably be accused of changing the subject.

According to G=MC, any of the above sentences that are true should remain true if the word 'grounds' is replaced by 'causes'. When we make this replacement, some of the sentences seem more intuitive than others; but we shouldn't rest too much on direct intuitions about cases, as there are many potentially-interfering pragmatic factors at work. Rather, the purpose of considering the causal versions of our examples is to highlight some immediate challenges to G=MC.

First, amongst the causal relata we find a wide variety of kinds of fact. Facts linked by causation according to the causal versions of the grounding sentences include facts about concrete entities (Socrates), facts about abstract entities (Singleton Socrates), and facts about entities which are neither clearly abstract nor clearly concrete (God, laws of nature). We might reasonably doubt whether any plausible theory of causation is able to encompass such a mixed bag of relata. This *challenge from relata heterogeneity* will be addressed in the next section.

Second, some of the causal relata are abstract entities. It is widely (although not universally) held that abstracta do not enter into causal relations. Indeed, acausality is one of the options that David Lewis considers when seeking to characterize the abstract/concrete distinction (Lewis 1986b). G=MC entails that abstracta (assuming that they ground or are grounded) do enter into causal relations; consequently G=MC appears not to do justice to the familiar thought that (at least some) abstract objects are outside the causal order[9]. This *challenge from abstract inactivity* will also be addressed in the next section.

Third, one relatively natural response to the causal versions of these sentences is to interpret them as metaphorical. According to this response, it isn't literally the case that Socrates' existence causes the existence of Singleton Socrates; rather, the nature of their relationship is in certain ways analogous to a causal relationship, which licenses the pretence that the one is the cause of the other. We might claim heuristic value for the pretence, while denying that it should be part of sober metaphysical theorizing. This *challenge from metaphor* is partially addressed in the

[9] Versions of this argument could be run with respect to specific kinds of abstract objects (such as sets), or with respect to some characteristic feature of some abstract objects (such as lack of spatial location). My response will also apply to these variant arguments.

next section, but my main response to it relies on the interventionist account of grounding which will be sketched in §4-5.

3. Causal Production and Causal Dependence

In this section we will look at a distinction made in the recent literature on causation, before applying it in response to the challenges from relata heterogeneity, abstract inactivity, and metaphor. The distinction I have in mind is between c*ausal production* and *causal dependence*. This distinction is defended forcefully by Ned Hall (Hall 2004); other related distinctions are proposed in Sober (1985), Hitchcock (2003) and Strevens (forthcoming)[10].

Hall argues that the following five claims about causation, while all apparently platitudinous, are not jointly satisfiable by any single notion of causation:

- **Transitivity**: If event[11] c is a cause of d, and d is a cause of e, then c is a cause of e.
- **Locality**: Causes are connected to their effects via spatiotemporally continuous sequences of causal intermediates.
- **Intrinsicness**: The causal structure of a process is determined by its intrinsic, non-causal character (together with the laws).
- **Dependence**: Counterfactual dependence between wholly distinct events is sufficient for causation.
- **Omissions**: Omissions—failures of events to occur—can both cause and be caused.

Hall's argument for their incompatibility appeals to a group of examples which have played a central role in the philosophy of causation. There are intuitive cases of causation - including those known as *double prevention* and *causation by omission* - which seem to violate Transitivity, Locality and Intrinsicness. But these three theses are frequently relied on to deal with the threat from cases of *overdetermination*, including cases of *pre-emption*. (These problem cases are outlined in §5, but for now we can set the details to one side.)

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[10] Strevens (forthcoming) discusses a distinction very similar to Hall's, but prefers different terminology: influence vs. difference-making. Further varieties of 'causal pluralism' are surveyed by Godfrey-Smith (2010). See also Cartwright (2004) and Psillos (2009).

[11] Although Hall formulates his principles in terms of events rather than of facts, he cannot be presupposing any overly restrictive view of the causal relata since he allows for omissions to be causes and effects.

Hall's diagnosis is that there are two different concepts of causation in play, with Transitivity, Locality and Intrinsicness true of one concept (causal production) and Dependence and Omissions true of the other concept (causal dependence). On this picture, there might be a variety of ways in which causal dependence can obtain: it need not go via causal production.

We need not here explore the complexities of analyzing causal production. But to give the flavour of the idea, it may help to mention some specific proposals which are naturally seen as attempts to analyze production. There are the mark-transference theories of Reichenbach (1958) and Salmon (1984), and the conserved-quantity transference theories associated with Fair (1979), Skyrms (1980), Dowe (1992) and Salmon (1994). These proposals generally look for some specific feature of a physical process which renders it suitable to transmit information, and then dub processes with that feature *causal processes*. Production is then analyzed in terms of appropriate chains of causal processes. Causal production also resembles the notorious notion of 'biff', employed informally by David Armstrong and taken seriously by Lewis (2000) and by Handfield *et al.* (2008).

The second concept of causation distinguished by Hall is the concept of causal dependence. Here Hall's proposal is very simple: causal dependence is just counterfactual dependence. But, as we shall see in the next section, this identification is tenable only given a specially-crafted theory of counterfactuals which excludes *backtracking* counterfactuals. This exclusion threatens the reductive ambitions of an analysis of causal dependence in terms of counterfactual dependence. But we can set these complications aside for the time being, regarding causal dependence as characterized by specific patterns of counterfactual dependence - never mind what precise mechanisms (or lack thereof!) give rise to these patterns.

On the view that I propose, metaphysical causation need not involve any process of causal production - no metaphysical biff! - but it does need to involve characteristically causal patterns of counterfactual dependence. We need to interpret G=MC accordingly: grounding is to be identified with metaphysical causal dependence rather than with metaphysical causal production.

We are now in a position to respond to the three challenges from the previous section. In each case, the challenge would be apt if G=MC were an identification of grounding with metaphysical causal production. But once we understand G=MC as an identification of grounding with metaphysical causal dependence, then the challenge loses its force.

Causal dependence allows for a wide range of causal relata, including (for example) omissions. Production, in contrast, typically involves certain very specific kinds of causal processes: the sorts of processes which involve energy transfer and are studied by fundamental physics. Since fundamental physics concerns itself only with a sparse and highly-restricted subset of entities and properties, it is hard to see how facts involving entities as heterogenous as those in our examples could enter into a relation of causal production. But, with Hall's distinction on board, we can grant this point while still allowing facts about our highly heterogenous entities to enter into relations of causal dependence. How exactly this plays out will become clearer in the next two sections, as we settle on a specific theory of causal dependence and go on to apply it to cases of metaphysical causation.

