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Relational properties: Definition, reduction, and states of affairs

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Abstract

This paper defines relational properties and argues for their reducibility in a, broadly speaking, Armstrongian framework of state of affairs ontology and truthmaking. While Armstrong's own characterisation and reduction of them arguably is the best one available in the literature of this framework, it suffers from two main problems. As will be shown, it neither defines relational properties very clearly (if at all), nor provides an adequate conception of their reduction. This paper attempts to remedy this situation in four steps. First, it introduces relational properties and why they matter in metaphysics in general. Second, by briefly comparing and contrasting them with extrinsic properties, and by briefly mapping them onto a tripartite division of relations, the particular kinds of relevant relational properties are identified. Third, it classifies relational properties and thereby makes possible an apt definition of them. Finally, using the notion of truthmaking, it outlines a more satisfactory case for their reduction.

KEYWORDS
Armstrong, reduction, relational properties, states of affairs, truthmaking

1 | INTRODUCTION

Relational properties are the monadic counterparts of relations, that is, the properties of one of their relata that 'correspond' to the relations.[1] They are ubiquitous in both ordinary and scientific thought and language. Examples include *being next to the fireplace*, corresponding to *being next to* holding between Fido and the fireplace, and possessed by Fido; *loving John*, corresponding to *loving* holding between Sam and John, and possessed by Sam; and *revolving around a star*, corresponding to *revolving around* holding between Earth and the Sun, and possessed by Earth. In contemporary metaphysics, it is usually held that relational properties are reducible in one way or another. In this paper, I shall pay particular attention to how this reducibility is conceived in David Armstrong's work in his middle period (the late 1970s to late 1990s). They may be said to be reducible to properties and relations, as in his *A Theory of Universals* (1978), or to states of affairs (instantiations of properties or relations), as in his *A World of States of Affairs* (1997). It may further be held that relational properties, as opposed to relations, do not really pose any metaphysical challenge at all, a view that is oftentimes put forward as obviously true. Consider, for example, John Heil's rhetorical question about them in his 2021 book on relations:

> Ascriptions of relational properties might best be understood as a way of singling out relations in which the focus, for whatever reason, is on one of the parties to the relation, one of the relata. Is there anything more to the ball's having the relational property of being next to the shoe, other than its being next to the shoe? (2021, section 2.2)

Against this, I maintain that relational properties are a serious ontological matter. Specifically, they potentially present an issue for our ontological economy: since they appear to be neither (non-relational) properties nor relations, but rather something in between, it might seem that a full ontology of attributes requires *three* categories (kinds, types) of attributes, rather than just two. This is because I subscribe to 'Lewis's Razor', the principle of ontological economy that of two theories that explain the *explananda* equally well we should choose the one with the smallest number of *types* (categories, types) of entities, as opposed to *tokens* of entities (Lewis, 1973, p. 87). For the purposes of this paper, I assume that Lewis's Razor is true. Given this, other things being equal, of two competing ontologies where the first one is committed to three categories – namely, relations, non-relational properties, and relational properties – and the second one to only two categories – relations and non-relational properties – we should choose the latter.

Some philosophers, however, assume with little or no argument that relational properties are reducible and that they therefore do not present us with an important ontological issue (e.g., Mumford, 2007, p. 34). Relatedly, they might, like Heil, appeal loosely to an intuition that there is 'not more' to them – or something along those lines. Of course, we can assume all we like, but a good argument is needed; and such an argument is, I submit, to provide a tenable reduction of relational properties. In a way, then, the important metaphysical question is not whether or not they are reducible, but *how* they are reducible.[2]

To my mind, there is a scarcity of literature dealing with this question – there certainly is little of relevance to the Armstrongian tradition of metaphysics. In this tradition, the best attempt at characterising and reducing them is arguably the one mentioned above, found in Armstrong's own 1978 and 1997 books. Unfortunately, this attempt suffers

[1]For simplicity of exposition, I shall restrict my examination here to relational properties corresponding to dyadic relations, assuming that what I say holds, *mutatis mutandis*, for all other adicities.

[2]Due in large part to the influence of Aristotle, the mentioned denigration of relational properties is antithetical to the historically dominant position in Western philosophy. Famously, in the *Metaphysics* Aristotle said that relations are 'least of all things a kind of entity of substance' (1088a 22). Unsurprisingly, what were called 'relations' in the Middle Ages were actually relational properties (Henninger, 1989, p. 4). However, Russell (1903) inverted this picture and convinced many philosophers that relations are irreducible and, if anything, it is relational properties that are reducible or ontologically unimportant or both (see Findlay, 1936).

from two major weaknesses. First, as we shall see, it does not define relational properties precisely, if at all. Second, it employs a notion of reduction, or reducibility (I use these terms interchangeably), namely, Armstrong's 'supervenience', which, as other authors have pointed out, is deeply problematic (see, e.g., Keinänen, 2008; Lowe, 2011; Orilia, 2016). In what follows, I shall try to remedy this situation, in three steps. First, I compare and contrast them with extrinsic properties, and I single out the particular kind of relational property to be investigated by associating it with external relations. Next, I classify relational properties, thereby enabling an apt definition of them. Third, I outline an alternative to Armstrong's 'supervenience' case for their reduction, namely, by showing that no relational property is a constituent of the truthmaker of the proposition that 'expresses' it.

