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STRUCTURE-MAKING

Kris McDaniel

Friends of states of affairs and structural universals appeal to a relation, structure-making, that is allegedly a kind of composition relation: structure-making 'builds' facts out of particulars and universals, and 'builds' structural universals out of unstructured universals. D. M. Armstrong, an eminent champion of structures, endorses two interesting theses concerning composition. First, that structure-making is a composition relation. Second, that it is not the only (fundamental) composition relation: Armstrong also believes in a mode of composition that he calls mereological, and which he takes to be the only kind of composition recognized by his philosophical adversaries, such as David Lewis. Armstrong, accordingly, is a kind of pluralist about compositional relations: there is more than one way to make wholes from parts. In this paper, I critically evaluate Armstrong's compositional pluralism.

1. Introduction

Structure-making is allegedly a kind of composition relation that 'builds' states of affairs out of particulars and universals and structural universals out of simpler universals.[1] Examples of states of affairs (sometimes also called 'facts') include *Fred's being hungry* and *Heathwood's being happy*. Examples of structural universals include *being an H_2O molecule* and *being a butane molecule*.

The concepts of composition and parthood are intimately linked: to say that the *xs compose y* is to say that each of the *xs* is a part of *y* and nothing is a part of *y* without *overlapping*—having a part in common with—one of the *xs*. Call the alleged parts of something generated by the structure-making relation *s-parts*, and the correlated relation *s-parthood*.[2] Call those things generated by structure-making *structures*.

Structures are employed to do various philosophical jobs: to serve as truth-makers [Armstrong 1997, Russell 1985], the relata of causal relations [Armstrong 1997], the immediate objects of perception [Daly 1997], and as

[1]See Armstrong [1986], Forrest [1986b], and Lewis [1986b, 1986c].
[2]The following *defined* concepts will be employed:

x s-overlaps y $=_{\text{df.}}$ there is a *z* that is an *s-part* of both *x* and *y*.
x is *s-disjoint* from *y* $=_{\text{df.}}$ *x* and *y* do not *s-overlap*.
x is a *proper s-part* of *y* $=_{\text{df.}}$ *x* is an *s-part* of *y* but *x* is not identical with *y*.
the *xs s-compose y* $=_{\text{df.}}$ each of the *xs* is an *s-part* of *y*; everything that is an *s-part* of *y s-overlaps* one of the *xs*.

It will be convenient to assume that there literally are entities that are *parthood relations*, although this assumption could be dropped without affecting substantially the arguments discussed here. Instead, one could speak of *parthood predicates*.

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the ontological basis of an actualist theory of possible worlds [Forrest 1986a, 1986b]. But that entities exist suited to perform these tasks does not entail that these entities are structures. Alexius Meinong [1960], who was no foe of states of affairs, had this to say:

> . . . this requirement is based solely on the analogy to the part–whole relation: an Objective is thereby treated as a complex of some kind and the object belonging to it as a kind of constituent. In many respects this may be in accordance with our insight into the nature of an Objective, which is as yet still immediately defective. However, no one will deny that this analogy is only an initial expedient in our embarrassment and that there would be no grounds for following this analogy rigorously for even part of the way.[3]
>
> [1960: 85]

Meinong's point is that we have little knowledge of the intrinsic features of states of affairs and that thinking of them as structures is a crutch: it might be useful for some purposes, but it will break if too much is rested on it. Positing that they have *structure* is a risky theoretical move with no immediately obvious pay-off.[4]

Moreover, there might be reasons to *deny* that anything has the kind of structure posited by friends of structure-making. David Lewis worries that

> mereology looks to be the general theory of composition, not the theory of one special kind of composition. Therefore I find 'unmereological composition' profoundly mysterious. After expelling it from set-theory, I scarcely want to welcome it back via the anatomy of facts.
>
> [1991: 57]

What motivates the claim that structures literally have part–whole structure is a view of modality known as *Humeanism*. Friends of states of affairs *need* structure-making to be a composition relation in order to avoid Humean worries about necessary connections between *distinct* existences. Humeans

[3]It is not clear whether Meinong's *objectives* are best thought of as *facts* or as *Russellian propositions*. Russellian propositions have a structure eerily similar to the structure of facts: they somehow consist of properties and particulars. Meinong's view identifies true propositions (objectives) with states of affairs that have being, whereas a false proposition is identical with a non-real state of affairs (which, nonetheless, *is*.) See Meinong [1960: 80]. (I thank Peter Simons for helpful discussion of Meinong.)

