The Proportionality of Common Sense Causal Claims

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This paper defends strong proportionality against what I take to be its principal objection – that proportionality fails to preserve common sense causal intuitions – by articulating independently plausible constraints on representing causal situations. I first assume the interventionist formulation of proportionality, following Woodward.[1] This views proportionality as a relational constraint on variable selection in causal modeling that requires that changes in the cause variable line up with those in the effect variable. I then argue that the principal objection derives from a failure to recognize two constraints on variable selection presupposed by interventionism: *exhaustivity* and *exclusivity*.

[1] Woodward 2003

1. Introduction

Yablo's principle of proportionality holds, roughly, that something counts as a cause of some effect just in case it includes the appropriate degree of causal information.[2] Proportionality has been put to various philosophical uses, such as a proposed solution for the causal exclusion argument, and as a justification and explanation of the dependence on high-level causal explanations in the special sciences. However, the precise formulation of such a principle has proven to be controversial.

I take the most promising formulation to be an interventionist one, following Woodward.[3] Such a formulation defines proportionality as a relational constraint on variable selection in causal modeling. In this paper, I argue that this formulation works well as it is – contra Franklin-Hall (see 2016) – so long as we recognize two independently plausible background requirements on variable selection. I call these *exhaustivity* and *exclusivity*. Exhaustivity holds that a variable must take at least one of its values. Exclusivity holds that a variable can take at most one of its values. Both constraints are relative to, and thereby help to make explicit, the modal assumptions implicit in causal inquiry.

Finally, with these requirements in place, I defend proportionality against its principal objection: that it fails to preserve fundamental causal intuitions. I demonstrate how this concern derives from a failure to recognize and integrate the modal assumptions implicit in causal inquiry, in tandem with an inappropriate use of variables to represent causal situations.

2. Interventionism

The formulation of proportionality that I endorse comes directly from Woodward, and is defined in terms of his interventionist account of causation. Interventionism expands on the intuition that causal claims provide

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[2] Yablo 1992
[3] Woodward 2003, 2008a, 2008b, 2010, 2016

manipulability information. If *X* causes *Y*, then manipulating or changing *X* is a way of manipulating *Y*. It then exploits the language of causal models to identify and articulate different causal relations of interest. A causal model can take a variety of forms, such as graphical, potential-outcome, and structural-equations models.[4] However, I'll restrict discussion of causal models in this paper to graphical models. A graphical model is, essentially, a set of variables – representing the causal relata – and a directed binary relation between them – representing causal influence.

Interventionism then defines the notion of an *intervention* on a system. An intervention, *I*, first must directly change the value of some variable, *X*, in such a way that it breaks the dependence that *X* may have had on other variables in the system. Second, *I* must be designed in such a way that any change in the effect variable, *Y*, will be the direct result of *X* and not of *I* itself. Finally, *I* must be wholly independent of other possible causes of *Y*, whether such causes are represented by the given model or not. A more precise formulation than this won't matter for the purposes of this paper.[5]

With this in place, the interventionist then defines a basic notion of cause, which corresponds most closely with the intuitive notion of *causal relevance*:

> (Principle M) *X* causes *Y* iff there are background circumstances B such that if some (single) intervention that changes the value of *X* (and no other variable) were to occur in B, then Y would change. (Woodward 2003, 222)

That is, in order for *X* to be a cause of *Y*, the change in *X* from one value to another as the result of an intervention corresponds to the change in *Y* from one value to another, given some fixed set of background parameters. Various kinds of causal relations are then captured by refinements on this basic notion. Due to

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[4] See Greenland and Brumback 2002 and Hitchcock 2009 for overviews of causal models.