2 | IDENTIFYING THE PROPER SUBJECT MATTER

Only some of the entities that go by the name 'relational properties' are relevant to this paper. In this section, I shall identify them. First, relational properties in general need to be differentiated from extrinsic properties. The terms 'relational property' and 'extrinsic property' are often used interchangeably, but this is ill-advised, for two reasons. On the one hand, some relational properties are intrinsic. On the other hand, the metaphysics of relational properties in our sense is to be distinguished from the literature on intrinsic and extrinsic properties. Second, the relations that relational properties correspond to – i.e., the relations of which they are the monadic counterparts – divide into two groups: those that are reducible and those that are irreducible. Only the latter is relevant to our purposes.

Consider the first aspect of distinguishing relational and extrinsic properties. Relational properties are similar to extrinsic properties, or 'non-intrinsic properties', that is, properties of a thing that are 'not entirely about that thing', such as 'being a brother, being in debt, being within three miles of Carfax, thinking of Vienna' (Lewis, 1983, p. 197). Extrinsic properties have received extensive attention among contemporary philosophers. Coordinated with this, focus has been devoted to the notion of 'intrinsic' – and 'extrinsic' then simply defined as 'non-intrinsic'. Intrinsicality in turn has been characterised in a number of ways. For instance, Lewis (ibid.) does it in terms of 'duplication', where intrinsic properties are those that cannot differ between duplicates; and Francescotti (2014) defines intrinsic properties as those that do not depend on the 'environment' of their bearer. In line with Lewis (1983), in a great deal of the work in this tradition, little or no attention is paid to difference in meaning between the terms 'extrinsic property' and 'relational property'. This is the case both in the literature specifically on the distinction between intrinsic and extrinsic properties (e.g., Francescotti, 2014), and in areas of metaphysics relatively unrelated to this research (e.g., De Muijnck, 2002). In other parts of the literature, authors are careful not to identify extrinsic and relational properties (or intrinsic and non-relational properties), whilst still considering them intimately related (e.g., Francescotti, 1999; Hoffmann-Kolss, 2010; Weatherson & Marshall, 2018).

At any rate, I think it is vital to distinguish relational properties from extrinsic properties, for two reasons. First, strictly speaking, relational properties in Lewis's sense are 'extrinsic relational properties', as opposed to 'intrinsic relational properties', to use Timothy Sprigge's terminology (1970, p. 74). Extrinsic relational properties, which are what we usually have in mind when talking about relational properties, correspond to a relation holding between distinct entities, such as me and my brother or Carfax and Vienna. In contrast, intrinsic relational properties seem to correspond, in some form or other, to the relation of *being a part of* (see ibid.), such as *having a hydrogen atom as a part*, possessed by an H_2O molecule, and *having London as a part*, possessed by Great Britain. Note that, in any case, as we shall see shortly, intrinsic relational properties are not relevant to the purposes of this paper.

Second, the large and often technical literature on extrinsic vs. intrinsic properties is frequently occupied with the task of defining these terms in a way that sidesteps considerations of how extrinsic properties are related to the ontological categories of properties and relations. This strategy contrasts with an Armstrongian approach to relational properties, with its close attention to these questions. (Likewise, it contrasts with the Aristotelian tradition in metaphysics, which construes a relational property as a (sub)category of properties that is somehow also similar to the category of relations and can serve as *ersatz* relations, see note 2 above).

Next, consider the second aspect of identifying our proper subject matter: singling out the relational properties that correspond to *ir*reducible relations. This is a plausible requirement, as the reduction of relational properties only seems interesting if the relations to which they correspond are not *themselves* reducible. In general, if a disputed entity E* is irreducible to entity E, but E is itself reducible, then E*'s irreducibility seems spurious, since E* would seem to inherit the reducibility of E. Conversely, if E* is reducible to E and E itself is also reducible, then E* would seem to be reducible twice over, as it were.

So, when is a relation irreducible? Roughly, this depends on which category it belongs to in a tripartite division of relations into 'strongly' internal and 'weakly' internal relations on the one hand, and external relations on the other. I note that while the division between internal and external relations is commonplace; the distinction between strongly and weakly internal relations is often overlooked or ignored. It is important, however (see Johansson, 2004, chapter 8; Meinertsen, 2011), not only in general, but also for our specific purposes here. Roughly, these relations can be distinguished as follows. Strongly internal relations are those that are necessitated by their relata per se or, equivalently, they are necessitated by essential properties of their relata. Thus, it is not possible that a strongly internal relation does not hold between its relata. For example, *being darker than* holding between the colours navy and cobalt is a strongly internal relation. Weakly internal relations are those that are necessitated by accidental properties of their relata. It *is* possible that a weakly internal relation does not hold between its relata. For instance, *being taller than* holding between John and Sam if they are 185 cm and 176 cm tall is a weakly internal relation. The heights of John and Sam are accidental properties of them; alternatively put, it is contingent that they have the heights they actually have. Hence, it is possible that John is not taller than Sam, and therefore possible that *being taller than* not hold between them.