The challenge from abstract inactivity is likewise blunted by taking G=MC as positing metaphysical causal dependence rather than metaphysical causal production. As I see it, the primary motivation for thinking that abstract objects are acausal is that abstract objects fail to engage in the kinds of activity which can sustain causal production. Abstracta do not have mass or couple to quantum fields. Will we then propose new dynamical theories for abstract objects, positing metaphysical forces between them, to account for metaphysical causation? No; a parallel physics of abstracta is a bad plan. But we can do full justice to this thought via a prohibition on abstract causal production, while still allowing for abstract causal dependence. This is because causal dependence need not rest on any productive connection between cause and effect. A classic example of this is causation by omission. But more generally, we can deny that dependence need go via production, undermining the challenge from abstract inactivity.

The challenge from metaphor requires a slightly different treatment. It is certainly very plausible that any talk of causal production by abstract entities is metaphorical in nature. However, opponents of G=MC can maintain that talk of causal dependence involving such entities is *also* metaphorical, and not to be taken seriously. Indeed causation by omission, just mentioned in response to the challenge from abstract inactivity, is itself frequently explained away as metaphorical. For example, Liebesman (2011) proposes this move as an alternative to Lewis's denial (Lewis 2004b) that causation is a relation. Our distinction between production and dependence therefore provides at most a partial response to the challenge from metaphor. I propose to meet the challenge in a different way, by first endorsing an account of causal dependence which can sustain a literal reading of causal dependence claims and then applying this account to metaphysical causal dependence. That is the task of the next two sections.

Before moving on to the interventionist treatment of metaphysical causation, a final sort of initial objection to G=MC must be considered. This objection appeals to a direct intuition that grounding is not a type of causation. A distinguished anticipation of this objection can be found in Kim (1973), who influentially criticized Lewis's theory of causation for not adequately distinguishing counterfactual dependence in virtue of causation from counterfactual dependence in virtue of two events overlapping and hence sharing a common part. Kim took it to be intuitively obvious that counterfactual dependencies deriving from overlap should not count as causation. Other similar objections maintain that it is intuitively obvious that causation must hold between events in time, or between concrete events.

Objections from direct intuition can be resisted either by denying the force of intuitions in the relevant domain, or by arguing that we do not in fact have the alleged intuitions. Examples of the former strategy include David Wallace on objective chance (Wallace 2012) and Alastair Wilson on laws of nature (Wilson 2013), and examples of the latter include Sydney Shoemaker on laws of nature (Shoemaker 1980, 1998) and Robert Williams on gunk (Williams 2006). Both strategies seem applicable to our intuitions concerning grounding and causation. We could maintain that the relevant issues are simply too highly theoretical and abstract for intuition to carry weight: nothing in our evolutionary history, one might argue, has adapted us to be accurate in our intuitions about fundamental metaphysics. Alternatively, we can offer ordinary causation - the general notion of causation applied specifically to material events - as the source of our problematic intuitions, saying that we mistake intuitions about ordinary causation for intuitions about causation in general. Such a mistake may be unsurprising, given the prominence of ordinary causation in our everyday lives. Doubtless some will reject both of these responses to the challenge from direct intuition; the remainder of the paper is directed at those who are prepared to take one or other of them seriously.

4. Metaphysical Dependence Counterfactuals

The simplest counterfactual analysis of causation is the early theory of Lewis (1973)[12]. Lewis defines causation as the ancestral of counterfactual dependence, where counterfactual dependence of P on Q requires the truth of $\neg Q \mathrel{\Box\!\!\rightarrow} \neg P$. Here are the Lewisian dependence counterfactuals corresponding to our examples[13]:

[12] This account draws directly on one of Hume's 'two definitions of cause' (Hume 1748).

[13] These examples are posed in the past tense (had not) instead of the present tense (were not to). I think this makes judgments clearer without affecting any substantive issues, and would invite readers who disagree to explain why the tense matters.

CF-Singleton: If Socrates had not existed, nor would have Singleton Socrates.

CF-Double-negation: If P had not been true, nor would ¬¬P have been.

CF-Disjunction: If P had not been true, nor would P∨Q have been.

CF-Conjunction: If P had not been true, nor would P&Q have been.

CF-Truthmaking: If Socrates had not existed, 'Socrates exists' would not have been true.

CF-Mind/body: If I had not been in brain state B, I would not have been in mental state M.

CF-Part/whole: If my head had not existed, I would not have existed.

CF-Act-consequentialism: If A had not had the best consequences, A would not have been right.

CF-Euthyphro: If God had not desired that P, P would not have been good.

CF-Noether: If the laws of nature had not been symmetric under time-translation, then energy would not have been a conserved quantity.

Some of these counterfactuals seem fine: for example, CF-Singleton, CF-Double-negation, and CF-Noether. This suggests we are on the right track. But it looks like there are problems with others of them, of two different kinds:

- Some of the antecedents may be metaphysically impossible, in which case those counterfactuals are *counterpossibles*.

- Some of the counterfactuals seem to have the wrong truth conditions. Perhaps if P had not been true, Q would have been true, in which case P∨Q would still have been true. Or perhaps if I had not been in brain state B, I might have been in a very similar state B*, in which case I would still have been in mental state M. (See Yablo 2004 and Menzies & List 2009 for more discussion).

I will postpone discussion of the first of these issues until §7. The second issue will be handled by the interventionist approach described later in this section. Before that, we have a more urgent issue to confront. Even if the CF counterfactuals do hold, there might nevertheless fail to be metaphysical causal dependence as a result of the truth of some *additional* counterfactuals.

Since grounding is usually taken to be anti-symmetric, if G=MC is correct then metaphysical causal dependence must likewise be anti-symmetric (at least for the most part). Therefore, in addition to the holding of a given CF counterfactual, a simple counterfactual account of metaphysical causation will typically require the *failure* to hold of the corresponding RCF counterfactual:

RCF-Singleton: If Singleton Socrates had not existed, Socrates would not have existed either.

RCF-Double-negation: If ¬¬P had not been true, P would not have been true either.

RCF-Disjunction: If P∨Q had not been true, P would not have been true either.

RCF-Conjunction: If P&Q had not been true, P would not have been true either.

RCF-Truthmaking: If 'Socrates exists' had been false, Socrates would not have existed.

RCF-Mind/body: If I had not been in mental state M, I would not have been in brain state B.

RCF-Part/whole: If I had not existed, my head would not have existed.

RCF-Act-consequentialism: If A had not been right, it would not have had the best consequences.

RCF-Euthyphro: If P had not been good, God would not have desired it.

RCF-Noether: If energy had not been a conserved quantity, the laws of nature would not have been symmetric under time-translation.