The existence of Russellian propositions is defended in Russell [1903: 43–55]. Recall Russell's famous remark in a letter to Frege [1980: 169]: 'I believe that in spite of all its snowfields Mont Blanc itself is a component part of what is actually asserted in the proposition 'Mont Blanc is more than 4,000 metres high''. (See also Bertrand Russell's [1973: 80] response to the quotation by Meinong.) The worries discussed here are also worries for Russellian propositions or structured situations.

[4]There seems to be almost universal assent among the friends of states of affairs that these entities literally are structured. Bertrand Russell [1985: 59]: 'The simplest of all imaginable facts are those which consist in the possession of a quality by some particular thing'. J. M. E. McTaggart [1924: 253]: 'I should define a substance as that which has qualities and is related, without being itself either a quality or relation, or having qualities and relations among its parts. (The first part is the traditional definition of substance. The last part is added to exclude facts.)' Reinhardt Grossman [1973: 145]: '. . . facts may be viewed as complex entities consisting of parts. I shall call the part–whole relation in which an entity stands to the fact of which it is a part *the relation of being a constituent of*'. D. H. Mellor [1993: 107]: 'What P (like any other universal) is, I maintain, is a constituent of atomic facts, like the fact that a is P'. Marian David [1994: 21]: 'The basic idea behind this account is that sentences and facts are both complex structured entities: sentences are composed of words and phrases; facts are composed of things, properties, and relations, and maybe also sets and functions'. Peter Forrest [1986b: 91]: 'the formation of states of affairs is a non-mereological mode of composition'. And finally, D. M. Armstrong [1991: 192]: 'A third, indirect, argument for states of affairs is perhaps even more important. It is that if mereological composition is the only form of composition that there is in the world, then the world has no real unity'.

love recombination. Provided that x and y are distinct contingent beings, x could exist in a world without y and vice versa. (Or, at the very least, a duplicate of x could exist without a duplicate of y and vice versa.)

D. M. Armstrong—a champion of states of affairs—embraces Humeanism.[5] However, states of affairs seem to pose counter-examples to the Humean principle. Consider the fact that Fred is fun. If Fred is not a part of the fact, Fred and the fact are distinct beings. (It is not plausible to think that the fact is a part of Fred, or that Fred merely overlaps the fact.) But then there is a necessary connection between distinct beings. If this fact exists, then Fred is fun. (This fact's job is to be such that, if it exists, then Fred is fun.) The fact that Fred is fun exists only if Fred exists. And, on the assumption that *being fun* is an *intrinsic* property, a duplicate of the fact that Fred is fun exists only if a duplicate of Fred exists.

Armstrong's response is that Fred is a *constituent*, i.e., an s-part, of the fact. Because they are not distinct, the Humean principle is preserved.

Armstrong holds that structure-making is one of two fundamental composition relations. Armstrong also believes there to be a composition relation that he calls *mereological*, which he takes to be the only composition relation recognized by his philosophical adversaries, such as David Lewis. There is more than one way that objects can fail to be distinct.

Here, I critically explore Armstrong's compositional pluralism, focusing on the views defended up to 1999.[6] I restrict my focus because Armstrong's work presents the most well-known systematic account of the structure of states of affairs. Anyone interested in the metaphysics of parts and wholes should be interested in seeing whether Armstrong's compositional pluralism is a credible view.

There are three ways to challenge Armstrong's compositional pluralism. First, one could argue against compositional pluralism in general, rather than Armstrong's version in particular. I address a general worry about compositional pluralism in section 2.

Second, one could attempt to show that s-parthood is not a parthood relation by arguing that there are necessary conditions on being a parthood relation not satisfied by s-parthood. I address arguments of this sort in sections 3 and 4.

Third, one could argue that structure-making is the *only* composition relation. This is an interesting position, and worthy of further exploration, but I won't explore it further here.

[5]Armstrong [1989b] defends the view that modal reality is exhausted by the permissible recombinations of states of affairs. Actuality exhaustively decomposes into states of affairs, and merely possible alternatives to actuality are alternative ways in which states of affairs could be arranged. Armstrong later writes, 'For myself, I agree with David Hume that there are no necessary connections between distinct existences …' [1991: 189–90]. 'My idea of possibility is the idea of free recombination of whatever are the elements of which the world is composed' [1991: 194].