Thus, given the plausible link between necessitation and reducibility, strongly and weakly internal relations are reducible to their relata. By contrast, external relations (e.g., *being next to* holding between John and Sam if they are standing next to each other) are *not* reducible to their relata. On the contrary, they are completely independent of them in the sense that it is logically possible for their relata to co-exist without the relation holding between them (Johansson, 2004, chapter 8).[3]

This principle of when relational properties are ontologically important (for our purposes) allows us to rule out several kinds of them for consideration here. As mentioned, intrinsic relational properties correspond to the relation of *being a part of*, which obviously is not an external relation. Therefore, they can be set aside in this paper. Similarly, we do not need to look closer at relational properties corresponding to strongly internal relations, such as *being a smaller number than 12* and *being (non-)identical to Socrates*; nor at those corresponding to weakly internal relations, such as *being taller than Sam*. In contrast, again, relational properties corresponding to external relations, including our examples of *loving John* and *revolving around a star*, are pertinent to our purposes. The term '*external* relational properties' springs to mind for these entities – but I think this qualification can be taken as read in what follows. Note that it is because of this result that our tripartite division of relations matters. Without it, it is easy to construe weakly internal relations as a kind of external relation.[4] Hence, it is also easy to wrongly consider relational properties corresponding to them as relevant to this paper.

3 | CLASSIFICATION AND DEFINITION OF RELATIONAL PROPERTIES

My classification of relational properties involves two levels of generality. The most general stage is between *pure* and *impure* relational properties. Roughly, the former are 'purified' of a specific relatum (e.g., *revolving around a*

[3]External relations are often said to include spatial, temporal, and causal relations. Personally, I think the case for spatial relations being external is quite strong (Paoletti, 2021), but I am undecided about temporal and causal relations. Several classic examples of external relations other than spatial ones, such as *loving*, are probably so dependent on causal facts that they are irreducible only if causal relations are external. Space does not permit discussion of these controversial issues here.

[4]Indeed, Simons (2016), whose purposes seem to require that he focus on what weakly internal relations have in common with external relations, calls the former 'weakly *external* relations'.

star); whereas the latter are not (e.g., *revolving around the Sun*). This distinction is found in Armstrong (1978), i.e., early on in Armstrong's middle period. The characteristic of the former is 'having R to something with property F', whereas (predicates for) the latter 'make essential reference to a particular' (ibid., p. 78). By the phrase 'something with property F', Armstrong has in mind *types* of particular, whereas he means *token* particulars with the expression 'essential reference to a particular'. That is, a pure relational property 'includes' a type of relatum; an impure one 'includes' a token of this type of relatum (e.g., *being a parent of a toddler* in contrast to *being a parent of Kim*). Thus in general: if *a* has R to *b*, and *b* is a G, then *a* has the pure relational property of *having R to a G*; and if *a* has R to *b*, then *a* has the impure relational property of *having R to b*.

The distinction between pure and impure relational properties is also present in authors not working in the Armstrongian tradition; for example, in Khamara (1988) and Francescotti (1999). I do not think their work has any bearing on the present classification, though. By contrast, a more recent distinction made my philosophers likewise not working in this tradition, namely, Ladyman et al. (2012), might seem to be pertinent.[5] The authors distinguish between 'object-involving' and 'identity-involving' properties. An object-involving property is one whose proper analysis makes reference to particular objects; an identity-involving property is one whose proper analysis involves the identity relation. They consider the features of being identity-involving vs. not identity-involving to cut across the distinction between object-involving and identity-involving properties. Thus, they view *being Mercury* to be both object-involving and identity-involving, and they view *being on Mercury* to be object-involving but not identity-involving. Conversely, they consider *being the inner-most planet* to not be object-involving but identity-involving, whereas they construe *having an iron core* as neither identity- nor object-involving (ibid., p. 169).

How does this distinction between object-involving and identity-involving influence my differentiation between pure and impure relational properties if at all? At first sight, it might seem to have relevant implications. For, first, a property that is neither identity- nor object-involving is obviously not a relational property, whether pure or impure. Second, an impure relational property seems to be object-involving, while a pure relational property does not. Both of these are clear similarities between the two distinctions.

However, a substantial difference from my classification arises with regard to the feature of being identity-involving. Of course, any relational property, whether pure or impure, is such that its proper analysis involves the identity-relation. But this seems insignificant. How could an analysis of a relational property not involve the identity relation? For example, how could an analysis of *loving John*, a relational property of Sam, not involve this relation? Trivially, it would involve the fact that Sam loves x and $x = \text{John}$ and/or the fact that $\text{John} = \text{John}$.

By contrast, properties that are identity-involving (but not object-involving), e.g., *being Mercury*, to use Ladyman et al.'s example, fall outside my account: to my mind, they are simply not relational properties. Rather, they are haecceities, which I think are not relational properties, contra Rosenkrantz (1993). Hence, in my view, only the feature of being object-involving, as opposed to being identity-involving, applies non-trivially to my division of relational properties. It seems to me, therefore, that Ladyman et al.'s distinction between object-involving and identity-involving properties as a whole does not apply to my account at all. If so, contrary to what perhaps initially appeared to be the case, it is not relevant to our purposes.