[5] See Woodward 2003, chapter 3, especially 98

the irrelevance of these and further details to my argument, I'll leave my overview of interventionism here.[6]

3. Proportionality as Relational Constraint on Variable Selection

Interventionism places variables front and center in how we represent and inquire into causation. Thus, more needs to be said about the criteria for variable selection. Although the variables can be taken to represent different things, I will assume throughout that the set of values of a particular variable represents a set of properties – constrained by a given property type – that are possibly instantiated by some particular thing. The assumed causal relata of this paper will therefore be property instantiations.

This paper addresses two questions relevant to variable selection: (i) What determines the range of values that a variable can take? (ii) At what level of description should the values of the variables be? Proportionality has been proposed as an answer to (ii). However, after laying out the proposal, I'll go on to argue that while (ii) can be answered by the principle of proportionality, it can only do so alongside an appropriate answer to (i). One aspect of such an answer is that the background modal context determines the range of values that a variable takes.

Constraints on variable selection can be divided into two kinds: relational constraints and non-relational constraints. *Relational constraints* pertain to the extrinsic nature of the variables in a causal model, to how "variables relate to one another." (Woodward 2016, 1056) One example of such a constraint is stability.[7] *Stability* is the persistence of the causal relation between a cause variable and an effect variable, despite changes in the background conditions. The more changes such a relation can survive, the more stable it is.

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[6] See Woodward 2003, chapter 2, especially section 3
[7] See Woodward 2010, 2016

Proportionality is just such a relational constraint. It holds that changes in a cause variable should line up with changes in an effect variable. Intuitively,

> Proportionality has to do with whether changes in the state of the cause 'line up' in the right way with changes in the state of the effect and with whether the cause and effect are characterized in a way that contains irrelevant detail. (Woodward 2010, 287)

Take Yablo's pigeon example.[8] Sophie the pigeon is trained to peck at red things and only at red things. She then pecks at a paint chip, which is a particular shade of red – scarlet. Which of the following is causally relevant to Sophie's pecking: the chip's being red or the chip's being scarlet?

When translated into interventionist terms, this becomes a false dichotomy. Take the variable, *P*, to be a variable representing whether the pigeon pecks or not. It can take the values: {*peck*, *not-peck*}. Now consider two alternative variables for representing the property-instantiations of the paint chip: the variable, *R*, which can take the values {*red*, *not-red*}, and the variable, *T*, which can take the values {*taupe, scarlet, cyan, mauve, crimson,* etc.}, where 'etc.' stands for all other physically possible colors at the same grain as those already made explicit. According to Principle M, the causal model in which *R* stands as causally relevant to *P* is just as accurate as one in which *T* so stands. In the *R* model, *R* is causally relevant to *P* because an intervention on *R* that changes its value from *not-red* to *red* changes *P*'s value from *not-peck* to *peck.* In the *T* model, *T* is causally relevant to *P* because an intervention on *T* that changes its value from *taupe* to *scarlet* changes *P*'s value from *not-peck* to *peck*.

Interventionism therefore doesn't ask the question, which variable stands in a causal relation to *P*? For, the answer is 'both'. *R* and *T* are each causally relevant to *P*. But, this doesn't mean that their respective relationship to *P* is the same. *R* is *proportional* to *P*, while *T* is not. All of the changes in *R* line up with changes in *P* – every intervention on *R* corresponds to a change in *P*. But only some of the

[8] Yablo 1992

changes in *T* line up with those in *P* – only certain interventions on *T* correspond to changes in *P*. The intervention that changes the value of *T* from *taupe* to *cyan*, for example, will not change the value of *P*.

Woodward defines proportionality more explicitly as,

> (P) There is a pattern of systematic counterfactual dependence (with the dependence understood along interventionist lines) between different possible states of the cause and the different possible states of the effect, where this pattern of dependence at least approximates to the following ideal: [it] should be such that (a) it explicitly or implicitly conveys accurate information about the conditions under which alternative states of the effect will be realized and (b) it conveys only such information – that is, the cause is not characterized in such a way that alternative states of it fail to be associated with changes in the effect. (2010, 298)

There are two views on what this difference between variables like *R* and *T* means. The first takes proportional variables such as *R* to represent genuine causes, while non-proportional variables such as *T* represent merely causally relevant factors. Proportionality is thereby considered a necessary constraint on causation. Call this *strong proportionality*.[9] The second view takes proportionality to be a merely pragmatic constraint on causal explanation.[10] Call this *weak proportionality*. Throughout this paper, I assume and defend strong proportionality.

