THE ENTAILMENT PROBLEM AND THE SUBSET ACCOUNT OF PROPERTY REALIZATION

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Proponents of the subset account of property realization commonly make the assumption that the summing of properties entails the summing of their forward-looking causal features. This paper seeks to establish that this assumption is false. Furthermore, it aims to demonstrate that without this assumption, the fact that the subset account captures an entailment relation becomes questionable.

Keywords: non-reductive physicalism, property realization, the subset account, entailment

Non-reductive physicalism has become something of an orthodoxy in the contemporary mental causation debate, largely because of dissatisfaction with alternative kinds of physicalism. However, non-reductive physicalists face the problem of capturing a relationship between mental and physical properties that is compatible with physicalism, but which does not collapse their position into either psychophysical reductionism or epiphenomenalism. An increasing number of non-reductive physicalists consider that this problem can be addressed by appealing to the subset account of property realization. This paper develops and defends an argument against the subset account, which entails that it cannot serve this purpose.

The structure of my argument is as follows:

1) To provide the basis for a plausible non-reductive physicalism, an account of property realization must satisfy the entailment requirement: if property *Y* realizes property *X*, then having *Y* must entail having *X*.
2) Proponents of the subset account make the (implicit) assumption that the summing (i.e. conjoining) of properties entails the summing of their forward-looking causal features. This assumption is false.

3) Without this assumption the subset account fails to satisfy the entailment requirement. Cases arise in which *Y* realizes *X* according to the subset account, but having *Y* does not entail having *X*.
4) Consequently, the subset account does not provide the basis for a plausible non-reductive physicalism.

1.

1.1 The Subset Account

I will concentrate on Sydney Shoemaker's formulation of the subset account, as he has done the most to articulate this position and to embed it in an ontological framework. However, his central claims about the subset account are generally representative of those who maintain this position. According to Shoemaker:

> Where *X* and *Y* are properties instantiated by the same object, *X* is realized by *Y* just in case the forward-looking causal features of *X* are a proper subset of the forward-looking causal features of *Y*. [2001; 2013]

I shall refer to this kind of realization as 's-realization'. Hence, if *X* and *Y* are instantiated by the same object and *X*'s forward-looking causal features are *a* and *b* and *Y*'s are *a*, *b* and *c*, then *Y* s-realizes *X*.

What are the 'forward-looking' causal features of a property? They concern the causal powers a property bestows on its bearers. More precisely, '[c]orresponding to every forward-looking causal feature of a property is a *conditional power* that property bestows on its possessors' [Shoemaker 2007: 24].

To explain Shoemaker's notion of a conditional power, take his example of the property of being knife-shaped. Shoemaker distinguishes 'conditional powers' from 'powers simpliciter', where the latter are a special case of the former. An object has a power simpliciter if, if it is in appropriate circumstances, it will have a certain effect. Hence, a steel knife has the power simpliciter to cut wood because, if it is applied to a wooden object with adequate force, it will cut it. Normally a power simpliciter of an object is determined by more than one of its intrinsic properties. Where a power simpliciter is determined by a combination of the object's properties, each of the properties in this combination bestows a conditional power on the object [Shoemaker 2003a: 212; Shoemaker 2007: 24]. Thus, being knife-shaped does not bestow the power simpliciter to cut wood, as to be able to cut wood it is not sufficient that an object is knife-shaped. However, an object with both the properties of being knife-shaped and being made of steel does have this power simpliciter. Hence, 'the property of being knife-shaped bestows on its possessor the conditional power of being able to cut wood if it is made of steel' [Shoemaker 2007: 24].

Being knife-shaped also bestows the conditional power to cut paper if made of steel, the conditional power to form a knife-shaped indentation in wax if made of wood, etc. To provide the complete set of forward-looking causal features that being knife-shaped has one must consider every combination of properties that an object with the property of being knife-shaped could instantiate, and every power that being knife-shaped bestows in each of these combinations.

Shoemaker's account of what it is for one conditional power to be identical with another is as follows:

> [I]f *A* is the conditional power of having power *P* conditionally upon having the properties in set *Q*, and *B* is the conditional power of having power *P*' conditionally upon having the properties in set *Q*', then *A* is identical to *B* just in case *P* is identical to *P*' and *Q* is identical to *Q*'. [2003a: 213]

This criterion of identity for conditional powers will be assumed throughout the discussion.

1.2 Non-Reductive Physicalism and the Entailment Requirement

Shoemaker, like many other non-reductive physicalists, invokes the subset account to defend non-reductive physicalism.[1] Mental properties are s-realized by physical properties. More generally, given such a view, all properties are physical or are s-realized by physical properties. If the subset account is to capture the relationship between mental and physical properties that the non-reductive physicalist requires, this places at least three demands on it.

The non-reductive physicalist holds—largely because of the argument from multiple realizability—that mental and physical properties are distinct. Hence, s-realized properties must be distinct from their realizers. As Shoemaker argues, given his criterion of property

[1] See, for example, Shoemaker [2013]. Other central proponents of this strategy include Clapp [2001]; Watkins [2002] and Wilson [1999].

identity, they are distinct. It states that properties are identical if and only if they bestow the same set of conditional powers [Shoemaker 2013: 42]. S-realized properties do not bestow the same set of conditional powers as their realizers. Rather, the conditional powers that an s-realized property bestows are a proper subset of those that its realizer bestows.