Let us, then, proceed to the second level of generality in the classification of relational properties. This stage concerns whether the involved relation has a *direction* ('order' or, in Russell's terminology, 'sense'). Intuitively, a relation has this feature only when it is non-symmetrical, as opposed to symmetrical, *pace* Russell (1903) and Grossmann (1983). Roughly, a relation R is symmetrical when it holds between *a* and *b* if and only if it also holds between *b* and *a*. An example is *being next to*, and it is the one I shall use in the classification below. By contrast, a non-symmetrical relation is a relation that is not symmetrical (MacBride, 2016). That is, roughly again, a relation R that holds between *a* and *b* is non-symmetrical just when it is not the case that *a* has R to *b* if and only if *b* has R to *a*. A classic example of such a relation is *loving*, which I shall also use in the classification. A special case of non-symmetrical relations are asymmetrical relations: a relation R is asymmetrical when it holds between *a* and *b*

[5] I thank an anonymous reviewer of this journal for bringing this source to my attention.

if and only if it does not hold between *b* and *a*. An example is *being taller than*. Given that they are a subgroup of non-symmetrical relations, our classification only needs to distinguish cases of relational properties corresponding to either symmetrical or non-symmetrical relations. Thus, with either symmetrical or non-symmetrical cases having both pure and impure relational properties corresponding to it – one for each relatum of a dyadic relation – we obtain a total of eight possible cases:

Pure relational properties for symmetrical relations R
(C1) If *a* has R to *b* and *b* is a G, then *having R to a G* is a relational property of *a*.
(C2) If *a* has R to *b* and *a* is an F, then *having R to an F* is a relational property of *b*.

For example, if R=*being next to*, *a*=John, *b*=Sam, G=*being a philosopher*, and F=*being a psychologist*, then *being next to a philosopher* is a pure relational property had by John and *being next to a psychologist* is a pure relational property possessed by Sam.

Pure relational properties for non-symmetrical relations R
(C3) If *a* has R to *b* and *b* is a G, then *having R to a G* is a relational property of *a*.
(C4) If *a* has R to *b* and *a* is an F, then *having Ř to an F* is a relational property of *b*, where Ř is the converse of R.[6]

For example, if R=*loving*, *a*=John, *b*=Sam, and G=*being a philosopher*, and F=*being a psychologist*, then *loving a philosopher* is a pure relational property, which John has, and *being loved by a psychologist* is a pure relational property, which Sam has.

Impure relational properties for symmetrical relations R
(C5) If *a* has R to *b*, then *having R to b* is a relational property of *a*.
(C6) If *a* has R to *b*, then *having R to a* is a relational property of *b*.

To use the same example as for pure relational properties, if R=*being next to*, *a*=John, and *b*=Sam, then *being next to Sam* is an impure relational property had of John and *being next to John* is an impure relational property possessed by Sam.

Impure relational properties for non-symmetrical relations R
(C7) If *a* has R to *b*, then *having R to b* is a relational property of *a*.
(C8) If *a* has R to *b*, then *having Ř to a* is a relational property of *b*, where Ř is the converse of R.

Correspondingly, if R=*loving*, *a*=John, and *b*=Sam, then *loving Sam* is a relational property of John; and *being loved by John* is an impure relational property of Sam.

This concludes our classification of relational properties. To my mind, this arrangement identifies the *differentiam* of a *genus et differentiam* definition of relational properties: it is simply the disjunction of the antecedents of the conditionals of C1–C8. Thus, we can define a relational property as this:

RELATIONAL PROPERTY
Property P is a relational property $=_{\text{df.}}$ P is a property such that, necessarily, it is instantiated if and only if the antecedent of C1, C2, …, or C8 is true.

Notice two virtues of this definition. First, it specifies for the *differentiam* C1–C8 what the sufficient condition for the existence of a relational property is. In each of C1 through C8, this sufficient condition is (the existence of) the

[6]A relation Ř is the converse of R if and only if *a*'s having R to *b* is equivalent to *b*'s having R to *a*.

state of affairs expressed by the antecedent of the conditional in case (the existence of the corresponding relational property is in turn expressed by the consequent). That is, the sufficient conditions are the following states of affairs: *a*'s having R to *b* and *b*'s being a G (C1, C3); *a*'s having R to *b* and *a*'s being an F (C2, C4); and *a*'s having R to *b* (C5–C8). Second, it is non-circular (the *definiendum* is not included in the *definiens*). Being conditionals, not biconditionals, C1–C8 only involve sufficient conditions for relational properties, not necessary *and* sufficient conditions. If they did – if, say, (C1) was

(C1′) *a* has R to *b* and *b* is a G if and only if *a* has *having R to a G*,

then the state(s) of affairs on the left-hand side of these biconditionals would somehow amount to the (having of a) relational property. In (C1′), in a sense, *a's having R to b* and *b's being a G* would therefore be equivalent to *a's having the relational property of having R to a G*; and similarly in the other cases. If so, it would be unclear how invoking the left-hand sides in the *definiens* of RELATIONAL PROPERTY would not also (equivalently) invoke relational properties, the *definiendum*, thus making the definition circular.