Unfortunately, many of these RCF counterfactuals seem to be as plausible, or nearly as plausible, as their CF counterparts. This looks like a challenge for defenders of G=MC; if the RCF counterfactuals are true, and if their truth suffices for causal dependence (as Hall's principle Dependence tells us it does), then G=MC delivers widespread two-way metaphysical causal dependence. That consequence could be used as a *reductio* of the very idea of metaphysical causation, and accordingly (at least for grounding enthusiasts) as a *reductio* of G=MC.

However, that conclusion would be much too hasty. The problem is not specific to metaphysical causation, and so cannot form the basis of an objection to G=MC. Similar problems with apparently-true reverse counterfactuals afflict counterfactual analyses of ordinary causation even in the simplest cases. Had the window not smashed, it would have been because no brick collided with it. But I am standing right by the window. So: *had the window not smashed, I would not have thrown the brick at it*. It is a familiar point that the apparent truth of this latter counterfactual should not lead us to conclude that the smashing of the window caused me to throw the brick. Any counterfactual account must deal with this problem of causal asymmetry somehow or other, and no reason has been given to think that successful solutions to the problem will not generalize to the case of metaphysical causation.

The standard way of dealing with the problem of causal asymmetry for counterfactual analyses of causation is to restrict the analysis so as to associate causal dependence only with a certain class of counterfactuals, a class which does not include the problematic smashing-to-throwing counterfactual. Lewis dubbed the problematic counterfactuals *back-trackers*, and restricted his analysis (Lewis 1973b/1986) so that only non-back-tracking counterfactuals were sufficient for causal dependence. In combination with Lewis's proposed semantics for non-back-tracking counterfactuals in terms of 'small miracles' (Lewis 1973a), this account successfully excludes the most obvious problem cases[14].

The word 'back-tracking' doesn't properly capture what is wrong with the RCF reverse metaphysical dependence counterfactuals. Unlike the smashing-to-throwing counterfactual, the RCF counterfactuals do not track back in time from the (supposed) cause and then forward again to the (supposed) effect; they instead track *down* in the 'order of being' from the (supposed) cause and then back *up* to the (supposed) effect. So we might call them *down-trackers*, using the collective term *wrong-tracker* to cover both back-trackers and down-trackers.

[14] Lewis (1979/1986) tweaked his original semantics to avoid cases like Kit Fine's example of Nixon's button (Fine 1975). The specifics will not concern us here.

If G=MC is on the right lines, it suggests that back-tracking and down-tracking are different ways of wrong-tracking, and that there is a unified class of non-wrong-tracking (or *right-tracking*) counterfactuals which sustain genuine relationships of causal dependence. We can test this hypothesis by considering a syntactic feature associated with back-trackers, described by Lewis as follows:

> Back-tracking counterfactuals, used in a context that favors their truth, are marked by a syntactic peculiarity. They are the ones in which the usual subjunctive conditional constructions are readily replaced by more complicated constructions: "If it were that. .. then it would have to be that ..." or the like.
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> Lewis (1979) p.458

This feature is also had by down-tracking counterfactuals. The RCF counterfactuals listed above are indeed more idiomatically posed with the more complicated forms Lewis refers to. If Socrates's singleton had not existed, then it *would have to have been that* Socrates didn't exist; if ¬¬P hadn't been true, P *could not have been* true either; if energy had not been a conserved quantity, the laws of nature *would have had to have been* non-symmetric under time-translations. The CF counterfactuals, in contrast, are if anything less felicitous when posed in these more complicated forms and certainly do not gain in felicity to the same extent.

An adequate counterfactual analysis of causation must provide a natural, informative and non-*ad-hoc* characterization of right-tracking counterfactuals. In the case of ordinary causation, we could try to pick out right-trackers by reference to time variables somehow associated with the antecedent and the consequent; we simply specify that the antecedent-time must be earlier than the consequent-time. This move is already unattractive in the case of ordinary causation, because it rules out causal loops, but it is transparently hopeless in the case of metaphysical causation. We (perhaps!) have a grasp on an event's temporal location that is independent of ordinary causal facts about it; we lack any grasp of the level of a fact in the order of being that is independent of grounding facts about it.

Lewis hoped to avoid making the temporal asymmetry of counterfactual dependence (and hence of causal dependence) into a necessary truth about causation. Instead, he hoped to exclude back-trackers by appeal to contingent features of worlds like ours, which he thought would infect back-trackers with widespread indeterminacy (Lewis 1979/1986). *If I had not flicked the switch, the light would not have gone on.* This counterfactual is determinately true: the closest antecedent-worlds will all be pretty similar, and in none of them the light goes on anyway. But

the reverse counterfactual, Lewis argued, is not determinately true. A wide variety of alternative courses of events could have given rise to the light not going on; my not flicking, a power cut, a blown bulb, a loose connection. The closest antecedent worlds are diverse, and there will be very little true at them all.

Will anything like this Lewisian indeterminacy-based manoeuvre work to distinguish right-tracking from wrong-tracking counterfactuals in full generality? No: even if it were successful in the case of ordinary causation (and it is not[15]), the manoeuvre would not carry over to the case of metaphysical causation. The asymmetry of traces in the actual world, as we have learned from thermal physics, is intimately tied to the monotonic increase in entropy in closed macroscopic systems. But there is apparently no physical basis for any asymmetry of traces in the metaphysical order of being, no physical quantity which is determined in a lawlike way to be greater for a grounding entity than for the grounded entity. Absent any independent reason to believe reality has the relevant feature, the Lewisian indeterminacy-based manoeuvre does not get off the ground.

One possible response to the difficulties with characterizing right-tracking is to capitulate, and to give up the goal of analyzing causation in non-causal terms. We could characterize the right-tracking counterfactuals as those where the consequent is causally dependent on the antecedent. Any resulting counterfactual theory of causation would then be so uninformative that it could scarcely qualify as an analysis; but perhaps this is the best we can do. Giving up in this way on the project of the counterfactual analysis of causation and 'taking causation as primitive' does not undermine G=MC. It does not threaten the analogy between grounding and ordinary causation emphasized throughout the paper, and it does not vitiate the theoretical benefits of identifying grounding with metaphysical causation set out in §1. However, in the remainder of this paper I will focus on a more ambitious approach to analyzing causation: the *interventionism* associated with Woodward (2003), Hitchcock (2001), and Pearl (2009).