Non-reductive physicalism aspires to avoid property-epiphenomenalism, the view that mental properties lack causal efficacy. Hence, s-realized properties must be causally efficacious. They are, as they bestow conditional powers. Moreover, it is argued that if mental properties are s-realized by physical properties, there is no threat of systematic causal overdetermination, as s-realized properties are not in causal competition with their realizers. (See, for example, Shoemaker [2007: 13]). There is no need to rehearse the arguments for and against this claim here, for my concern is with a third requirement.

To capture the physicalism in non-reductive physicalism, non-reductive physicalists hold that having a mental property is in some sense 'nothing over and above' having a physical property. The notion of 'nothing over and aboveness' is notoriously unclear. But, regardless of how one interprets it, presumably for the having of property *X* to be 'nothing over and above' the having of property *Y*, having *Y* must at least entail having *X*. If so, then if *Y* s-realizes *X*, having *Y* must entail having *X*. It is this entailment requirement that is of crucial importance to this paper.[2]

The formulation of the entailment requirement needs one important refinement—a refinement that Shoemaker's own discussion of the topic draws our attention to. Shoemaker understands the realization relation to be an entailment relation. This fact is made obvious by his general comments about realization. For Shoemaker, to realize is to 'make real' in a sense of 'makes' that is constitutive; 'the instantiation of the mental property consists in the existence of its physical realizer' [2013: 39]. (It is this sense in which the mental is 'nothing over and above' the physical.) As having the realized property *consists in* having the realizer, having the realizer must entail having the realized property. But, as Shoemaker makes clear, how exactly to formulate the entailment requirement depends on whether properties have their causal profiles essentially; on whether having the set of conditional powers associated with a property is necessary for having that property. If this is the case, the entailment requirement should simply be formulated as the claim that if *Y* s-realizes *X* then having *Y*

[2] For an excellent discussion of a version of the entailment requirement and its importance in evaluating theories of realization, see Morris [2010]. Morris argues that the primary physicalist constraint on a theory of realization is that it should non-trivially imply that instances of physically realized properties are necessitated, in a modally strong sense, by how things are physically.

must entail having *X*, and Shoemaker considers that, given the subset account, it is 'straightforwardly true that the instantiation of the realizer property entails the instantiation of the realized property' [2001: 94]. If, however, properties have their causal profiles contingently, then what entails the instantiation of the realized property is 'not the instantiation of the realizer property by itself, but its instantiation *having the causal features it in fact has*, or, what comes to the same thing, *being governed by the causal laws that in fact hold*' [2001: 94]. We should then include in the realizer a set of laws. That is, *X*'s s-realizer is *Y* and such that *L*, where '*L*' stands for the causal laws that actually obtain [2001: 95]. The entailment requirement should thus be formulated as the claim that if *Y* and such that *L* s-realizes *X*, then having *Y* together with the obtaining of *L*, must entail having *X*.

I will argue that, contrary to Shoemaker, the subset account fails to satisfy the entailment requirement. Hence, it cannot provide a satisfactory basis for non-reductive physicalism.[3] For simplicity—that is, to avoid having to talk about realizers such as '*Y* and such that *L*'—I shall assume that properties have their causal profiles essentially. (This is Shoemaker's position [2007: Appendix]). However, this assumption is not essential to my argument, which would hold equally if one adopted the contingency view.[4]

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[3]As an aside, note that Shoemaker [2013: 42] has recently retracted a previous version of the subset account precisely because it failed to meet the entailment requirement. That version added the requirement that for *X* to be s-realized by *Y* the backward-looking causal features of *Y* must be a proper subset of those of *X*, where these concern what sorts of states of affairs can cause its instantiation [Shoemaker 2003b; Shoemaker 2007]. McLaughlin [2007: 160] demonstrates that, given this extra claim, the subset account fails to meet the entailment requirement. This paper establishes that, for very different reasons, even without the extra claim about backward-looking causal features, the subset account fails to meet the entailment requirement.

[4] An anonymous referee has pointed out that the subset account can easily be made to satisfy the entailment requirement by re-formulating it as follows:

> Where *X* and *Y* are properties instantiated by the same object, *X* is s-realized* by *Y* just in case the forward-looking causal features of *X* are a proper subset of those of *Y*, and having *Y* entails having *X*.

It is trivially true that if *Y* s-realizes* *X*, having *Y* entails having *X*. However, there are at least two problems with this re-formulation. First, what seems to be doing all of the work within this re-formulated version of the subset account is the entailment claim—the claim that having *Y* must entail having *X*. It is unclear what further purpose is served by the claim that the forward-looking causal features of *X* must be a proper subset of those of *Y*. (For further development of this kind of point, see McLaughlin [2007] and Morris [2010: 399].) Secondly, if *Y* s-realizes* *X*, the fact that having *Y* entails having *X* is not a consequence of the fact that the forward-looking causal features of *X* are a proper subset of those of *Y*. It is instead an additional, brute claim of the subset account. Hence, it leaves the question of why the realization relation is an entailment relation unanswered, when

2.

I now turn to the second claim of my argument: The summing of properties does not entail the summing of their forward-looking causal features.