Given these two qualities of RELATIONAL PROPERTY, I think it is of some general theoretical interest in itself. Also, it seems to be a significant improvement of Armstrong's definition of relational properties. In fact, in his 1997 book, he seems to eschew trying to define them altogether, preferring instead to only characterise them indirectly with specific cases (e.g., *being a father*) or general formal expressions (e.g., *having R to a G*).[7] To my knowledge, RELATIONAL PROPERTY is the first attempt at properly defining relational properties in the context of Armstrongian state of affairs ontology. At any rate, whatever value it may have in itself, or in such a framework, it will earn its keep in the following section. For, as I shall try to show there, if coupled with a clear conception of reduction, it is helpful in a strategy of demonstrating *why* relational properties are reducible (assuming that they are). Let us now, therefore, turn to the topic of their reduction.

4 | THE REDUCTION OF RELATIONAL PROPERTIES

4.1 | Armstrong's reduction of relational properties

The metaphysics of the later part of Armstrong's middle period, which forms the framework for his best reduction of relational properties, is a state of affairs ontology (for a detailed defence of an Armstrongian state of affairs ontology, see Meinertsen, 2018). In this ontology, states of affairs are instantiations of properties or relations by particulars. The properties or relations are universals (just when the states of affairs are 'first-class', as we shall see). The states of affairs are contingent complexes with the particulars and universals as constituents.[8] Some of these universals are monadic (non-relational), others are polyadic (relations). For example, the state of affairs of *this tomato's being red* has a tomato and the monadic universal *being red* as constituents; and the state of affairs of *John's loving Sam* has John, Sam, and the relational universal *loving* as constituents. Armstrong uses this metaphysics to provide a reduction of relational properties. He is very clear about their resultant ontological status: as I indicated earlier, he maintains that relational properties are 'supervenient' on states of affairs. This reduction differs from the early phase of his middle period, such as in his *A Theory of Universals*, where the notion of states of affairs did not play any important role. At that point, he tried to reduce them to relations and non-relational properties without invoking the notion of states of affairs. Such an approach is, of course, appealing to metaphysicians who are sceptical about states of affairs. He only provided a rough hint about how this reduction might look (1978,

[7]He was more ambitious in 1978, and did put forward a definition of sorts at that point, see Armstrong (1978, p. 79). However, as we shall see below (section 4.1), his work from this period is not especially significant to this paper.
[8]Armstrong also has a conception of necessary 'states of affairs', but we can ignore it (see below).

p. 78), however, and I think his suggestion is quite obscure. Actually, I doubt if it is even possible to reduce relational properties on an ontology of non-relational properties and relations without states of affairs.[9] Hence, I shall only describe his later reduction of relational properties to states of affairs (1997, pp. 91–93). As a preliminary, this requires a sketch of his notion of supervenience and his separation of supervenient and non-supervenient properties.

Armstrong's general concept of reducibility is closely linked to his notion of supervenience. What does he mean by ‘supervenience’? He holds that ‘entity Q supervenes upon entity P if and only if it is impossible that P should exist and Q not exist, where P is possible’ (ibid., p. 11), and that:

> Qs supervene on Ps if and only if there are P-worlds and every possible P-world is a Q-world. Alternatively put, worlds that are not Q-worlds are not P-worlds. No difference in what supervenes without some difference in the base that it supervenes upon, with absolute necessity. (ibid., p. 45)

By ‘absolute necessity’ in this passage, Armstrong probably has in mind some fairly strong notion of metaphysical necessity. But we need not dwell on this point. Suffice it to say that, in accordance with these statements, he thinks of supervenient entities as being *necessitated* by their subvenient bases. Armstrong is fond of using this expression when describing the relationship between the subvenient and the supervenient (e.g., ibid., pp. 12, 45, 92).

It should be pointed out here that Armstrong applies his notion of supervenience to properties per se, since this brings to light other types of properties with which he groups (most) relational properties (when construing the latter as supervenient). He divides properties into ‘first-class’, ‘second-class’, and ‘third-class properties’ (ibid., pp. 43–46). Roughly, all and only first-class properties are sparse, while second- and third-class properties are abundant. Second-class properties (e.g., *being green*) are contingent, whereas their third-class cousins (e.g., *being self-identical*) are necessary. (Unsurprisingly, given Armstrong's general empiricist and a posteriori orientation, he pays little or no attention to third-class properties.) As a universal realist, Armstrong identifies all and only first-class properties with universals, and as a scientific realist, he in turn identifies these with the properties postulated by natural science, especially fundamental physics. Second- and third-class properties, which are thus not universals, are supervenient on first-class properties.