[6]Armstrong's views have since changed. Armstrong [2004a, 2004b] now holds that universals and particulars *overlap*, and that instantiation is *partial identity*. States of affairs either no longer play a role—this seems to be the view of [2004a]—or are taken to be the *intersection* of particulars and universals (this seems to be the view of [2004b]. The former view is deeply problematic, since the postulated parthood relation violates two principles constitutive on being a parthood relation: a very weak remainder principle and a transitivity principle for overlap; see Armstrong [2004a: 141]. The latter view is not problematic in this way, but it is also not clear whether, strictly speaking, Armstrong now believes in *universals*, or has instead embraced a trope theory of properties. Armstrong's new views deserve a separate examination.

2. Compositional Pluralism

Following McDaniel [2004], *compositional monism* is the view that there is exactly one fundamental parthood relation. *Compositional pluralists* hold that there are many fundamental parthood relations.

The key word is 'fundamental'. Objects have all sorts of parts: spatially connected parts, causally integrated parts, functional parts, immediate parts, etc. For each kind of part, there is a corresponding parthood relation. But they are definable in terms of a more basic notion of part and other concepts:

> x is a *causally integrated part of* $y =_{\text{df.}}$ x is a part of y and each of x's parts is robustly causally related to every other part of x.

> x is a *functional part of* $y =_{\text{df.}}$ x is a part of y and x plays some functional role in the production of some state of y.

> x is an *immediate proper part of* $y =_{\text{df.}}$ x is a proper part of y and there is no other proper part of y, z, such that x is a proper part of z.

No one is a compositional pluralist simply because she believes in these parthood relations.

A parthood relation is a *fundamental parthood relation* just in case it is not analysable in terms of some other parthood relation. The debate between the compositional monist and the pluralist is over the number of fundamental parthood relations in this sense. There is another sense in which a parthood relation could be said to be fundamental: a parthood relation is fundamental *simpliciter* just in case it is not analysable in terms of any other property or relation.[7] According to *strong compositional pluralism*, there are two fundamental parthood relations that are fundamental *simpliciter*. I suspect that Armstrong is a strong compositional pluralist, although the textual evidence for this is scant and indirect. Deciding this will not matter to what follows.

One might worry that the debate between pluralists and monists is empty. Consider the pluralist's parthood relations. Isn't there is a general parthood relation, namely, the disjunction of these parthood relations? Presumably it is this most general parthood relation that the monist is interested in.[8] Won't the monist take the pluralist's parthood relations to be *restrictions* on this most general parthood relation? What, then, is there to disagree about?

The pluralist can recognize a general parthood relation, but will deny that it is *basic*, *fundamental*, or *natural* in the sense of David Lewis [1983a, 1986a].[9] Rather, the most natural parthood relations are 'restricted'

[7]One could accordingly be a compositional pluralist but hold that no fundamental parthood relation is fundamental *simpliciter*.

[8]Consider this passage by Husserl [1901: 5]: 'We interpret the word "part" in the *widest* sense: we call anything a "part" that can be distinguished "in" an object, or, objectively phrased, that is "present" in it.' But see also Husserl [1901: 27, section 15] for interesting comments on the variety of kinds of parts and wholes.

[9]At the very least, the pluralist can recognize a general parthood predicate satisfied by all and only those things that exemplify some particular parthood relation.

parthood relations; the general parthood relation is a *mere disjunction* of, or less natural than, the specific parthood relations embraced by the pluralist. Anyone who grants that some distinctions *carve nature at the joints*, whereas others do not, can appreciate the dispute between the compositional pluralist and the compositional monist.

Moreover, it's not obvious a monist can recognize all of the pluralist's parthood relations. David Lewis [1986b, 1986c] denies that structure-making is a composition relation because it is not extensional. There is no restriction on the parthood relation that Lewis recognizes that yields something equivalent to a non-extensional s-parthood relation.[10] We will see in section 4.3 that the generic parthood relation definable from the parthood relations recognized by Armstrong behaves in ways that render it unsuitable to serve as *the* fundamental parthood relation in terms of which all other parthood relations must be understood.

Compositional pluralism is intelligible. We now turn to the doctrine itself. How do we *individuate* the fundamental composition relations? There are at least three possibilities. First, the relations might apply to objects from distinct categories. For example, according to McDaniel [2004], there are two fundamental parthood relations: a relation that is instantiated only by spatiotemporal regions, and a relation instantiated by material objects.[11] Second, the relations might differ with respect to their logical form. In the system of McDaniel [2004], the relation instantiated by material objects is a three-place relation *x is a part of y at region R*, whereas the one instantiated only by regions is the two-placed *x is a part of y*. The relations posited by Armstrong do not differ with respect to their logical from: both are two-placed. Third, the relations might obey different (but presumably partially overlapping) sets of axioms. We will see in sections 3 and 4 that Armstrong's compositional pluralism posits two fundamental parthood relations that do not play by (all of) the same rules.