2.1 The Argument

Shoemaker maintains that, as it stands, the subset account makes 'any conjunctive property a realizer of each of its conjuncts' [2007: 13]. His reasoning is presumably as follows: Take any two properties *X* and *Y* that are instantiated by the same object. Say that *X* has forward-looking causal feature *a* and that *Y* has *b*. The conjunctive property *X*-and-*Y* will therefore have forward-looking causal features *a* and *b*. (The assumption being that the summing of properties entails the summing of their forward-looking causal features). Thus *X*-and-*Y* s-realizes *X* and s-realizes *Y*.[5]

I would question this reasoning. Return to the property of being knife-shaped. It bestows the conditional power to cut wood if made of steel. In accordance with the claim that the summing of properties entails the summing of their forward-looking causal features, being knife-shaped-and-being one foot long also bestows this conditional power. But what about a property such as being knife-shaped-and-being made of butter? Does it bestow the

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arguably it is precisely this fact that cries out for explanation. (See Morris [2010: 399-400] for further defence of a point along these lines.)

[5] Shoemaker is certainly not alone in this reasoning. See, for example, Wilson [2009: 165].

Note that Shoemaker wishes to deny that every conjunctive property s-realizes its conjuncts. He therefore restricts the class of conjunctive properties that count as s-realizers. According to Shoemaker, the forward-looking causal features of a conjunctive property always contain as a proper subset those of each of its conjuncts. However, Shoemaker adds the requirement that a conjunctive property only counts as an s-realizer of one of its conjuncts if there is an asymmetrical relation between the conjuncts, such that the instantiation of one of the conjuncts narrows the way determinable powers bestowed by the other conjunct (the one that is realized) can be exercised, but not vice versa [2007: 28]. A discussion of this restriction is not of relevance to this paper. My issue is with Shoemaker's assumption that the forward-looking causal features of a conjunctive property always contain as a proper subset those of each of its conjuncts. I reject this assumption. I therefore consider that, even without Shoemaker's restriction, not all conjunctive properties s-realize their conjuncts. Furthermore, if one grants Shoemaker's restriction, this does not affect my argument. As will become clear, my argument is concerned with establishing that some conjunctive properties are *s-realized by* their conjuncts. Shoemaker's restriction limits which conjunctive properties s-realize their conjuncts. It does not limit which conjunctive properties are s-realized by their conjuncts. Nor is it designed to do so, for Shoemaker assumes that there are no such cases.

conditional power to cut wood if made of steel? Surely not. Indeed, it is only by losing the property of being made of butter—and, thus, losing this conjunctive property—that an object could cut wood. Hence, if one considers every combination of properties that an object with the property of being knife-shaped-and-being made of butter could instantiate, and every power that this conjunctive property bestows in each of these combinations, the power to cut wood will not be among them. Therefore, being knife-shaped bestows a conditional power that being knife-shaped-and-being made of butter does not. Consequently, being knife-shaped-and-being made of butter does not s-realize being knife-shaped.

This example is not in any way unusual. Being made of steel bestows the conditional power to cut wood if knife-shaped, but being made of steel-and-being round does not. Being round bestows the conditional power to bounce if made of rubber, but being round-and-being made of steel does not. More generally, say that the conditional powers that *X* bestows includes *A*, where '*A*' is 'the conditional power of having power *p* conditionally upon having property *Q*'. And, say that having property *Y* entails not having *Q*. *X* bestows *A*, but *X*-and-*Y* doesn't.

Hence, the subset account does not make every conjunctive property a realizer of each of its conjuncts. In claiming that it does, the underlying error is to assume that the summing of properties entails the summing of their forward-looking causal features. Given the above, this assumption is incorrect.

2.2 Objections

Before considering the implications of this claim, I shall consider a reply that Shoemaker has made to it.[6] For brevity, let '*K*' stand for 'the property of being knife-shaped', '*S*' for 'the property of being made of steel', '*B*' for 'the property of being made of butter and '*K*-and-*B*' for 'the property of being knife-shaped-and-being made of butter'. The reply is as follows: Contrary to my suggestion, there is no conditional power that *K* bestows but that *K*-and-*B* does not. Like *K*, *K*-and-*B* *does* bestow on an object the conditional power to cut wood if it has *S*. This follows from the fact that the conditional claim 'if it were the case that something which has *K*-and-*B* also had *S*, then it would be the case that it had the power to cut wood' is true. Of course, the conditional power could never be exercised by any object that instantiates *K*-and-*B*. It could only be exercised by an object that also had *S*, but it is

[6] This reply was made by Shoemaker in private correspondence.

impossible for something to have both *K*-and-*B* and *S*, as it is impossible for something to have both *B* and *S*. That said, the conditional claim is still true.

The problem with this reply is that it results in an unsatisfactory account of conditional powers. It is not merely technologically or nomologically impossible for something to be made of butter and of steel at the same time. It is metaphysically impossible; false in all possible words. Therefore, the conditional 'if it were the case that something which has *K*-and-*B* also had *S*, then it would be the case that it had the power to cut wood' is a counterpossible. That is, one whose antecedent is metaphysically impossible.

Consequently, given the traditional Lewis-Stalnaker semantics for counterfactuals—which I assume that Shoemaker and other proponents of the subset account would not wish to oppose—this conditional is indeed true, but only *vacuously* [Lewis 1973; Stalnaker 1968]. Hence, take Lewis' analysis of the meaning of a counterfactual conditional. According to it:

> 'If it had been the case that *p*, then it would have been the case that *q*' is true if and only if *q* is true in all of the closest possible worlds in which *p* is true.