Unlike the Lewisian approach, interventionism does not comprise a full reduction of causation to counterfactual dependence, but it is still a form of counterfactual theory since it involves a non-trivial 'systematic connection between causal claims and certain counterfactuals' (Woodward 2003, p. 70). As with Lewis's counterfactual theory, the counterfactual dependencies sufficient for causation must be restricted in order to prevent wrong-trackers from giving rise to spurious causation. To encode the distinction between right-trackers and wrong-trackers, interventionists make use of

[15] Elga (2001) has persuasively argued that the asymmetry-of-traces account is hopeless.

causal models consisting of a set of *variables*, a set of *structural equations* relating values of the variables, and an *assignment* of actual values. Right-tracking counterfactuals are those with antecedents specifying some combination of interventions on model variables, and with consequents specifying some values for other model variables. Causal models, and the interventionist counterfactuals they encode, will be explored in more detail in the next section

The notion of an intervention does a lot of work for interventionists. It effectively plays the role allotted to small miracles in the Lewisian semantics for right-tracking counterfactuals, the role of specifying that the antecedent be realized in a way which does not 'drag along' unwanted causal history. An intervention is a 'clean' alteration of the value of a particular variable which does not affect the values of upstream causal variables: for example, an intervention on the reading of a barometer leaves unchanged both the pressure in the room and the barometer's own causal origins. Here is Woodward's official definition of an intervention:

(**IV**) I is an intervention variable for X with respect to Y iff

1. I causes X;
2. I acts as a switch for all other variables that cause X. That is, certain values of I are such that when I attains those values, X ceases to depend on the values of other variables that cause X and instead depends only on the value taken by I;
3. Any directed path from I to Y goes through X. That is, I does not directly cause Y and is not a cause of any causes of Y that are distinct from X except, of course, for those causes of Y, if any, that are built into the $I \rightarrow X \rightarrow \rightarrow Y$ connection itself; that is, except for (a) any causes of Y that are effects of X (i.e., variables that are causally between X and Y) and (b) any causes of Y that are between I and X and have no effect on Y independently of X;
4. I is (statistically) independent of any variable Z that causes Y and that is on a directed path that does not go through X.

Woodward (2003), p.98

It is immediately apparent that this characterization will not issue in a reductive theory of causation, since the notion of an intervention is explicitly causal[16]. Nonetheless, interventionists typically maintain that their account is still informative because it shows us how various distinct causal claims are conceptually connected to

[16] Reutlinger (2012) argues (his 'first argument') that the notion of an intervention can be dispensed with to yield a bare counterfactual theory which gives truth-conditions for causal claims equivalent to those yielded by Woodward's theory. I find this contention plausible, but it will only dispense with the causal ideology employed in conjuncts 1 and 2 of Woodward's definition. The bare counterfactual theory that Reutlinger recommends will still fail to be reductive as it will need to build in the explicitly causal constraints on right-tracking counterfactuals imposed by Woodward's conjuncts 3 and 4.

one another. The approach will deliver verdicts about specific causal dependencies once we have specified a causal model, even though there is no algorithm for building causal models which does not itself appeal to causal judgments.

If this non-reductive approach to explicating causation is worthwhile in the case of ordinary causation, then it ought also to be worthwhile in the case of metaphysical causation. By applying the interventionist analysis to grounding construed as metaphysical causation, we might accordingly hope to derive some interesting and informative results about the relation of different grounding claims to one another. That will be my approach in the next section.

5. Metaphysical Causal Models

From an interventionist perspective, the counterfactual dependency judgments underlying claims of metaphysical causation will be underwritten by a particular *metaphysical causal model*. Such models may initially seem unfamiliar, so it will be helpful to look at a range of examples. This section describes causal models for four disputed kinds of case from the causation literature, offers some metaphysical causal models with the same structure, and discusses some interpretive problems that arise.

The models presented will help us in at least three ways. Firstly, the models will reflect a range of potential patterns of metaphysical causation. This will further illustrate of the flexibility of an approach to grounding based around G=MC. Secondly, the models correspond to metaphysical versions of a number of well-known puzzle cases from the causation literature. They include cases (omission and double prevention) which motivate Hall's distinction between causal production and causal dependence, as well as cases (symmetric overdetermination and pre-emption) which have often been raised as counterexamples to simple counterfactual theories of causation but which can be correctly handled by the interventionist approach[17]. These cases illustrate that the same theoretical pressures arise both in the case of grounding and in the case of ordinary causation, further reinforcing the causation-grounding analogy. Thirdly, these models and the interventionist counterfactuals that they encode provide us with concrete examples which will be exploited later on in this section to explicate the concept of a metaphysical intervention and in §7 to frame my arguments concerning counterpossible dependence.

[17] The ability to handle these problem cases is a major advantage claimed by proponents of interventionism, since such cases have often been thought to be fatal to counterfactual analyses of causation. See Woodward (2003, p.77-81) for an interventionist treatment of pre-emption (in both its early and late varieties), and see Woodward (2003, p.83-84) for an interventionist treatment of symmetric overdetermination.

For each type of causal structure discussed below, I provide an ordinary causal model and two candidates for metaphysical causal models with the same structure. (I also provide one 'mixed' causal model combining the two types of causal connection.) Each model, formally speaking, consists of a set of variables representing features of reality, a set of structural equations linking the values of the variables according to the causal structure of reality, and an assignment function specifying which values the variables actually take.

We may think of each variable as a question, and of the possible values of each variable as the various possible answers to that question (Briggs 2012a). Variables may in general be either discrete (whether Socrates exists) or continuous (how tall Socrates is). The facts that ground and are grounded, in this framework for modelling metaphysical causation, are thus identified with question-answer pairs: think of them, if you like, as 'the fact that A is the correct answer to Q'. For yes/no questions, we conventionally assign a value of 1 for 'yes' and 0 for 'no'. The structural equations of a causal model are written in the form A=*f*(B,C, D...). It is important to note that this '=' does not denote identity, or even a symmetric relation. Instead it expresses the asymmetric counterfactual dependence of A on a function of some other variables. Thus, each causal model encodes a set of counterfactual dependencies: if B, C, D *were* set to specific values by an intervention, A *would* take a specific value. This central role played by counterfactual claims in the interventionist framework is what marks it out as part of the broad tradition of counterfactual approaches to causation. For the standard philosophical account of interventionist counterfactuals, see Woodward (2003, p.59-61); for detailed explorations of their semantics, see Briggs (2012a) and Santorio (MS).

The structural equations and assignment function of a causal model may be represented by a directed graph with actual variable values at nodes. (The causal modelling literature, being practically-oriented, tends to ignore possible cases of causal loops and require the graphs to be acyclic.) These graphical visualizations, while heuristically useful, leave out important aspects of the structure of causal models: they do not represent the alternative values a variable could have taken, or the dependency relations between these unactualized variable values. Accordingly, many distinct causal models may be represented by a single directed acyclic graph, so we must also provide a full set of structural equations to properly characterize our metaphysical causal models. In the following examples, the structural equations and assignments (and hence the visual representations) are held fixed as we move from examples of ordinary causation to examples of metaphysical causation; only the interpretations of the variables are altered.

Our first kind of case, causation by omission, involves a dependence of the effect (here, the fact that the plant dies) on some other fact's not obtaining (here, on my failure to water the plant.) The plant dies *because* I do not water it.