3. Armstrong's Compositional Pluralism

The temporal part of Armstrong that lasts until around 1997 is a compositional pluralist:

> States of affairs hold their constituents together in a non-mereological form of composition, a form that even allows the possibility of having different states of affairs with identical constituents.
>
> [Armstrong 1997: 118]

[10]A parthood relation is extensional just in case things having the same parts are identical. As we will see, Armstrong embraces the (one) mode of composition that Lewis believes in. We will call this mode *m-composition*. Because s-composition is not extensional, but *m*-composition is, we cannot reduce s-composition to m-composition plus other concepts. (So, for example, we can't say that the *xs* s-compose *y* just in case the *xs* m-compose *y* and the *xs* are 'structurally related to each other'.) I thank Ben Caplan and Jonathan Schaffer for helpful discussion on this issue. It will later be explained why s-composition must be treated as non-extensional.

[11]Kit Fine [1999] defends a scheme in which there are two parthood relations defined on material objects, which differ with respect to their *adicity* and which axioms they obey. In an earlier paper [1994], he also defends a kind of compositional pluralism. Other compositional pluralists include Grossman [1973] and Simons [1987].

> Lewis holds that mereological composition is the only form of composition there is .... We part company with Lewis in this work. The moral drawn in the present work is that there has to be at least one other form of composition in the world. We have already found non-mereological composition in states of affairs.
>
> [ibid.: 187]

According to Armstrong, one kind of composition—dubbed by Armstrong *mereological*—obeys the axioms of standard mereology. These axioms are:

(Unrestricted Composition): For any *xs*, the *xs* compose some *y*.

(Extensionality): If the *xs* compose *y* and the *xs* compose *z*, then $y=z$.

(Transitivity): If *x* is a part of *y* and *y* is a part of *z*, then *x* is a part of *z*.[12]

Although Armstrong holds that one composition relation obeys these axioms, Armstrong does not hold that every composition relation does. Perhaps this is why Armstrong *labels* the composition relation that obeys these axioms *mereological*: it is partially individuated by the principles of classical mereology that govern it. Call the parts of something generated by mereological composition *m-parts*.[13]

According to Armstrong [1997: 12–13], the products of mereological composition are an 'ontological free lunch'. Armstrong apparently holds this view because he thinks that, given standard mereology, sums *supervene* on their m-parts in the sense that, given the existence of some things, the existence of an m-sum of them follows. However, this claim is ambiguous. On one reading, *given* standard mereology, it's true: if there are some *xs*, there is an m-sum of the *xs*. This is the reading licensed by the principle of unrestricted composition. In more ordinary English, we would say that objects always have *a* sum, provided that we believe standard mereology. (Many of us don't!)

But there is a second reading of Armstrong's slogan that neither follows from the axioms of standard mereology, nor is obviously true: if the *xs* m-compose a *y*, then in any world in which the *xs* exist, the *xs* m-compose that very same *y*. This is the thesis that m-parts have their m-wholes essentially. It's not clear to me if Armstrong endorses this stronger thesis.[14]

The products of structure-making are not ontologically free. Structures do not supervene on their s-parts, even in the weak sense. Consider a world in which some things are square and blue, while other things are circular and red, but nothing is square and red. In this world, there is no *fact* that is

[12]This is the minimal axiom system for the mereology adopted by Lewis [1991].
[13]As before, it will also be convenient to employ the following definitions:

> *x m-overlaps y* $=_{\text{df.}}$ there is a *z* that is an *m-part* of both *x* and *y*.
> *x* is *m-disjoint* from *y* $=_{\text{df.}}$ *x* and *y* do not *m-overlap*.
> *x* is a *proper m-part* of *y* $=_{\text{df.}}$ *x* is an *m-part* of *y* but *x* is not identical with *y*.
> the *xs m-compose y* $=_{\text{df.}}$ each of the *xs* is an *m-part* of *y*; everything that is an *m-part* of *y m-overlaps* one of the *xs*.

[14]He seems to endorse this view on page 112 of Armstrong [1989b].

s-composed out of a square thing and the universal *redness*.[15] Universal composition is not true of structure-making: Armstrong wants to distinguish worlds in which Socrates and tallness exist and Socrates is tall from worlds in which Socrates and tallness exist but Socrates is not tall. If structure-making satisfied unrestricted composition, this goal would be unattainable.

Satisfying universal composition is not a conceptually necessary condition on being a parthood relation. Many—perhaps even most—philosophers deny that *any* parthood relation satisfies unrestricted composition.[16] These philosophers are not confused about the meaning of 'part'.