'If it had been the case that *p*, then it would have been the case that *q*' is therefore true if there is no world in which *p* is true—that is, if *p* is metaphysically impossible—as it is vacuously true that *q* is true in 'all' of the closest worlds in which *p* is true. Therefore, to accept Shoemaker's response, one must allow that conditional propositions that are vacuously true pick out conditional powers.

But then one gets an explosion of conditional powers. If *p* is metaphysically impossible, then *any* counterfactual which has *p* as an antecedent is vacuously true—the consequent of a counterpossible makes no difference to its truth-value. Hence, it is vacuously true that if it were the case that something which has *K*-and-*B* also had *S* then it would be the case that it had the power to make wood explode, the power to turn wood invisible, the power to make the whole world invisible, and so on. Are we really to conclude that all of these conditional propositions pick out conditional powers that *K*-and-*B* bestows?[7]

Perhaps one's answer is 'Yes!' One might claim that all that there is to an object having a conditional power is that the relevant counterfactual conditional is true. Then, given that there are vacuously true counterfactuals, there are going to be 'trivial' conditional powers—that is, conditional powers for which the relevant counterfactual conditional is vacuously true.

[7] I'm grateful to E. J. Lowe for helpful discussion on this issue.

This is problematic. It is one thing to accept that there are vacuously true counterfactuals, and another to suggest that they do ontological work. (Hence, although Lewis accepts that there are vacuously true counterfactuals, they play no role whatsoever in his counterfactual theory of causation). If counterpossibles pick out conditional powers, this leads to a deflationary account of conditional powers that is hard to square with the ontological work that they are supposed to do. Conditional powers, according to Shoemaker, provide the basis for a robust ontological account of properties. What it is for a property to exist and for one property to be identical with another is to be accounted for in terms of them. To take properties ontologically seriously, one must therefore take conditional powers ontologically seriously. One cannot do this if one accepts trivial conditional powers. One might concede that trivial conditional powers exist, but that they play no role in an account of property existence or identity. But, then, they shouldn't play any role in an account of property dependence and, hence, the subset account.

Consequently, accepting that counterpossibles pick out conditional powers leads to an unsatisfactory account of conditional powers. For this reason, the claim that *K*-and-*B* bestows on an object the conditional power to cut wood if it has *S* should be rejected, if it requires one to accept that counterpossibles pick out conditional powers.

But perhaps it doesn't require this? Here is an alternative response to that offered by Shoemaker: An object, *x*, that has *K*-and-*B*, is such that if it were the case that *x* had *S*, then it would be the case that *x* had the power to cut wood. This counterfactual is not vacuously true, as the antecedent doesn't state that *x* continues to have *K*-and-*B* when *x* gains *S*. But, still, it is true in virtue of *x* having *K*. Why isn't this enough to say that *K*-and-*B* bestows on *x* the conditional power to cut wood if *x* has *S*?[8]

The problem with this response is that it conflicts with Shoemaker's understanding of what it is for a property to bestow a conditional power. For Shoemaker, to say that *K* bestows on an object the conditional power to cut wood if it has *S*, just means that if the object had *K* 'combined with', that is, as well as, *S*, then it would have the power to cut wood simpliciter—being knife-shaped is not sufficient for an object to be able to cut wood, but a *steel* knife is able to cut a wooden object (if applied to it with suitable pressure) [Shoemaker 2003a; 212]. Correspondingly, to say that *K*-and-*B* bestows on an object the conditional power to cut wood if it has *S*, just means that that if the object had *K*-and-*B* combined with *S*, then it would have the power to cut wood simpliciter.

[8] I'm grateful to a referee for this suggestion.

The response under consideration appeals to the fact that if an object has *K*-and-*B* and then gains *S*—thereby, losing *B*, and thus losing *K*-and-*B*—it would have the power to cut wood simpliciter. However, this is ultimately to claim that if an object had the combination of *K* and *S*, it would have the power to cut wood simpliciter; not to claim that if it had the combination of *K*-and-*B* and *S*, it would have the power to cut wood simpliciter. Consequently, given Shoemaker's account of what it is for a property to bestow a conditional power, it allows one to accept that *K* bestows on an object the conditional power to cut wood if it has *S*, but not that *K*-and-*B* does. That claim would only follow from the claim that if an object had the combination of *K*-and-*B* and *S*, then it would have the power to cut wood simpliciter. Therefore, given Shoemaker's account, this response is unsatisfactory.

Hence, in conclusion, given Shoemaker's account of what it is for a property to bestow a conditional power, unless we accept the unsatisfactory claim that counterpossibles pick out conditional powers, *K*-and-*B* does not bestow one of the conditional powers that *K* does. More generally, the summing of properties does not entail the summing of their forward-looking causal features.

3.

I turn to the third claim of my argument: Without the assumption that the summing of properties entails the summing of their forward-looking causal features, the subset account fails to satisfy the entailment requirement.