Corresponding to this division of properties, Armstrong distinguishes between first-class and second-class states of affairs (and third-class states of affairs, which are necessary and which, as indicated, can be ignored). He introduces them as follows:

> The first-class properties of particulars are the universals they instantiate. The second-class properties of particulars have the following necessary and sufficient condition. They are not universals, but when truly predicated of a particular, the resultant truth is a contingent one [unlike a predication of a third-class property]. The rationale behind this is [mainly] that second-class properties are to be thought of as constituents of (second-class) states of affairs, and states of affairs are all contingent. (ibid., p. 44)

How are first-class properties (and states of affairs) and second-class properties (and states of affairs) connected? In order to answer this, Armstrong proposes a ‘bridge between the universals, which are the first-class properties and relations, and the second-class properties and relations’ (ibid., p. 44). This bridge is a thesis of supervenience:

> Take the totality of all first-class states of affairs. Any world that has *just* these states of affairs, with their constituent properties that are all universals, will exactly agree in all second-class

[9]For the contrary – albeit unargued – position that Armstrong's first reduction attempt would suffice, see Mumford (2007, p. 34).

> states of affairs with their second-class properties….The supervenience thesis is this. Given all the first-class states of affairs, all the second-class states of affairs supervene, are entailed, are necessitated. This will involve the supervenience of all second-class properties that can be truly predicated. (ibid., p. 45)

As mentioned at the outset of this paper, however, as other authors have pointed out, Armstrong's notion of supervenience is associated with serious difficulties. As an example of these, consider the fact that he combines his thesis of supervenience with a dubious claim about the ontological status of supervenient entities. He maintains that supervenient entities are 'nothing over and above' their subvenient bases or 'no addition of being' to them – what he calls 'an ontological free lunch' (ibid., pp. 12–13, *et passim*), though he still thinks they are not unreal. To my mind, this claim seems rather implausible, for how can something be both 'nothing over and above' and not unreal? Similarly, Lowe (2011) comments: 'I wish to voice some concern about [Armstrong's] notion of the "ontological free lunch". A free lunch is a *lunch*, and so something rather than nothing. But "no addition of being" sounds very much like nothing to me.'[10]

In any event, Armstrong applies his concept of supervenience to relational properties. Using the classification of Section 3, recall that if *a* has R to *b*, and *b* is a G, then *a* has the pure relational property of *having R to a G* (C1, C3). Accordingly, as Armstrong in effect claims, this relational property is supervenient on (the co-existence of) the states of affairs *a's having R to b* and *b's being a G*. As an example of a pure relational property supervenient on states of affairs in this manner, consider that *revolving around a star* is supervenient on (the co-existence of) (1) the state of affairs of *Earth's revolving around the Sun* and (2) the state of affairs of *the Sun's being a star*. In short, pure relational properties are supervenient on *two* states of affairs. Recall next that if *a* has R to *b*, then *a* has the impure relational property of *having R to b* (C5, C7). Consequently, this relational property is supervenient on *a's having R to b*. For example, *revolving around the Sun* is supervenient on *Earth's revolving around the Sun*. In a word, impure relational properties are supervenient on only *one* state of affairs.

This, in effect, is Armstrong's reduction of relational properties to states of affairs, made more precise (or less unclear) than how he formulates it himself. While Armstrong advocates his reduction for all relational properties, he nonetheless suggests that certain pure relational properties may be universals. In 1997, he makes this surprising assertion alongside his brief description of what – again, in effect – is his analysis of pure and impure relational properties and their supervenience that I just presented:

> [R]elational properties supervene upon states of affairs…If *a* has R to *b*, and *b* is a G, then *a* has the relational property of *having R to a G*, with this property supervening upon these two states of affairs. If R and G are both universals, then this relational property would appear to be a *universal* itself.
>
> (1997, p. 92, my emphasis)

As we saw, however, Armstrong holds that (i) all and only universals are first-class properties, and that (ii) no first-class property is reducible (supervenient). Obviously, it is incoherent to hold both that all relational properties are reducible and yet that some of them are not reducible, even if the latter option, as in the quoted passage, is asserted with Armstrong's characteristic tentativeness ('would appear').[11] Of course, a more charitable interpretation of his suggestion would be that he allows that some relational properties are exceptions to the general rule that relational properties are reducible, or something along those lines. But he offers no account of how these exceptions could be universals and hence irreducible, despite being relational

[10]For a recent overview of this and other criticisms of the thesis of the ontological free lunch, and an attempt to interpret it coherently, see Orilia (2016).

[11]It may be noted that this was not a kind of slip of Armstrong's 1997 book. In 1978, we find what is basically the same view (Armstrong, 1978, p. 78).

properties. And, intuitively, such an account would smack of ad hocery. Perhaps, this quandary is another symptom of the problematic nature of Armstrong's notion of supervenience. At any rate, in the following section, I shall develop the reductionist strategy by using the notion of truthmaking.

4.2 | The truthmaking reduction of relational properties

Let us outline the theory of *reduction to truthmakers* (truthmaking reducibility), or TM-reducibility for short (following Meinertsen, 2018, pp. 24–36). Roughly speaking, an entity is TM-reducible when it is reducible to the truthmaker of the truthbearer expressing it. This means that it is not a constituent of the truthmaker. Therefore, as one might put it, the TM-reducible entity does not exist at the level of truthmakers.