Omission: Dessication

Variables

C: Whether I water the plant

E: Whether the plant dies

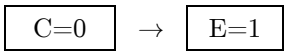
Structural Equations

E=1-C

Assignment

C=0; E=1

Graphical Representation



Cases of causation by omission play a prominent role in the causation literature: in §3, we saw Hall appeal to them in defending his distinction between dependence and production, and they drove Lewis to deny that causation is a relation at all (Lewis 2004). And examples of grounding with the same structure are easy to find. Here are two: it is the case that all sets are pure *because* it is not the case that concreta exist, and it is the case that 'P' is false *because* it is not the case that P.

Omission: Pure Sets

Variables

C: Whether concreta exist

E: Whether all sets are pure

Omission: Falsehood

Variables

C: Whether it is the case that p

E: Whether 'p' is false

In cases of grounding by prevention, the negative fact plays the role of effect rather than the role of cause. Problems for production-style theories of causation are made most vivid by cases of *double prevention*. In an example from Hall (2004), a fighter plane escorting a friendly bomber shoots down an enemy who threatened the bomber, and is therefore a cause of the eventual successful bombing trip:

Double Prevention: Aerial Combat

Variables

C: Whether Escort shoots down Enemy

P: Whether Enemy shoots down Bomber

Q: Whether Bomber approaches enemy territory

R: Whether Bomber arrives at target

E: Whether Bomber bombs target

Structural Equations

P=1-C

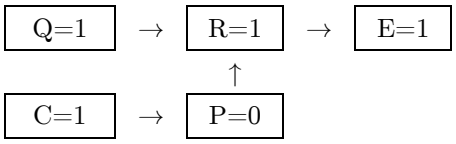
R=max(Q-P,0)

E=R

Assignment

C=1; P=0; Q=1; R=1; E=1

Graphical Representation



Double prevention cases for grounding can be constructed simply by chaining together cases of grounding by prevention. In the first example, the switch being set to on prevents it from being an electrical insulator, which would have prevented the circuit from being closed; so the switch being on is a cause of the circuit being live For the second example, we assume a possible-worlds account of modality. The lack of zombies in any possible world prevents zombies from being metaphysically possible; the possibility of zombies would have prevented the mental from supervening on the physical, which would have rendered physicalism false; accordingly, the lack of zombies in any world grounds the truth of physicalism.

Double Prevention: Circuit

Variables

C: Whether the switch is set to on

P: Whether the switch is an insulator

Q: Whether the switch is wired to the battery

R: Whether the circuit is closed

E: Whether the circuit is live

Double Prevention: Physicalism

Variables

C: Whether no possible world contains zombies

P: Whether zombies are metaphysically possible

Q: Whether minds are constituted by matter

R: Whether the mental supervenes on the physical

E: Whether physicalism is correct

Causation by omission and causation by prevention have seemed mysterious primarily because of the peculiar metaphysical status of omissions. In contrast, cases of *overdetermination* are interesting because they challenge simple counterfactual analyses. We can distinguish symmetrically overdetermined causation (where both causes, intuitively, 'take effect') from pre-emption (where one potential cause is prevented from taking effect by the action of another). A familiar and gruesome example of symmetric overdetermination is the firing squad:

Symmetric Overdetermination: Firing Squad

Variables

A: Whether guard A fires

B: Whether guard B fires

E: Whether the prisoner dies

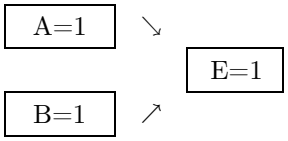
Structural Equations

E=max(A, B, 0)

Assignment

A=1; B=1; E=1

Graphical Representation



Symmetrically overdetermined grounding is commonplace. The presence of arsenic and the presence of strychnine each suffice to make a potion poisonous, and the truth of P and the truth of Q each suffice for the truth of their disjunction.

Symmetric Overdetermination: Poison

Variables

A: Whether the potion contains 1 gram of arsenic

B: Whether the potion contains 1 gram of strychnine

E: Whether the potion is poisonous

Symmetric Overdetermination: Disjunction

Variables

A: Whether P is the case

B: Whether Q is the case

E: Whether P∨Q is the case

In pre-emption cases, a potential cause is prevented from taking effect by the triggering of a causal chain leading to the effect via a different route. (In the causation literature, it is common to distinguish early pre-emption from late pre-

emption; here we will only need to consider early pre-emption.) In the following typical case, Kangaroo's eating of a tasty shrub is pre-empted by Wombat's:

Early Pre-emption: Marsupials

Variables

C: Whether Wombat bites into the plant

P: Whether Wombat swallows the plant

Q: Whether Kangaroo sees the plant

R: Whether Kangaroo eats the plant

E: Whether the plant is digested

Structural Equations

P=C

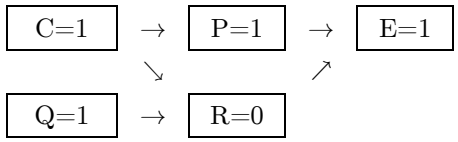
R=max(Q-C, 0)

E=min(P, R)

Assignment

C=1; P=1; Q=1; R=0; E=1

Graphical Representation



Cases of grounding early pre-emption tend to involve one principle trumping another. In our first example, the presence and arrangement of my particles trumps the presence and arrangement of a subset of them in constituting a person; in our second example the circumstances according to which a cricket delivery counts as a 'no ball' trump the circumstances according to which it counts as a 'wide'.

Early Pre-emption: Constitution

Variables

C: Whether my particles are arranged me-wise here.

P: Whether there is a person with exactly ten fingers here.

Q: A subset of my particles are arranged me-without-a-little-finger-wise.

R: Whether there is a person with exactly nine fingers here.

E: There is a person here

Early Pre-emption: Cricket Extra

Variables

C: Whether the bowler over-steps the crease

P: Whether the ball should be called a no-ball

Q: Whether the ball passes two metres wide of the off-stump

R: Whether the ball should be called a wide

E: Whether the batting team should be awarded one run

One final kind of case deserves to be mentioned. The causal models described above each involve either ordinary causation or metaphysical causation, but we can also combine the two sorts of causal link in a single model to produce 'mixed' causal models. Such models seem quite unproblematic. In the following example, the ordinary causal history of the cricket ball and the rules of cricket conspire to cause the fact that the batsman's team is all out.