Given that the summing of properties doesn't entail the summing of their forward-looking causal features, far from it being the case that all conjunctive properties s-realize their conjuncts, some conjunctive properties are actually s-realized by one of their conjuncts. This is demonstrated by the following example:

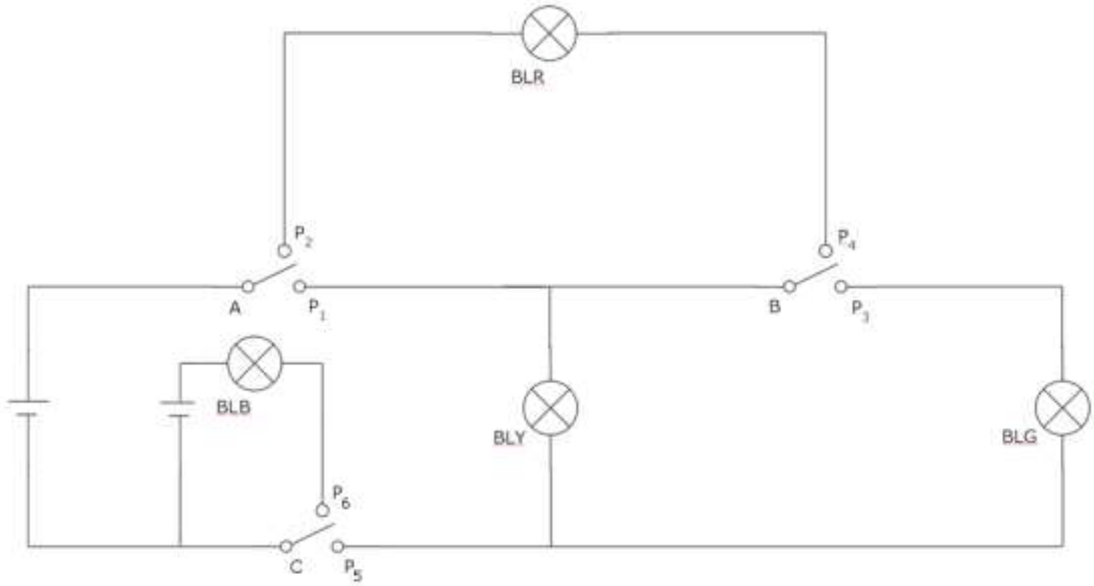

Figure 1: Four-light circuit

For brevity, designate the property of having switch A in position 1 by '*A1'*, the property of having switch B in position 3 by '*B3*', and so on. The blue bulb (BLB) shines if the circuit has *C6*—in other words, if switch C is in position 6. The red bulb (BLR) shines if the circuit has *A2*, *B4* and *C5*. The green bulb (BLG) shines if it has *A1*, *B3* and *C5*. The yellow bulb (BLY) shines if it has *A1* and *C5*, or, if it has *A2*, *B4* and *C5*.

Consider properties *A1* and *B4*. Say that '*y*' stands for 'the conditional power to make the yellow bulb shine', '*g*' for 'the conditional power to make the green bulb shine', and '*r*' for 'the conditional power to make the red bulb shine'. *A1* bestows on the circuit:

i) *y* if it has *C5*. (I.e. the conditional power to make the yellow bulb shine if it has C5.)

ii) *g* if it has *B3* and *C5*.

B4 bestows on the circuit:

i) *r* if it has *A2* and *C5*.

ii) *y* if it has *A2* and *C5*.

For the sake of simplicity, for the moment, assume that these are the only conditional powers that *A1* and *B4* bestow.[9]

[9] §4 presents a more complex version of the argument that abandons this assumption.

Now consider the conjunctive property *A1*-and-*B4*. Is the set of conditional powers that it bestows the sum of those bestowed by *A1* and *B4*? Like *A1*, *A1*-and-*B4* bestows *y* if the circuit has *C5*. However, unlike *A1*, *A1*-and-*B4* does not bestow *g* if the circuit has *B3* and *C5*. This is for the same reason that being knife-shaped-and-being made of butter does not bestow the conditional power to cut wood if made of steel. The underpinning conditional proposition—if it were the case that the circuit which has *A1*-and-*B4* also had *B3* and *C5*, then it would be the case that it had the power to make the green bulb shine—has an impossible antecedent. Having *A1*-and-*B4* excludes having *B3*. And, as argued, if counterpossibles pick out conditional powers this trivialises the notion of a conditional power. Similar reasoning leads to the conclusion that, unlike *B4*, *A1*-and-*B4* does not bestow on the circuit either *r* if it has *A2* and *C5*, or, *y* if it has *A2* and *C5*. Hence, *A1*-and-*B4* only bestows on the circuit:

i) *y* if it has *C5*.

Thus, given the assumption that all of the conditional powers that *A1* and *B4* bestow have been listed, the conditional powers that *A1*-and-*B4* bestows are in fact a proper subset of those that *A1* bestows. Hence, *A1* s-realizes *A1*-and-*B4*.

According to the entailment requirement, if *A1* s-realizes *A1*-and-*B4*, having *A1* must entail having *A1*-and-*B4*. But this is implausible. Given the standard, common-sense, understanding of property compositionality, to have a conjunctive property an object must have each of the conjunctive property's conjuncts.[10] Hence, for a ball to have the conjunctive property of being red-and-being round it must be red and round. Likewise, for the circuit to have *A1*-and-*B4* it must have *A1* and *B4*. Therefore, for having *A1* to entail having *A1*-and-*B4*, having *A1* must entail having *A1 and* having *B4*. But having *A1* does not entail having *B4*—clearly switch B could be in position 3 while switch A is in position 1. As having *A1* does not entail having *B4*, having *A1* does not entail having *A1*-and-*B4*.