4. Non-Relational Constraints: Exhaustivity and Exclusivity

Non-relational constraints, on the other hand, pertain to the intrinsic nature of the variables in a causal model. These constraints "can be applied to variables, individually, independently of how they relate to other variables." (Woodward

[9] See List and Menzies 2009; Menzies and List 2010; and Papineau 2013
[10] See Woodward 2015; Shapiro and Sober 2012; McDonnell 2017; and Weslake 2013, 2017

2016, 1057) One example is *metaphysical naturalness*, which requires that variables pick out only natural properties, on some understanding of 'natural'.[11]

What I propose to call the exhaustivity and the exclusivity constraint are similarly non-relational constraints. Take exhaustivity first. The *exhaustivity constraint* requires that a variable's values capture the entire range of relevant possibilities for whatever type of thing the variable represents. An exhaustive variable is one that must take one of its values, given whatever background modal constraints are in place.

Since I've restricted this discussion to variables whose values represent the property instantiation of some target object, I can define exhaustivity in more precise terms. *Exhaustivity* is the constraint on a variable in a causal model that holds that its values must jointly represent the range of possibilities of property instantiation by the given object for the given property-type. If the property-type is a color, for example, then the values must somehow exhaust the color spectrum. This can be done quite simply with a binary variable that can take the values: {*some particular color*, *not-(that particular color)*}.

Next, the *exclusivity constraint* holds that the values of a given variable should be such that any one excludes all the others. Woodward references exclusivity when he writes,

> When considering the values of a single variable, we want those values to be logically exclusive, in the sense that variable *X*'s taking value *v* excludes *X*'s also taking value *v'*, where $v \neq v'$. (2016, 1064)

In other words, if two things are not exclusive – if they could occur together – then they should be represented by distinct variables. While exhaustivity holds that a variable should take *at least* one of its values, exclusivity holds that a variable should take *at most* one of its values.

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[11] See Lewis 1983; Menzies 1996; Paul 2000; and Franklin-Hall 2016

Importantly, exhaustivity and exclusivity are each relative to a background modal context. In possible worlds terminology, the modal context is the set of possible worlds relevant to the truth of the counterfactual that captures the causal claim. It can be described as a set of worlds, or perhaps more succinctly as a list of background assumptions that define such a set. These assumptions can include any constraint that operates in a law-like fashion.

For example, the causal claim, "The chip's being scarlet caused the pigeon to peck," corresponds to the counterfactual, "Had the chip not been scarlet, the pigeon wouldn't have pecked." The modal context of this claim and corresponding counterfactual is the set of possible worlds that determines whether the counterfactual is true. So, if this claim and counterfactual are meant to represent a *specific* causal situation near a local paint chip factory that specializes in just the colors scarlet and cyan, and no others, then the relevant set of possible worlds will be constrained to those in which the paint chip takes one of the two factory colors – cyan or scarlet. In this context, the variable, *C,* that can take the values {*cyan, scarlet*}, is an exhaustive variable. Further, given this set of worlds, the counterfactual is true.

If instead these are meant to represent any *general* causal situation involving paint chips and a red-pecking pigeon, then the relevant set of possible worlds will be more inclusive, including all worlds in which the paint chip takes any color within the color spectrum. *C* is not exhaustive relative to this more inclusive modal context. But the variable *T*, from before, is. Given this more inclusive set of worlds, the counterfactual is false, since the pigeon will peck in response to shades of red other than scarlet.