Early Pre-emption: Cricket Wicket

Variables

C: Whether the batsman catches the ball

P: Whether the batsman should be given out handled the ball

Q: Whether the ball approaches the wicket

R: Whether the ball strikes the wicket

E: Whether the batsman's team is all out

The interventionist account of causation uses causal models to encode counterfactuals of a special type - *interventionist counterfactuals* - with antecedents corresponding to combinations of interventions on model variable settings, and with consequents corresponding to conjunctions of model variable settings. The truth of appropriate interventionist counterfactuals suffice for relations of causal dependence between the relevant variables. Other counterfactuals - including the wrongtrackers described in §4 - do not meet this criterion and hence do not suffice for causal dependence. The appeal to causal models thus provides interventionists with a solution to the problem of counterfactual asymmetry which afflicted earlier counterfactual analyses of causation. I suggest that we should understand our metaphysical causal models as likewise encoding a range of interventionist counterfactuals. This move resolves the asymmetry problem for counterfactual accounts of metaphysical causation raised in §4; the CF counterfactuals are true interventionist counterfactuals derived from genuine causal models, while the RCF counterfactuals are not.

So far, so good. But the notion of an intervention may seem problematic in the grounding context. How can we make sense of an intervention on a variable like C in the Physicalism example, which has its value of metaphysical necessity? Intervening on non-contingent facts is metaphysically impossible. And how can we make sense of an intervention on a variable like E in the Falsehood example, which has its value metaphysically necessitated by upstream variable C?

Interventionists have tended to apply a constraint such as the following to the variables within a causal model[18]:

> *Independent Manipulability:* It is metaphysically possible that every proper subset of the variables in [a causal model] be set to every combination of their possible values by independent interventions
>
> Weslake (MS)

Independent Manipulability is not compatible with an interventionist treatment of metaphysical causation. Metaphysical causes metaphysically necessitate their effects, so some combinations of variable values in metaphysical causal models are metaphysically impossible. No metaphysically possible intervention can give rise to a metaphysically impossible state of affairs. Advocates of G=MC should embrace this consequence: metaphysical causation is inextricably bound up with counterpossible dependence, as I argue in more detail in §7. The appeal to impossible interventions is a feature, not a bug, in the account of grounding developed in this paper.

I am proposing that in the light of G=MC we ought to abandon Independent Manipulability in the grounding context, and accordingly we ought to deny that it is a fully general requirement on causal models. But a principle very like Independent Manipulability may still have a subsidiary role to play. Such a principle might be true of the ordinary causation that interventionists have typically modelled, yet fail for metaphysical causation. These considerations may in fact offer a natural way of distinguishing between different species of the genus causation: individuate types of causation by the 'innermost' sphere of possibilities required to count interventions on the model variables as incompossible. For example, biological causation could be linked to causal models where combinations of variable values are at most biologically incompossible, physical causation could be linked to causal models where combinations of variable values are at most physically incompossible, and so on.

In §7, I will revisit the interventionist approach to grounding, using it to argue from a popular view about the semantics of counterfactuals to the falsity of a broad range of grounding claims. But before doing so, in §6 I will complete my case for G=MC by outlining some additional aspects of the grounding-causation analogy.

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[18] Weslake (MS) and Woodward (MS) each use a constraint of this sort as part of their interventionist solutions to the causal exclusion problem. Although I cannot tackle the exclusion problem here, any widespread causal overdetermination resulting from G=MC ought not to worry us. Common-sense may tell us that events are not systematically overdetermined with respect to ordinary causation, but I see no reason to think that it tells us that events are not systematically overdetermined with respect to causation in general.

6. Summarizing the Grounding-Causation Analogy

Orthodoxy has it that the relations of grounding and causal dependence comprise partial orderings, having the logical properties of anti-symmetry, irreflexivity and transitivity. However, it turns out that these logical properties can be challenged for both relations, and in exactly analogous ways.

Take transitivity first. The cases which seem to threaten the transitivity of ordinary causation are cases of pre-emption where the cause triggers *and then cuts off* an alternative causal pathway to the effect[19]. Hall gives the example (Hall 2004) of a climber, who sees a boulder rolling towards her and ducks; the boulder passes harmlessly overhead and she walks on. Plausibly, the falling rock caused her ducking, and her ducking caused her survival, but the falling rock did not cause her survival. As Jonathan Schaffer has pointed out, we can generate structurally similar cases to challenge the transitivity of grounding. Schaffer (2012) discusses a case of a dented sphere O, arguing that the dent in O grounds O having determinate shape S*, and that O having S* grounds O being near-spherical, but that the dent does not ground O being near-spherical. The rock case and the sphere case involve the same causal model, with only the interpretations of the variables changed.

Not only can analogous challenges be raised to the transitivity of both ordinary causation and grounding, these challenges can be met in the same sorts of ways. Friends of transitivity for grounding and for causation can bite the bullet, either by rejecting one of the intuitive causal premises (e.g. Paul 2000) or by embracing the counterintuitive causal conclusion (e.g. Lewis 2000). Schaffer (2012) proposes a contrastive treatment of grounding as a diagnosis of the transitivity failure; this treatment mirrors exactly his contrastive treatment of causation (Schaffer 2005). Interventionism allows for the possibility of transitivity failures both for metaphysical causation and for ordinary causation, while also letting us specify conditions under which causal relations will be transitive (Woodward 2003, p.79-81).

The anti-symmetry (and consequently the irreflexivity) of causation has likewise been challenged. One of Lewis's motivations for not building the temporal asymmetry of causation directly into his 1979 analysis (Lewis 1979/1986) was the desire to allow for the coherence of backwards causation, such as might occur in cases of consistent time travel. For example, consider the case of the bootstrapping time-traveller: Old Tim travels back in time and gives the blueprint for a time-machine to Young Tim, who uses it to build a time-machine and later completes the

[19] As far as I am aware, Nancy Cartwright was the first to draw attention to this type of example (in Cartwright 1979).

loop. In recent work, the anti-symmetry of grounding has been challenged in a similar way. Naomi Thompson (Thompson MS) and Elizabeth Barnes (Barnes MS) have given several candidate examples of grounding loops, concluding that grounding is non-symmetric. A nice example of Thompson's is the following pair of propositions, where the truth of each is grounded in the truth of the other:

P: 'Q is true'
Q: 'P is true'

Again, the same sorts of response to these challenges to anti-symmetry are available in the causation and grounding cases. (Probably the most popular responses will be either to reject all the purported cases of symmetric causation and symmetric grounding, or to endorse symmetry in either case only when restricted to some specific kinds of subject-matter.)

A final - and rather more nebulous - point of analogy between grounding and causation concerns their methodological status. Each notion has historically attracted suspicion from philosophers of empiricist inclinations: consider Hume's argument that causation cannot be perceived (Hume 1748), Lewis's campaign to account for everything in the scientific and manifest image in terms of his doctrine of Humean Supervenience (Lewis 1986a), Sider's affirmation that "as a Humean I'm suspicious of metaphysical pushings and pullings" (Sider 2011 p.145) and Daly's recent arguments that the notion of grounding is 'unintelligible' or 'obscure' because it cannot be characterized in independent terms (Daly 2012). Relations of cause and ground are thought to lack clear content just insofar as they go beyond the uncontroversial notions (constant conjunction, supervenience) that they are supposed to explain. Here is not the place to properly evaluate this line of thought (although §7 explores one way in which it could perhaps be developed); it will suffice for present purposes to note that its existence extends the analogy between grounding and causation.