Thus *A1* s-realizes *A1*-and-*B4*, but having *A1* does not entail having *A1*-and-*B4*. Consequently, the subset account fails to meet the entailment requirement.

4.

[10] See, for example, Armstrong [1980: 30] and Armstrong [1997: 123].

As it stands, the following objection can be raised against my argument: Not all of the conditional powers that *A1* and *B4* bestow on the circuit have been considered. Some of the further conditional powers that *B4* bestows are ones that *A1*-and-*B4* bestows, but *A1* does not. Hence, *A1*-and-*B4* is not s-realized by *A1*, and the entailment problem does not arise.

To give a specific example: Various components can be added to the circuit without rearranging any of its original parts. Say that a conductor is added with a battery running directly down from the red bulb to the yellow one. Then the red bulb will shine if the circuit has *B4*. Where '*D'* stands for 'the property of having a conductor with a battery running directly from the red bulb to the yellow one', *A1* bestows on the circuit:

i) *y* if it has *C5*.

ii) *g* if it has *B3* and *C5*.

B4 bestows on the circuit:

i) *r* if it has *A2* and *C5*.

ii) *y* if it has *A2* and *C5*.

iii) *r* if it has *D*.

And *A1*-and-*B4* bestows on the circuit:

i) *y* if it has *C5*.

ii) *r* if it has *D*.

The conditional powers that *A1*-and-*B4* bestows are, therefore, not a proper subset of those that *A1* bestows.

This example successfully demonstrates that *A1* does not s-realize *A1*-and-*B4*. However, it simply calls for a revision to my argument. The problem-case rests on the idea that one can add components to the circuit—in this case, a conductor connecting the red and yellow bulb—to generate further conditional powers that *B4* bestows. But, one can also add components to the circuit which would prevent a conductor from being placed here. One way would be to run a strip of wood, or some other insulator, directly from terminal 2 to terminal 4. Let '*W*' stand for 'the property of having a strip of wood running from terminal 2 to 4'. If the circuit has *W* then it can't also have *D*.[11] Now contrast the conditional powers that *A1*-and-*W*, *B4*-and-*W* and *A1*-and-*B4*-and-*W* bestow with those that *A1*, *B4* and *A1*-and-*B4*

[11] Alternatively, one could simply observe that the circuit in *Four-light circuit* does not have *D*—there is instead a gap between the bulbs—and appeal to whatever (complex) property of the circuit it is that makes this true. This would work just as well. However, what this property might be is a notoriously contentious issue and one that I don't wish to get into here. For a discussion of the ontology of gaps, see Casati and Varzi [1995].

bestow. If the conditional powers that *A1*-and-*B4*-and-*W* bestows are a proper subset of those that *A1*-and-*W* bestows—and, hence, if *A1*-and-*W* s-realizes *A1*-and-*B4*-and-*W*—this gives rises to the entailment problem. The claim that *A1*-and-*W* entails *A1*-and-*B4*-and-*W* is no less problematic than the claim that *A1* entails *A1*-and-*B4*.

Are the conditional powers that *A1*-and-*B4*-and-*W* bestows on the circuit a proper subset of those that *A1*-and-*W* bestows?

Well, first, crucially, unlike *B4*, *B4*-and-*W* does not bestow on the circuit *r* if it has *D*. This is because the underpinning conditional has an impossible antecedent—having *B4*-and-*W* excludes having *D*. And, as argued, it is implausible that counterpossibles pick out conditional powers. Having *A1*-and-*B4*-and-*W* also excludes having *D*. Hence, for the same reason, unlike *A1*-and-*B4*, *A1*-and-*B4*-and-*W* does not bestow on the circuit *r* if it has *D*.

Secondly, *A1*-and-*W*, *B4*-and-*W* and *A1*-and-*B4*-and-*W* clearly bestow all of the conditional powers on the original list. That is: *A1*-and-*W* bestows on the circuit:

i) *y* if it has *C5*.

ii) *g* if it has *B3* and *C5*.

B4-and-W bestows on the circuit:

i) *r* if it has *A2* and *C5*.

ii) *y* if it has *A2* and *C5*.

And, *A1*-and-*B4-and-W* bestows on the circuit:

i) *y* if it has *C5*.

Thirdly, although *W* will itself bestow conditional powers on the circuit, some of which *A1*-and-*B4*-and-*W* will inherit, these are non-problematic. *W* bestows, for example, the conditional power to catch fire when struck by a match if dry. However, this conditional power is one that *A1*-and-*W*, *B4*-and-*W* and *A1*-and-*B4*-and-*W* all also bestow. Hence, it does not provide a counterexample to the claim that the conditional powers that *A1*-and-*B4*-and-*W* bestows are a proper subset of those that *A1*-and-*W* bestows. The conditional powers that *W* bestows would only be of concern if one of them wasn't inherited by *A1*-and-*W* and yet was inherited by *A1*-and-*B4*-and-*W*. I cannot think of any such example. (Such a suggestion seems strange in any case. See below.)

Together, these three points entail that the conditional powers that *A1*-and-*B4*-and-*W* bestows on the circuit are a proper subset of those that *A1*-and-*W* bestows, provided that '*r* if the circuit has *D*' is the only conditional power that *A1*-and-*B4* bestows that *A1* doesn't.