A point of note here is that the constraints of exhaustivity and exclusivity are indeed non-relational constraints in the sense previously defined. Although they are relative to the modal context, they are *not* relative to other variables in the model. They are properties of a variable taken independently as a representation of the target scenario.

I hold that causal models successfully represent causal situations in part by requiring exhaustive and exclusive variables. Proportionality, defined in terms of causal models, also requires exhaustive and exclusive variables. A significant upshot of this is that the proportional cause is not only relative to the target effect variable, but also to the background modal context.

5. Interventionist Proportionality Does the Trick

Franklin-Hall contends that Woodward's formulation of proportionality doesn't successfully prioritize intuitively proportional causal relata, such as red in the pigeon example. However, as I'll argue, presupposing my notion of exhaustivity corrects for this objection.

Franklin-Hall argues that proportionality as laid out in section 3 is inadequate for capturing the kind of causal explanation we're looking for. To do so, she calls upon Sophie and her paint chip. She then introduces a comparison between the causal variable, *R*, that can take the values: {*red*, *not-red*}, (as above), and a variable, *C*, that can instead take the values: {*cyan, scarlet*} (as above). *R*, as before, is proportional to, and therefore a genuine cause of, *Y*. But, she argues, *C*, too, is proportional to *Y*, since every possible intervention on *C* changes the value of *Y*. An intervention on *C* that changes its value from *cyan* to *scarlet* changes *Y* from *not-peck* to *peck*, and an intervention that changes *C*'s value from *scarlet* to *cyan* changes *Y*'s value from *peck* to *not-peck*. Thus, the changes in *C* line up with the changes in *Y* just as well as the changes in *R* do. The problem, then, is that proportionality, as formulated, is insufficient to its intended task. It fails to privilege a variable like *R* over one like *C*, and so fails to prioritize a causal model that uses *R* over one that uses *C*.

In response to this problem, a natural move would be to find a way to disqualify variables like *C* from the arena. Intuitively, *C* is not the right kind of variable. But, why not? I propose that our aversion to variables like *C* is due to their failure to exhaustively represent the implicit modal context of the situation. The background possibilities relative to the paint chip include the full color spectrum.

Unless the possible color of the paint chip is restricted in some way – by the local factory, for example – then the target object can fail to take one of *C*'s two values. There are other physically possible colors that the paint chip could have – such as beige or olive green – and *C*'s values fail to represent these possibilities.

Relative to the implicit modal context, then, *C* is not an exhaustive variable. The variable, *R*, on the other hand, is exhaustive, since the object must take one of *R*'s two values. By requiring exhaustive variables, *C* is discounted as a candidate variable *relative to the implicit modal context*, and *R* takes privilege as the proportional cause.

In general, two variables are in proper competition with each other over which is proportional to some effect variable only when they are exhaustive relative to the same modal context. *C* and *R* are not competitors for proportionality relative to *Y*, since only one of them can contain an exhaustive set of active possibilities relative to any given modal context.

6. Preserving Causal Intuitions

The strongest objection to proportionality, as raised by Bontly, Shapiro and Sober, McDonnell, and Weslake, is that it seems to render many common sense causal claims false.[12] Call this the *objection from common sense*. It objects to strong proportionality by attempting to demonstrate that if proportionality is required of something to be a cause, then many things that we would naturally call causes don't actually qualify.

Take as an example the situation where Socrates drinks hemlock and then dies, and the corresponding causal claim, 'Socrates's drinking hemlock caused him to die'. The objection goes that drinking hemlock is not actually proportional to Socrates dying. For example, if Socrates had not drank hemlock, but still consumed it – by eating a dozen leaves, for example – then he still would have

[12] See Bontly 2005; Shapiro and Sober 2012; McDonnell 2017; and Weslake 2013, 2017

died. This seems to show that the changes in the variable that represents Socrates drinking hemlock don't line up with the changes in the variable that represents Socrates dying. The first variable could change values from *Socrates-drinks-hemlock* to *Socrates-eats-hemlock* and the second variable would retain the value *Socrates-dies*. This common sense causal claim is therefore not proportional. The proportional cause should be, instead, *consuming hemlock*.