There aren't good *conceptual* arguments for holding that universal composition is true of all composition relations, but there might be good metaphysical arguments for this conclusion. The most promising is the *argument from vagueness*.[17] Roughly, the argument is this: any restriction on composition will either be arbitrary, fail to match our intuitions concerning when composition occurs, or be vague. Arbitrary restrictions are unmotivated. Restrictions not motivated by intuition are unmotivated. A vague restriction might fit the intuitions that motivate it, but since the restriction is vague, there will be cases in which there is no fact of the matter whether composition has obtained. But there cannot be cases in which there is no fact of the matter whether composition has obtained, for if there were, then there would be no fact of the matter about the number of things existing.

I won't determine here whether this argument is sound.[18] However, even if this argument shows that we should not restrict the composition relation defined on material objects, it does *not* show that we should not restrict *any* composition relation.[19] The restriction on composition that friends of structure-making posit is neither metaphysically arbitrary, nor unmotivated by intuition, nor vague. There are two products of s-composition: structural universals and states of affairs. These products are produced from some combination of particulars and universals or universals and universals. Particulars never s-compose anything on their own. There is a perfectly precise restriction on s-composition: some *xs* s-compose a *y* only if at least one of the *xs* is a property or relation.[20]

This restriction on composition is clearly not metaphysically arbitrary, since there is a real metaphysical distinction to be made between properties and relations on one hand and particulars on the other. Nor is this restriction vague: it is a perfectly precise restriction statable using only the

[15]Recall that Armstrong does not accept non-obtaining facts. However, even those who believe in non-obtaining facts should deny universalism, since there is no fact consisting merely of the universals *redness* and *love*. (Thanks to an anonymous referee for this suggestion.)

[16]Perhaps the parthood relation exemplified by all and only spatiotemporal regions satisfies unrestricted composition. On why unrestricted composition (and standard mereology in general) is plausibly true of the part–whole relation defined on regions, see Simons [1987: 132–3].

[17]The argument from vagueness for unrestricted composition was first raised in Lewis [1986a: 212–13]. The argument was later refined in Sider [2001: 120–32].

[18]But see Nolan [2006] for worries about this argument.

[19]Nolan [2006: 724] concurs.

[20]We might wish to allow that every particular s-composes itself. (This will follow if we allow that every particular is an s-part of itself.) Accordingly, a more cautious but still perfectly precise statement of the restriction is:

> Some *xs* s-compose a *y* only if either (i) there is exactly one of the *xs* and it is identical with *y* or (ii) at least one of the *xs* is a property or relation.

quasi-logical vocabulary of plurals and the precise metaphysical notions of 'particular' and 'universal'. The argument from vagueness cannot motivate unrestricting structure-making.[21]

We have discussed one necessary condition on some *xs* s-composing a *y*. Let us consider the *Special S-Composition Question* (SSCQ), which asks for a true and informative way of filling in the following schema:

(SSCQ): The *xs* s-compose a *y* if and only if _____.[22]

Answering SSCQ is harder than one might think. Let us divide our labour. We know that s-composition produces two sorts of structures: structural universals and states of affairs. Accordingly, there arise questions of how to complete the following schemas:

(Universals): The *xs* s-compose a structural universal if and only if _____.
(SOAS): The *xs* s-compose a state of affairs if and only if _____.

Armstrong does not try to answer Universals. Granted, it is at least partially an *a posteriori* matter which structural universals exist, since it is an *a posteriori* matter which s-atomic universals exist. But it is also an *a posteriori* matter which atomic physical objects exist, and this fact does not preclude attempts by philosophers to determine when atomic physical objects make a whole.

Moreover, Armstrong does countenance an apparently *a priori* sufficient condition for the s-composition of a structural universal: if there is some *x* that instantiates universals P and Q, then there is a structural universal s-composed of P and Q. Armstrong calls these structural universals 'conjunctive universals'.[23] So why is there no attempt to systematically answer Universals?

[21]This is not to say that all worries about vagueness evaporate. Suppose that it can be vague whether some objects have an m-fusion. Suppose that it is not vague that, if those objects have an m-fusion, m-fusion exemplifies the universal *F*. (Perhaps *F* is a mass-property that the m-fusion would have in virtue of the masses of its m-parts.) So it is not vague that, if there is an m-fusion of those objects, there is an s-fusion of the m-fusion and the universal *F*. It seems to me to follow that it must be vague whether there is such an s-fusion. Of course, anyone motivated by the argument from vagueness will deny that it can be vague whether some objects have an m-fusion. Thanks to Elizabeth Barnes, Ross Cameron, and Robbie Williams for discussion.