Now this isn't the only conditional power that *A1*-and-*B4* bestows that *A1* doesn't. To give a second example, if a conductor is added connecting terminal 2 and A, the red bulb would shine if the circuit had *B4* and *C5*. Hence, *B4* bestows on the circuit *r* if it has *C5* and a conductor connecting terminal 2 and A. *A1*-and-*B4* bestows this conditional power, but *A1* doesn't. Note, however, that this second problem-case, and plausibly any further one, can be dealt with *individually* in the same way that the first problem-case was dealt with.

The method used to deal with the first problem-case can be generalised as follows: Let *x* be the conditional power of having power *p* conditionally upon having property *Q*. Say that *B4* and *A1*-and-*B4* bestow *x* on the circuit, but *A1* does not. To reply, provide some property *S* that it is possible for the circuit to have, such that having *S* entails not having *Q*. Then contrast the conditional powers that *A1*-and-*S*, *B4*-and-*S* and *A1*-and-*B4*-and-*S* bestow with those that *A1*, *B4* and *A1*-and-*B4* bestow.

Given that counterpossibles do not pick out conditional powers, unlike *B4* and *A1*-and-*B4*, neither *B4*-and-*S* nor *A1*-and-*B4*-and-*S* will bestow *x*. Provided that it is also the case that:

i) *A1*-and-*S*, *B4*-and-*S* and *A1*-and-*B4*-and *S* bestow the conditional powers on the original list, i.e. *A1*-and-*S* must bestow *y* if *C5*, *B4*-and-*S* must bestow *r* if *A2* and *C5*, etc.

And:

ii) If *S* bestows some conditional power *y* and *A1*-and-*S* doesn't inherit *y*, then neither does *A1*-and-*B4*-and-*S*.

Then, *A1*-and-*S* s-realizes *A1*-and-*B4*-and-*S*, if *x* is the only conditional power that *A1*-and-*B4* bestows that *A1* does not.

In the first problem-case, a candidate for *S* was identified simply by considering basic additions that could be made to the circuit. In the second problem-case, similar considerations allow one to identify a candidate for *S*. Hence, '*S*' could be the property of having an insulator, such as rubber, encasing terminal A (except for a gap for the switch and the wire to A's left). Having this property entails not having a conductor connecting terminal 2 and A, as the rubber would prevent the conductor from coming into contact with A. However, this kind of consideration certainly does not exhaust the possible candidates for *S*. Condition (i) states that *A1*-and-*S*, *B4*-and-*S* and *A1*-and-*B4*-and-*S* must bestow the conditional powers on the original list. Therefore, *S* couldn't be, for example, the property of having a switch in place of the red bulb. But within these limits, *S* can be any property whatsoever that it is possible for the circuit to have. (For example, the circuit's size is unimportant. Thus, *S* could be the property of being of a size that is unobservable.) It is, therefore, hard to think of a problem-case in which a candidate for *S* could not be identified.

Regarding condition (i), *A1*-and-*S*, *B4*-and-*S* and *A1*-and-*B4*-and *S* will bestow the conditional powers on the original list, because, as just discussed, *S* will have been chosen with precisely this requirement in mind.

Condition (ii) will also arguably hold in every case. Say that *S* bestows *y*, where *y* is the conditional power of having power *p* conditionally upon having property *R*. If *A1*-and-*S* doesn't bestow *y*, why is this? The reason must be that the underpinning conditional has an impossible antecedent. Having *A1*-and-*S* excludes having *R*, and this must be because having *A1* excludes having *R*. But, then, presumably having *A1*-and-*B4*-and-*S* will also exclude having *R*. Hence, the claim that *A1*-and-*B4*-and-*S* bestows *y* should be rejected for the same reason. Consequently, if *A1*-and-*S* does not inherit *y*, then plausibly neither will *A1*-and-*B4*-and-*S*.

It is obviously not possible in this paper to consider each conditional power that it might be argued that *A1*-and-*B4* bestows but which *A1* does not. However, given the above considerations, it is reasonable to suggest that one will be able to deal with each such case using the above method. The challenge for the proponent of the subset account is to identify a plausible problem-case in which this method cannot be used.

We have considered how to respond to each problem-case individually, but how do we combine these responses? The answer is within a single pair of conjunctive properties. To explain, return to the first problem-case. Unlike *A1*, *A1*-and-*B4* bestows *r* if it has *D*. Therefore, *A1* doesn't s-realizes *A1*-and-*B4*. The response was to appeal to property *W*. *A1*-and-*W* s-realizes *A1*-and-*B4*-and-*W*, if this is the only conditional power that *A1*-and-*B4* bestows that *A1* does not. But it isn't. For example, *A1*-and-*B4* bestows *r* if it has *C5* and a conductor connecting terminal 2 and A, but *A1* does not. Furthermore, like *A1*-and-*B4*, *A1*-and-*B4*-and-*W* bestows this conditional power. Like *A1*, *A1*-and-*W* does not. Hence, *A1*-and-*W* does not s-realize *A1*-and-*B4*-and-*W*.

Now our response to the claim that *A1*-and-*B4* bestows *r* if it has *C5* and a conductor connecting terminal 2 and A but *A1* doesn't, was to appeal to property *S*, where '*S*' is the property of having rubber encasing A. Add *S* to the previous pair of conjunctive properties (i.e. to *A1*-and-*W* and to *A1*-and-*B4*-and-*W*). If there were no further examples of conditional powers that *A1*-and-*B4* bestows that *A1* does not, this would mean that *A1*-and-*W*-and-*S* s-realizes *A1*-and-*B4*-and-*W*-and-*S*. This would give rise to the entailment problem.