We are now in a position to draw together the various strings of the grounding-causation analogy and to sum up the case for G=MC. Grounding and causation are alike in the following respects:

- Both the relations of (strict partial) grounding and causation are ordinarily thought to form a partial order. (§2)
- Both grounding and causation can be informatively cited in explanations. (§2)
- Grounding and causation stand in the same general relations to laws, necessity and inference. (§2)

- Both grounding and causation are closely associated with distinctive patterns of one-way counterfactual dependence. (§4)
- The projects of reducing each notion to counterfactuals face structurally similar problems with wrong-tracking counterfactuals. (§4)
- Analogous puzzle cases challenge counterfactual analyses of each notion. (§5)
- A generalized interventionist approach can be applied to both notions, providing in each case an account which is non-reductive but potentially still informative and which handles the main puzzle cases. (§5)
- Transitivity and anti-symmetry can be challenged for each notion by appeal to analogous types of cases, and structurally similar responses are available to these challenges. (§6)
- Both notions seem 'spooky', the sort of thing that an austere empiricist should not want in their picture of the fundamental world. (§6)

My case for G=MC rests upon this systematic analogy, and upon the benefits of G=MC (described in §1) with respect to ideological parsimony and to the grounding-explanation connection.

That is all I have to say in support of my central thesis that grounding is metaphysical causation. In §7, I will draw on G=MC to offer a diagnosis of the widespread resistance that grounding ideology continues to face in contemporary metaphysics.

7. Counterpossible Dependence

In this section, I will present and assess an argument from G=MC and from the thesis that counterpossible counterfactuals are vacuously true to the conclusion that grounding cannot play the central role in metaphysics which it has recently been assigned. The problem is that grounding generically involves *counterpossible dependence*. According to G=MC, wherever we have a case of grounding we have a case of metaphysical causal dependence. Associated with causal dependence, via the causal modelling approach, are interventionist counterfactuals of the sort that were identified in §5. And some of the interventionist counterfactuals involved are counterpossibles: they have metaphysically impossible antecedents.

At first glance, it may seem as though only some of the examples of grounding that we have been working with will involve counterpossible dependence. The CF counterfactuals of §4 seem all to have metaphysically contingent antecedents, with the possible exceptions of CF-Euthyphro (on some conceptions of God) and of CF-

Noether (on some conceptions of laws of natures). In the causal models of §5, we find a few more examples of counterpossible dependence:

- If it had not failed to be the case that p, then 'p' would not have been false. *(For any p which is metaphysically impossible.)*
- If some possible world had contained zombies, then zombies would have been metaphysically possible.

Still, it might appear as though the interventionist counterfactuals associated with the rest of our causal models will have metaphysically possible antecedents. However, to stop here would be to neglect the point (emphasized in §4) that one-way causal dependence requires the *failure to hold* of certain dependence counterfactuals.

The causal models of §5, given an interventionist reading, encode the falsity of the following 'reverse' interventionist counterfactuals:

- *If an intervention had been made to prevent all sets from being pure*, then there would have been concreta.
- *If an intervention had been made to prevent the potion from being poisonous*, then the potion would not have contained 1g arsenic.

These counterfactuals are false, according to the causal models in question, since the variable settings described in the consequent are not obtained by applying the intervention described in the antecedent to the relevant causal model. The variable settings described in the antecedent are downstream of the variable settings in the consequent, so the interventions leave the latter untouched. These reverse interventionist counterfactuals must come out false if our metaphysical causal models are to accurately represent the grounding structure of the world.

In the case of ordinary causation, the analogues of these troublesome reverse interventionist counterfactuals are counterfactuals like 'if an intervention had occurred to keep the plant alive, then I would have watered it'. Interventionists rely on the falsity of these counterfactuals in order to obtain the verdict that the survival of the plant does not cause my watering of it. No worries, when ordinary causation is concerned: there are plenty of metaphysically possible ways for the plant to stay alive even if I fail to water it. (Perhaps someone else waters it, or perhaps there is a fortuitous leak in the roof.) But when metaphysical causation is concerned, interventions on any variables other than those with no variables upstream of them will result in metaphysically impossible combinations of variable values.

The point may be made as follows. Interventions alter the value of a variable, but not via any of the pathways internal to the causal model. Rather, interventions involve an external influence which is not explicitly represented by the causal model, and which severs the dependencies encoded in the structural equations of the causal model. Intervening on whether the plant dies, for example, breaks the connection expressed by the structural equation 'E=1-C': if someone else waters the plant, C=0 but E=0. The intervention therefore falsifies the material conditional 'if C takes value x, E takes value 1-x'. But material conditionals of this form are typically supposed to be necessary truths in the grounding context: on orthodox views of grounding, if C grounds E then C necessitates E[20]. So any intervention on a metaphysical causal model variable which has any variables upstream of it will falsify some necessarily true material conditional, and the interventionist counterfactual which has as antecedent that such an intervention occurs will be a counterpossible counterfactual. Accordingly non-trivial metaphysical causal models (those with more than one variable) do generically involve some counterpossible dependence.

Counterpossible counterfactuals pose a difficult philosophical puzzle. Familiar semantic accounts of counterfactuals in terms of possible worlds break down when applied to counterpossible counterfactuals, for obvious reasons; and non-trivial counterpossibles falsify some natural principles connecting counterfactuals with the logic of metaphysical modality (Williamson 2008). In the light of such problems, a popular and strikingly simple response has been to declare all counterpossible conditionals trivially true. Our differential responses to counterpossibles can then be explained away on pragmatic grounds. Call this the *conservative* approach.

David Lewis was a conservative: he described himself as "fairly content to let counterfactuals with impossible antecedents be vacuously true" (Lewis 1973 p.25), noting that this approach is enforced (at least for inconsistent antecedents) by the combination of *ex falso quodlibet* and the attractive thesis that counterfactuals where the antecedent logically implies the consequent are automatically true; though he also called these reasons "less than decisive" (*ibid.* p.25). Stalnaker (1996) adopts a similar position, for similar reasons. Conservatism has also recently been fiercely defended by Timothy Williamson, who writes:

> The logic of quantifiers was confused and retarded for centuries by unwillingness to recognize vacuously true universal generalizations; we

[20] Parsons (1999) and Briggs (2012b), amongst others, deny that truthmaking entails the corresponding necessitated material conditional; so if truthmaking is a kind of grounding then they constitute exceptions to this rule.