Consider first the notion of truthmaking. It refers to a relationship between truthbearers (sentences, statements, propositions) and the world. Truthmakers 'make true' sentences, statements or propositions when true. Clearly, then, the notion of truthmaker presupposes the notion of truth. Plausibly, however, this notion is too fundamental to be defined, and hence the concept of truthmaking cannot be defined. Still, it may be feasible to 'correlate' truthmaking with other concepts. For instance, it may be claimed that truthbearers, when true, are true 'in virtue of' their truthmakers (Rodriguez-Pereyra, 2002, pp. 34–35). Personally, I am rather sceptical about the usefulness of the 'in virtue of' locution. I prefer to characterise truthmaking indirectly via an entailment relation between truthbearers. I take the latter to be propositions, but that is merely a pragmatic choice. I use propositions only in a heuristic fashion (in the manner of Simons, 2000). I do not wish to commit myself to any particular ontology of propositions, such as the view that they are *abstracta*. Note that such a description precisely is only indirect, since truthmaking is primarily a relation between worldly truthmakers and propositions, not between propositions. It is merely a characterisation of truthmaking by means of a relation between propositions (entailment). Since <E exists> corresponds trivially to any existent E, this is not a problem. Thus, truthmakers must satisfy the following schema of entailment between propositions (Fox, 1987, p. 189):

(T) Entity E is a truthmaker of <p> iff <E exists> entails <p>.

Someone might object that entailment is unsuited to account for truthmaking, even when it is only used indirectly in this way. One reason for this objection may be that (T) implies that any entity is a truthmaker for any necessary truth. However, if we restrict the use of (T) to contingent truths, this difficulty is avoided. A further reason may be that the notion of entailment arguably presupposes the notion of truth, making (T) viciously circular. But, to repeat, (T) does not purport to be a proper definition. In any event, thanks to the satisfaction of schema (T) by truthmakers, we can adopt the convenient locution that truthmakers 'necessitate' the propositions they make true.

As Armstrong argues (1989, 1997), *states of affairs* are a good candidate for the truthmaking entity or entities. The particulars and universals that a truthbearer is about cannot by themselves make it true, but the state of affairs that is the instantiation of the universal by the particular(s) can. For example, the proposition <John is next to Sam> is made true by the state of affairs of *John's being next to Sam*. While this proposition is about John, Sam, and the relation of *being next to*, it is not entailed by the proposition <John, Sam and *being next to* co-exist>, that is, the co-existence of John, Sam, and *being next to* does not necessitate the truth of the proposition that John is next to Sam. Suppose John is next to Kim instead of Sam, whilst Sam is elsewhere. In this case, John, Sam, and the relation of *being next to* still co-exist, but the proposition <John is next to Sam> is false. By contrast, necessarily, if the state of affairs of *John's being next to Sam* exists, the proposition <John is next to Sam> is true. And similarly in other cases. (This holds in general; there are exceptions. Contingent existentials, for example, are made true by the entity said to exist: <Sam exists> is made true by Sam).

Having sketched truthmaking in this manner, it is possible to define TM-reducibility suitable for a reduction of relational properties to states of affairs. Since, as mentioned, I consider propositions to be truthbearers, let us say that a putative entity E*, such as a relational property, is 'expressed' by the relevant proposition <p>. (For ease of exposition, I shall usually talk of the entity E in the singular, but the argument applies to the plural too.) Here 'express' or its grammatical variants is a global term for whatever is involved in the truth-conditions of the corresponding declarative sentence or statement. Of course, it is a non-literal usage of the notion of expression, since propositions do not literally express anything; they *are* what is expressed (by the sentences of statements that literally express them). Fortunately, 'expression' of propositions is linked to the literal notion of expression in a straightforward way. For, in general, a proposition 'expresses' an entity E if and only if the sentence or statement that expresses the proposition *also* expresses E. For example, the sentence or statement 'John loves Sam', which expresses the proposition that John loves Sam, or <John loves Sam>, *also* expresses John, Sam, *loving*, *loving Sam*, etc. Since the usage is non-literal, however, I shall continue to use the term only in inverted commas.

Next, let us say that <p> 'expresses' an entity E* if and only if (i) <p> entails the existence of E * and (ii) E* may or may not be included in what makes <p> true. What does it mean for E* to be, or not to be, included in what makes <p> true? For E* to be included in what makes <p> true, i.e., in the truthmaker of p, is for E* to be a *constituent* of this truthmaker. For instance, consider the case of a pure relational property for a symmetrical relation (C1, C2). Using again our example where R = *being next to*, *a* = John, *b* = Sam, G = *being a philosopher*, and F = *being a psychologist*, the following is the case. *Being next to a philosopher* is a pure relational property had by John (C1) and *being next to a psychologist* is a pure relational property possessed by Sam (C2). In C1, <p> is the proposition that John is next to Sam and Sam is a philosopher, and E* is the pure relational property of *being next to a philosopher*. Here, then, E* is included in the truthmaker of <p> if and only if *being next to a philosopher* is a constituent of this truthmaker.