Each problem-case will require us to add a further property to the pair of conjunctive properties in this way.[12] In doing so, the entailment problem will simply be moved to a more complex pair of conjunctive properties. Ultimately, one will be faced with the claim that *A1*-and-*F* s-realizes *A1*-and-*B4*-and-*F*, where '*F*' is itself a conjunctive property whose conjuncts include *W* and *S*. Regardless of how many conjuncts *F* has, having *A1*-and-*F* will not entail having *A1*-and-*B4*-and-*F*.

5.

Given that the subset account faces the entailment problem, it might seem that there are a few straightforward responses. I conclude this paper by briefly raising and rejecting three such responses.

5.1 Restrict the Subset Account

One response is simply to add the restriction that where *Y* s-realizes *X*, *Y* must not be a conjunct of *X*. However, if the only reason for adding this restriction is to evade the entailment problem, this response is ad hoc. Matters would be different if one could give some independent reason for excluding *Y* from being an s-realizer of *X* if *Y* is a conjunct of *X*. But, in the absence of such a reason, this response is uncompelling. If there are cases where *X* and *Y* are instantiated by the same object and the forward-looking causal features of *X* are a proper subset of those of *Y*, but *Y* does not entail *X*, then surely this demonstrates that s-realization does not capture an entailment relation. Simply banning the relevant cases does nothing to alleviate this worry.

5.2 Reject Conjunctive Properties

Another response is to reject conjunctive properties. With Shoemaker, I have assumed that there are conjunctive properties; given that *X* and *Y* are distinct properties, then if an object has *X* and *Y*, it also has the conjunctive property *X*-and-*Y*. Contrary to this, one might claim

[12] The combination of properties each conjunctive property picks out must, of course, be a combination that it is possible for the circuit to have. However, for this to be a serious objection to my argument, some specific example must be provided to demonstrate that an impossible combination of properties would need to be invoked.

that an object that has *X* and *Y* does not have a third property *X*-and-*Y*. The predicate '*X* and *Y*' is not, to use Armstrong's term, a 'property-predicate' [1997: 27]. If there are no conjunctive properties, the claim that some conjunctive properties are s-realized by one of their conjuncts can be dismissed.

However, the rejection of conjunctive properties is contentious, even among those who advocate a sparse account of properties. Thus Armstrong [1980], one of the central proponents of a sparse account of properties, rejects disjunctive, negative and determinable properties, but defends the existence of conjunctive properties. His reason for this is to accommodate the possibility that properties are infinitely resoluble [1980: 32]. I do not wish to enter into a discussion about whether Armstrong is correct on this issue—my point is simply that if accepting the subset account requires one to abandon conjunctive properties, many philosophers, including those who adopt a sparse account of properties, will view this as too high a price to pay.

5.3 Appeal to the Cluster Theory of Properties

Finally, one might argue that the entailment problem does not demonstrate the falsity of the subset account, but does demonstrate that the subset account needs to be combined with the cluster theory of properties—the theory that properties are identical with clusters of conditional powers.[13]

If the cluster theory is accepted, the subset account satisfies the entailment requirement. If a property is identical with the cluster of conditional powers that it bestows, this entails that:

> *Sufficiency*: Having the set of conditional powers associated with a property is sufficient for having that property.

If *Sufficiency* is true, the subset account must satisfy the entailment requirement. This is because if *Y* s-realizes *X*, then, if an object has *Y*, it will have, not only the set of conditional powers associated with *Y*, but also the set of conditional powers associated with *X*. Given *Sufficiency*, the object therefore has *X*. Hence, given *Sufficiency*, if *Y* s-realizes *X*, having *Y* entails having *X*.

[13] Shoemaker used to maintain this theory. (See, for example, Shoemaker [2003a]). However, he considers the subset account to be entirely independent from it [2001: 80].

However, just as this paper raises a problem for the subset account, it also raises a problem for *Sufficiency*. As discussed, given the standard, common-sense, understanding of property compositionality, to have a conjunctive property an object must have each of the conjunctive property's conjuncts. If the argument presented in this paper is correct, to accept *Sufficiency* it appears that one must abandon this common-sense claim. In *Four-light circuit*, the conclusion was that the conditional powers that *A1*-and-*B4*-and-*F* bestows are a proper subset of those that *A1*-and-*F* bestows (where '*F*' is itself a conjunctive property). Thus, if the circuit has *A1*-and-*F* it will have, not only the set of conditional powers associated with *A1*-and-*F*, but also the set of conditional powers associated with *A1*-and-*B4*-and-*F*. Given *Sufficiency*, having *A1*-and-*F* is therefore sufficient for having *A1*-and-*B4*-and-*F*. Hence, given *Sufficiency*, for the circuit to have *A1*-and-*B4*-and-*F* it need not have *B4*. The fact that *Sufficiency* is a consequence of the cluster theory does nothing to mitigate this problem. Rather, insofar as *Sufficiency* is problematic, so is the cluster theory. Proponents of the subset account therefore need to look elsewhere to find a convincing solution to the entailment problem.[14]

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