[22]The SSCQ is modelled after van Inwagen's [1990] *Special Composition Question*. I thank Jake Bridge and Cody Gilmore for helpful discussion of SSCQ.

[23]Armstrong [1978: 36–9] previously held that conjunctive universals were m-fusions of their conjuncts. He recanted in Armstrong [1989b: 70, 112]. Getting clearer on the mereology of conjunctive universals allows us to make sense of some cryptic remarks by Armstrong. In [1989b: xi, 70] Armstrong writes, 'Conjunctive universals embed states of affairs'. Although this remark might suggest that conjunctive universals have states of affairs as proper parts, this is not what Armstrong means. What Armstrong means is this: necessarily, if a conjunctive universal P&Q exists, then there is an *x* such that the state of affairs of *x* having P exists and the state of affairs of *x* having Q exists. Since we have a necessary connection between two existences, they must not be distinct. Let the brackets '{,}' represent states of affairs, i.e., {P, *a*} is the state of affairs in which *a* exemplifies P. Let the '<' represent the relation *x is an s-part of y*. Let '*' represent the relation *x s-overlaps y*. We now succinctly state the following:

If P&Q exists, then there is an x such that the following exist: {P, *x*}, {Q, *x*}, {P&Q, *x*}.

Moreover, it is true that:

P&Q < {P&Q, *x*}
P < P&Q, Q < P&Q
P&Q * {P, *x*}, P&Q * {Q, *x*}

Note that conjunctive universals do not contain states of affairs as proper parts, but rather, necessarily s-overlap certain states of affairs and are proper s-parts of others.

We turn now to SOAS. The answer to SOAS must be given recursively.

There are three base-steps. Base step one: we allow that everything s-composes itself, so every state of affairs s-composes a state of affairs. Base step two: the answer to Universals (whatever it is). We follow Armstrong in treating structural universals as states of affairs. Armstrong [1983: 84] makes it clear that it is not necessary that a state of affairs contains a particular as an s-part: 'Universals having properties, or being related, will also be states of affairs: higher order states of affairs'. For example, laws of nature consist in universals so related. These states of affairs are both facts and universals [Armstrong 1983: 88–92].[24] Base step three: the *x*s s-compose a state of affairs if at least one of the xs is a property or relation, and the other *x*s instantiate it.

We now state the following clause:

(SOAS-R): the *xs* s-compose an SOA if and only if either (a) there is exactly one of the *xs* and it is a state of affairs or (b) some of the *xs* s-compose some property or relation R such that the remaining *xs* s-compose some *ys* such that the *ys* instantiate R.

Here is an example to illustrate how the answer to SOAS works. Suppose that the *xs* are a water molecule, *being hydrogen*, *being oxygen*, and *the bonding relation*. By base step 2, Universals, there is a structural universal s-composed of *being hydrogen, being oxygen,* and the *bonding relation*. This structural universal is *being a water molecule*. *Being a water molecule* is instantiated by the water molecule. Some of the *xs* (*being hydrogen*, *being oxygen*, and *the bonding relation*) s-compose a property R (*being a water molecule*) such that the remaining *xs* (the sole remaining one of the *xs* is the water molecule) s-compose something (the water molecule, via base step one) which exemplifies R. It thereby follows from SOAS-R that there is a state of affairs consisting of the water molecule and the structural property *being a water molecule*. This is exactly the right result.

Note that conjunctive states of affairs—such as the state of affairs of *a's being F and b's being G*—are *not* s-fusions of their conjuncts. Rather, they are mereological sums of their conjuncts, i.e., m-fusions of their conjuncts. This is why Armstrong holds that they are ontologically free: given the existence of *a's being F* and the existence of *b's being G*, the m-fusion of these things exists.[25]

I turn to *extensionality*. Structure-making is not extensional. Consider the structural universal *methane*. A methane molecule consists of one carbon

[24]That a state of affairs might also be a universal is initially surprising. But note that the only states of affairs that are also universals are those that have only universals as constituents. And these states of affairs consist in universals being related by a higher-order relation. The assumption that structural universals are states of affairs could be dropped; the only cost would be that the answer to SSCQ would require further base clauses to state it.