However, this objection is mistaken. It fails to respect the exhaustivity constraint on variable selection, and thereby equivocates between different background modal contexts. It further fails to respect exclusivity, and thereby runs together what should be different variables. Rectifying this illuminates the implicit proportionality of common sense causal claims.

First, the objection ignores the fact that proportionality, in requiring exhaustive and exclusive variables, is relative to modal context. Take the hemlock example just outlined. Importantly, this example and corresponding claim are under-defined.[13] Translated into interventionist terms, all that this description provides is that there is some variable that takes a value that represents Socrates drinking hemlock, and an intervention on this variable changes the value of some other variable to one that represents Socrates dying. But, a number of different variables could represent the purported cause, and a number of different models could represent its relationship to the effect of Socrates' dying. Which of these is accurate depends on what the relevant alternatives to drinking hemlock are. How these details get filled in will determine whether or not the variable that represents Socrates drinking hemlock is proportional.

I hold that the common sense claim that drinking hemlock causes Socrates's death implicitly takes the relevant alternative to be Socrates's *not* drinking hemlock. The default context is taken to be that hemlock was the only possible poison, and drinking it the only possible means of consumption. Given this context, the exhaustive variable would take the values {*drinks-hemlock*, *doesn't-*

[13] I take this to be common knowledge. See Franklin-Hall 2016; McDonnell 2017; and Weslake 2017

drink-hemlock}. But, such a variable is indeed proportional to the effect variable. Thus, the common sense cause is, in fact, proportional.

Such a defense requires that common sense claims be implicitly relative to a modal context. I'm not the first to relativize common sense claims to context. Philosophers such as Mackie and Schaffer make such a move, albeit with different ends in mind.[14] However, both McDonnell and Weslake explicitly deny this kind of relativity.[15] They claim that the very fact that we have strong and convergent intuitions about common sense examples, despite their being under-determined, demonstrates that the intuitions are not sensitive to filling in details.

In response, I argue that we respond to common sense causal examples in the same way that we respond to standard conversations. According to Grice, communication is governed by a set of conversational maxims. [16, 17] The maxims most relevant to how an audience engages with these under-defined causal examples are the maxims of *quantity* and *relation*. Taken together, these maxims enjoin an interlocutor to,

> Make your contribution as informative as is required (for the current purposes of exchange)….[and no] more informative than is required,….[and b]e relevant. (1989, 26 – 27)

Thus, the conversationally natural way to fill in the modal context of these examples is to take each fact as informative and relevant, and to assume that all informative facts have been provided.

The only information provided by the hemlock example is the following: (i) Socrates drinks hemlock. (ii) Socrates dies. The Gricean maxims tell us that this is all the information needed, and that nothing significant has been left out. So, the details are filled in as continuous with everyday life. In possible world speak,

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[14] See Mackie 1974, especially chapter 2; and Schaffer 2005
[15] McDonnell 2017; Weslake 2017
[16] See Grice 1989
[17] Bontly makes a similar point (see 2005)

we're looking only at worlds which have a similar environment, a biologically similar Socrates, etc., and in which laws of metaphysical necessity hold.

The causal focus is on Socrates's drinking hemlock. This means that in evaluating the causal relationship, everything else is held fixed and the fact of the drinking hemlock is varied. Due to the absence of any other details, the only real alternative to Socrates's drinking hemlock is his not drinking hemlock. Nothing suggests that there are alternative means of consuming the hemlock. Further, it's not a common occurrence in everyday life to have alternative means of consuming a given poison. Treating *eating hemlock* as a relevant alternative would be to arbitrarily introduce something that wasn't otherwise specified, and whose presence can't be justified by everyday experience.