> should not allow the logic of counterfactuals to be similarly confused by unwillingness to recognize vacuously true counterpossibles.
>
> Williamson (2008) p.175

From the conservative perspective, according to which all counterpossibles are trivially true, the interventionist counterfactuals associated with counterpossible dependence are all trivialized. If an intervention were to prevent there from being any sets, there would still be Socrates, right enough; but it is also true on this picture that, if an intervention were to prevent there from being any sets, then there would *not* still be Socrates. Conservatism about counterpossible counterfactuals undermines the differences in truth-value between interventionist counterfactuals that are essential for providing structure to metaphysical causal models.

Take a step back for a minute, and revisit the familiar claim that purely modal analyses of the grounding relation are destined to fail. It is part of the contemporary folklore that grounding goes beyond a merely modal connection such as one-way supervenience (Bennett & McLaughlin 2005). Many of the classic examples which underwrite this folklore are due to Kit Fine (e.g. Fine 2001). Singleton Socrates necessarily exists *iff* Socrates does; so no two worlds can differ with respect to whether Singleton Socrates exists without differing with respect to whether Socrates exists, and vice versa. So there is *two-way* supervenience between the existence of Socrates and the existence of Singleton Socrates. If the latter is grounded in the former, as intuition seems to tell us, then grounding is not one-way supervenience.

G=MC provides a way to revive the spirit, if not the letter, of modal analyses of grounding: instead of analyzing grounding in terms of necessitated material conditions, we can analyze it in terms of subjunctive conditionals, using causal models to encode asymmetric patterns of counterfactual dependence. The trick is to adopt a theory of counterfactuals which allows for non-trivial counterpossible truth and falsity, and which can accordingly underwrite the needed variation in truth-value of the interventionist counterfactuals encoded in metaphysical causal models.

I will use the term 'liberal' to cover those philosophers, such as Priest, Nolan, Fine, Goodman, and Brogaard & Salerno, who affirm that there are some true counterpossibles as well as some false counterpossibles. Several advocates of this program (Nolan 1997, Goodman 2004, Priest 2005, Jago forthcoming) have developed a framework of *sui generis* impossible worlds to underwrite a familiar closeness-based semantics for assessing counterpossibles, while Restall (1997) proposes instead to reduce impossible worlds to sets of possible worlds.

Accepting non-trivial counterpossibles opens the way for counterfactual-based treatments of the difficult cases - such as Singleton - which sank the one-way supervenience analysis of grounding[21]. Although one-way grounding cannot be captured via necessitated strict conditionals, as in the supervenience approach, it can be captured in terms of interventionist counterfactuals instead. As I suggested above, this retains the spirit of the supervenience analysis: the ideological resources appealed to are just those of our ordinary counterfactual thinking, so long as it is allowed to range beyond the limits of the possible[22].

At this point we come to a parting of the ways for advocates of G=MC. Consider the following *reductio* argument (similar arguments could be developed using any one of the causal models of §5):

1. G=MC is correct. (Premise.)
2. The interventionist analysis of causation is correct. (Premise)
3. The existence of Socrates grounds the existence of Singleton Socrates, but not vice versa. (Premise.)
4. If G=MC and Interventionism are both correct, then if A grounds B (and not *vice versa*) then an intervention on B would alter the truth-value of A, but not *vice versa*. (Definitions of Interventionism, G=MC.)
5. It is false that if an intervention had been made to prevent Singleton Socrates from existing, then Socrates would not have existed. (From 1, 2, 3, 4.)
6. 'If an intervention had been made to prevent Singleton Socrates from existing, then Socrates would not have existed' is a counterpossible counterfactual[23]. (Premise.)
7. Not all counterpossible counterfactuals are trivially true. (From 5, 6.)
8. All counterpossible counterfactuals are trivially true. (Premise.)
9. *Reductio*. (From 7, 8.)

[21] After writing this paper, I discovered that Krakauer (2012) develops an analysis of grounding which, like mine, makes use of counterpossible conditionals. However, Krakauer rejects G=MC and develops his analysis in a rather different way. A comparison of our approaches will have to await another occasion.

[22] It is interesting to compare my revival of the modal analysis of grounding in terms of counterfactuals with the revival of the modal account of essence by Brogaard & Salerno (2007). They similarly rely on non-trivial counterpossible counterfactuals to distinguish essential properties an object from properties merely necessitated by the object's existence. In light of the close connection between grounding and essence, counterfactual accounts of grounding and essence are natural companions.

[23] To see this, recall that an intervention leaves variables upstream in the causal model unaffected. *Whether Socrates exists* is causally upstream of *whether Singleton Socrates exists*.

If we want to combine G=MC with an interventionist approach to causation, then we cannot simultaneously uphold 3 and 8. Skeptics about non-trivial counterpossibles, who prize straightforward and elegant connections between metaphysical modality and the logic of counterfactuals, will be driven to reject grounding as a useful notion in metaphysics. In contrast, friends of non-trivial counterpossibles will be still able to countenance widespread metaphysical causation on an interventionist model. They can allow for non-trivial truth and falsity among the interventionist counterfactuals associated with all of our various candidate examples, thereby recovering the desired patterns of metaphysical causal dependence.

I will not try to adjudicate this dispute here; it runs much too deep. Instead, I will conclude this section by adducing a final piece of (circumstantial) evidence for G=MC. In my experience, philosophers do cleave in relatively orderly fashion along the lines just sketched. Liberals who are happy with talk of grounding also tend to be happy with non-trivial counterpossible counterfactuals (Kit Fine, Daniel Nolan, Graham Priest and Jonathan Schaffer are paradigm examples), while conservatives (amongst them David Lewis, Robert Stalnaker, and Timothy Williamson) are suspicious both of non-trivial counterpossibles and of grounding. G=MC explains this sociological division: grounding characteristically involves the counterpossible dependence which liberals endorse but conservatives reject.

8. Conclusion

It is time to sum up. I have argued for G=MC on the basis of its ideological parsimony and its explanatory virtues, and on the basis of the close analogy between grounding and causation which has been charted over the course of this paper. G=MC makes sense of how we understand and assess grounding claims, and of the role we put them to in metaphysical theorizing. When combined with an interventionist approach to causation and with a semantics for counterfactuals which allows for non-trivial counterpossible truth and falsity, G=MC delivers sensible verdicts over a wide variety of cases.

G=MC also casts into sharp relief a divide that runs through contemporary metaphysics, between conservatives who reject counterpossible dependence and liberals who endorse it. Recognizing this divide provides us with a new handle on recent controversies over grounding. If G=MC is on the right lines, then the legitimacy of grounding talk stands or falls with the coherence of non-trival counterpossible truth and falsity.

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