Suppose that this truthmaker of <p> were the state of affairs of *John's having the relational property of being next to a philosopher*. The relational property would then be a constituent of this state of affairs. That is, it would exist at the level of truthmakers. It would not be TM-reducible. Now, of course, on the view that relational properties are TM-reducible, this is precisely not the case. On this view, the truthmaker for <p>, i.e., <John is next to Sam and Sam is a philosopher>, does *not* include the relational property of *being next to a philosopher*. To put it formally, the truthmaker of the proposition <*a* has R to *b* and *b* is G> that 'expresses' that *a* has the relational property of *having R to a G*, does *not* include *having R to a G*. Similarly for C2–C8. Hence, no relational property is included in a truthmaker. (Again, allowing for exceptional cases, such as existentials).

What *do* the truthmakers in case include, then? They include (non-relational) properties and relations, as well as particulars. For instantiations of the former by the particulars *are* the states of affairs that *are* the truthmakers for propositions that 'express' relational properties. As we shall see presently, in the cases of a pure relational property, the truthmaker is two states of affairs. (Or, alternatively, the conjunctive state of affairs that is the conjunction of these two states of affairs – the difference between these two options can be ignored here).

As a general view, TM-reducibility can be defined as follows:

TM-REDUCIBILITY

Entity E* 'expressed' by <p> is TM-reducible to entity E $=_{\text{df.}}$ E make(s) <p> true.

As mentioned, I agree with Armstrong that truthmakers are states of affairs (in most cases). Thus, in general, E in TM-REDUCIBILITY are states of affairs. Given this, it follows that *relational properties are TM-reducible to states of affairs*. For instance, consider again <*a* has R to *b* and *b* is a G> – the proposition of (C1) in our classification that 'expresses' the pure relational property *having R to a G*. It is made true by (the co-existence of) the two states of affairs *a's having R to b* and *b's being a G*. Hence, *having R to a G* 'expressed' by the proposition <*a* has R to a G> is TM-reducible to two states of affairs, just as it is 'supervenient' on them, as we saw in Section 4.1. Similarly in the other cases for pure relational properties, (C2–C4).

To use our concrete example for (C1) again, consider the proposition <John is next to Sam and Sam is a philosopher> that ‘expresses’ the pure relational property of *being next to a philosopher*. This proposition is made true by the two states of affairs of *John's being next to Sam* and *Sam's being a philosopher*. Hence, *being next to a philosopher* is TM-reducible to these two states of affairs.

Analogously, <*a* has R to *b*> – the proposition of (C5) that ‘expresses’ the impure relational property *having R to b* – is made true by *a*'s having R to *b*. Therefore, *having R to b* is TM-reducible to one state of affairs; and similarly in the other cases of impure relational properties, (C5–C8). This also is analogous to what we saw in Section 4.1, for the ‘supervenience’ of impure relational properties. With the previous concrete example for (C5), consider again the proposition <John is next to Sam> that ‘expresses’ the impure relational property of *being next to Sam*. This proposition is made true by the state of affairs of *John's being next to Sam*.

Finally, notice a big difference from Armstrong's surprising claim quoted above that a certain relational property ‘would appear to be a universal’ (irreducible) despite relational properties generally being supervenient (reducible). Recall from Section 4.1 that, by Armstrong's definition of supervenience, if Q is supervenient on P, then it is impossible that P exist and Q not exist (where P is possible). He suggested that in a case of *a's having R to a G*, with R and G both universals, *having R to a G* ‘would appear to be a universal’. For this to be true, then, it must be possible that *a* has R to a G (i.e., that the state of affairs of *a's having R to a G* exists), but that *a* does not have the relational property of *having R to a G*. How can this be possible? And why does it matter that R and G are universals? These questions seem to be shrouded in mystery, perhaps due to the problematic nature of Amstrong's concept of supervenience. On the TM-reducibility view, by contrast, first, it is clearly *not* possible for *a's having R to a G* to exist and *having R to a G* to not also exist: by definition, *having R to a G* is ‘expressed’ by the antecedent of (C1). And, second, by TM-REDUCIBILITY, *having R to a G* is TM-reducible to the truthmaker of this antecedent. The lines seem to be very clear. And it does not enter the picture at all whether or not R and G are universals.

5 | CONCLUDING REMARKS

In this paper, I have defended the thesis that relational properties are reducible. After motivating this topic, I distinguished relational properties from extrinsic properties and identified the particular type of relational properties that is pertinent to reduction (the one corresponding to external relations). Next, I classified them according to (i) whether they are pure or impure, and (ii) the direction of their corresponding relations, thereby enabling a significantly more precise definition of them than what seems to have been previously available. Finally, using this definition, I demonstrated how they are truthmaking reducible to states of affairs, and through that, I hope, in turn answered with clarity the question of how they are reducible. This is notably different from Armstrong's unclear and hard-to-follow ‘supervenience reduction’, even though it shares his splendid idea that relational properties are reducible to states of affairs. And, of course, it broadly fits in with the tradition from Russell that, contra Aristotle, relations cannot be replaced by relational properties, and with the contemporary idea that relational properties are reducible.

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