The objection from common sense assumes different possible alternatives than what I take to be implicit, and then tries to say that relative to these other alternatives, the common sense causal claim is not proportional. I have argued that the common sense cause is simply not relative to these other alternatives.

However, even given other possible alternatives, the common sense cause would still be proportional. The second mistake that the objection makes is that it fails to appreciate the constraint of exclusivity.

The objection holds that there is some relevant alternative to Socrates's drinking hemlock that preserves his consuming it. Take as an arbitrary alternative his eating hemlock. Socrates could both drink and eat the hemlock – he could wash down a hemlock salad with a glass of hemlock milk, for example. Following exclusivity, then, these possibilities should be represented by distinct variables – one that can take the value *drinks-hemlock*, call this *D*, and one that can take *eats-hemlock*, call this *E*.

But, now there is no problem. Following Woodward's response to early pre-emption cases,[18] we can hold *E* fixed at the value that represents Socrates not eating the hemlock, and see if the changes in *D* – which we can ensure meets exhaustivity by giving it the second value *doesn't-drink-hemlock* – line up with the changes in the effect variable. They do. When an intervention sets the value of the cause variable to *drinks-hemlock*, the effect variable takes the value *dies*. When an intervention sets the value of the cause variable instead to *doesn't-drink-hemlock*, the effect variable changes value to *doesn't-die*. Once again, the common sense cause is proportional.

If, on the other hand, the situation is such that Socrates's drinking hemlock is indeed mutually exclusive with his eating hemlock, then *drinks-hemlock* and *eats-hemlock* could be values of the same variable. Imagine that Socrates's jailor only has enough money to purchase either hemlock leaves or hemlock milk, but not both. In this case, neither Socrates's drinking nor his eating will be proportional. The proportional cause is instead his consuming hemlock. The proportional variable will therefore be one that takes as values {*consumes-hemlock*, *doesn't-consume-hemlock*}.

But, this is not in conflict with common sense – so long as we abstract away from normal everyday circumstances, and instead genuinely fix the situation as one in which Socrates is forced to consume hemlock, arbitrarily receiving hemlock leaves or milk. When, given this background, we're asked what causes Socrates's death, it is natural to say that it was his consuming hemlock. After all, it isn't the drinking nor the eating that makes a difference to whether Socrates dies, since had he not done one he would have done the other. It is his consuming hemlock rather than not.

Finally, I'd like to point out that the intuition that Socrates's consuming hemlock is the more proportional cause is actually misguided. The naïve intuition holds that an exhaustive and exclusive variable with the value *consumes-hemlock* – call this H_1 – is more proportional to the exhaustive and exclusive variable with the

[18] See Woodward 2003

value *drinks-hemlock* – call this H_2. But, the modal context to which H_1 will be exhaustive is different than that to which H_2 will be. They're therefore not even in competition for proportionality. Instead, I suggest that this intuition is a response to the fact that H_1's modal context is more inclusive than that of H_2. H_1 can accurately (and proportionally) represent the cause of Socrates's death in a wider range of situations than can H_2. But, this is about stability – as earlier defined – not about proportionality. The model that employs H_1 is simply *more stable* than that which employs H_2. This putative proportionality intuition is actually responding to the property of stability.

7. Conclusion

In this paper, I have defended the interventionist formulation of proportionality by explicating the exhaustivity and exclusivity constraints, and stipulating that proportionality requires variables that meet these constraints.

These constraints have been defined on the assumption that a variable represents a particular object's instantiations of a particular type of property. But, they are easily generalized to cover alternate objects of representation. Take events, for example. If variables represent particular kinds of events occurring or failing to occur, then exhaustivity would require that the values of a variable cover the entire range of possibilities of event occurrence for whatever type of event the variable represents. Exclusivity would require that the values of a variable be event occurrences such that no two could occur simultaneously.

Finally, I have articulated how the interventionist formulation of proportionality responds to the objection from common sense. Such an objection dissolves once the explicated constraints on variable selection are honored.

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