[25]Armstrong's views on conjunctive states of affairs are not as precise as one might hope. Consider, for example, Armstrong [1989a: 91]: '. . . a conjunction of states of affairs is itself a state of affairs. Then consider (1) *a*'s being F and *b*'s being G; and (2) *a*'s being G and *b's* being F. Two wholly distinct states of affairs, it may be, but with the same constituents'.In some sense (1) and (2) have the same constituents. (To anticipate section 4.3, (1) and (2) have the same g-parts.) But it is not true that (1) and (2) have the same m-parts. Nor do they have the same s-parts.

atom bonded to each of four hydrogen atoms; according to the friend of structural universals, the universal *methane* consists of *being a carbon atom*, *being a hydrogen atom*, and the *bonding* relation [Lewis 1986b: 33]. Consider next a butane molecule, which consists of four carbon atoms and ten hydrogen atoms; but the structural universal *being a butane molecule* consists of *being a carbon atom*, *being a hydrogen atom*, and the *bonding* relation. Both structural universals have the same s-parts (although of course their instances differ with respect to their m-parts).[26]

States of affairs are no different; the state of affairs in which I love you has the same s-parts as the state of affairs in which you love me—the constituents are simply you, me, and love—but these states of affairs are distinct [Armstrong 1989a: 99–101; 1997:118–19]. Extensionality does not hold for this mode of composition.[27]

It is controversial whether the parthood relation that obtains between you and your hand, or this table and its leg, satisfies extensionality. Consider those friends of *material constitution* who hold that a statue and the lump of clay that constitute it are numerically distinct, but are such that every atomic part of one is a part of the other.[28] Any friend of this view must deny extensionality. Why is this problematic?

There are two worries about the claim that statue/lump cases are counter-examples to extensionality. One worry concerns the alleged local supervenience of composition. The second worry is the so-called 'grounding problem'.

In order to state the first worry properly, I introduce the notion of *plural duplication*: some *xs* are plural duplicates of some *ys* just in case there is a 1–1 correspondence between the *xs* and the *ys* that preserves intrinsic properties and external relations.[29] The relevant local supervenience thesis is:

(LST): If the *xs* are plural duplicates of the *ys*, then the *xs* have *n* sums just in case the *ys* have *n* sums.[30]

Informally, LST claims that whether composition occurs and how many times it occurs is always a *local* matter, determined entirely by the properties and the relations of the things doing the composing.

[26]One of the anonymous referees suggested that *methane* has further s-parts, such as the property *having exactly one carbon atom as an m-part* and *having exactly four hydrogen atoms as m-parts*. On this suggestion, *butane* does not have these properties as s-parts. Hence, extensionality is preserved. This is an interesting suggestion, and worthy of further discussion. Armstrong does not appear to countenance this sort of property, but were he to do so, this sort of counter-example to extensionality would be undercut.

[27]There are several moves one might consider. First, hold that the way in which the other constituents of a fact are arranged is itself a constituent of the fact. However, Armstrong [1991] explicitly denies this: 'Arrangement of constituents is not a further constituent, in particular it is not a constituent relation'; see page 192. A second option, suggested to me by one of the anonymous referees, appeals to *impure structural universals*: 'Say that *(thing that) loves* and *(thing that is) loved by* are different universals. The atomic s-parts of the two states of affairs are the same: I, you, *loves*, and *loved by*. But it is not true that they have the same proper s-parts. The first has the composite s-parts *loves you* and *loved by me*, whereas the second has the composite s-parts *loves me* and *loved by you*. Extensionality is indeed violated, but only at the atomic level'. A third option is to deny that these counter-examples arise, since there are no non-symmetric relations. The non-reality of non-symmetric relations is defended by Dorr [2004]. This is not a move that Armstrong would like, since he is inclined to think that *causation* is a fundamental, non-symmetric relation.

[28]Friends of *constitution* include Baker [1997, 2000], Thomson [1998], and Wiggins [2001].

[29]It follows from this definition of plural duplication that, if the *xs* and *ys* are plural duplicates, then any m-fusion of the *xs* is a duplicate of any m-fusion of the *ys*.

[30]If extensionality holds, then the number of sums of some *x*s will always be either one or zero.

Peter van Inwagen defends something like LST with the following remarks:

> Whether certain objects add up to or compose some larger object does not depend on anything else besides the spatial and causal relations they bear to each other. If ... someone wants to know whether the bricks in a certain brickyard make up a composite object, he need not attend to anything outside the brickyard, for no information gathered from that quarter could possibly be relevant to his question.
>
> [van Inwagen 1990: 12]

Most friends of constitution will deny LST.[31] The artist creates a statue out of the clay. Those *xs* that are simple parts of the statue compose both the statue and the clay. Suppose there is also a lump of clay shaped like that statue even though no person shaped the clay. This lump fails to constitute anything. Consider the *ys* that compose it. The *xs* and the *ys* are plural duplicates. Yet the *xs* have two sums, whereas the *ys* have only one sum.

Perhaps LST is true. What is interesting is that the theory of structure-making is *consistent* with LST.

Pretend that *love* is a perfectly natural non-symmetric external relation.[32] Suppose that I love you but you do not love me. Consider the state of affairs in which I love you. That state of affairs is s-composed of you, me, and the two-place relation *x loves y*. Consider now a duplicate of you and a duplicate of me. Unlike me, my duplicate gets lucky: the duplicate of you loves the duplicate of me. There are accordingly two states of affairs s-composed of the same parts: the duplicate of me, the duplicate of you, and the relation *x loves y*.

But notice that this case is not a counter-example to LST. For although I, you, and love s-compose exactly one thing, whereas the duplicates of me, the duplicate of you, and love (the duplicate of love is love itself) s-compose exactly two things, LST is not violated since I, you, and love are not plural duplicates of the duplicate of me, the duplicate of you, and love. For given that you do not love me, but the duplicate of you does love the duplicate of me, there can be no 1–1 function between these two groups that preserves intrinsic properties and external relations.

So the composition of facts from things and properties does not violate LST, nor does the composition of structural universals from simpler universals. For, necessarily, whenever some universals have *n* s-fusions, any plural duplicates of those universals will have *n* s-fusions, since some universals are plural duplicates of some universals only if there is a 1–1 correspondence between them that preserves *identity*. Any universal is identical with any duplicate of that universal. It follows that some universals, the *Us*, are plural duplicates of some universals, the *Vs*, if and

[31]Perhaps those friends of constitution who deny the existence of artifacts can accept LST. I thank an anonymous referee for suggesting this.

[32]Strictly speaking, some particulars and a relation s-compose a state of affairs only if that relation is an external relation. A more plausible candidate for being a perfectly natural, non-symmetric external relation is the relation *x is before y*. But it is more fun to talk about love.

only if the *Us* are the *Vs*. So, trivially, the s-composition of structural universals from simpler universals is consistent with LST. Worries about the local supervenience of composition can't motivate extensionality for structure-making.

Let's turn to the so-called 'the grounding problem'.[33] Recall the statue and the lump. How can they differ with respect to their modal properties despite being alike in all non-modal respects?[34] This difference seems ungrounded in the non-modal intrinsic and extrinsic properties of the statue and the lump. Does the theory of structure-making face the grounding problem?

It will be useful to formulate the grounding problem as the following argument:

P1. If s-composition is non-extensional, then there are brute modal differences between pairs of objects that are not grounded in non-modal intrinsic or extrinsic differences.

P2. There aren't brute modal differences between pairs of objects that are not grounded in non-modal intrinsic or extrinsic differences.

Hence, s-composition is extensional.

In what follows, I won't challenge P2, although it is not obvious whether P2 is true.

Consider two states of affairs that are counter-examples to extensionality, $<$Rab$>$ and $<$Rba$>$. Necessarily, $<$Rab$>$ exists only if *a* bears R to *b*, whereas, necessarily, $<$Rba$>$ exists only if *b* bears R to *a*. But both $<$Rab$>$ and $<$Rba$>$ are s-fusions of R, *a*, and *b*. These two states of affairs have different modal profiles. What 'grounds' this difference?

In order to assess whether there is a 'grounding problem', we need to determine whether $<$Rab$>$ and $<$Rba$>$ are intrinsic duplicates, and whether they differ with respect to some non-modal extrinsic properties. If they do not differ either intrinsically or extrinsically, the grounding problem might have some traction. If, however, they do differ either intrinsically or extrinsically, the grounding problem won't arise. The friend of structure-making can reject P1 of the argument.

Some obscure remarks in Armstrong [1997: 120–2], suggest that Armstrong holds that $<$Rab$>$ and $<$Rba$>$ differ intrinsically. That they do differ is plausible: although $<$Rab$>$ and $<$Rba$>$ are made of the same parts, they *arrange* these parts in different ways. Since the arrangement of the parts of $<$Rab$>$ is not a constituent of $<$Rab$>$, it must be, in some sense, a feature of $<$Rab$>$. And so too for $<$Rba$>$. But then $<$Rab$>$ and $<$Rba$>$ are *not* alike intrinsically, unlike the statue and the lump.[35]

[33]This is the problem Karen Bennett [2004] focuses on.

[34]Or, to be more cautious, how can the lump and the statue differ modally when they are alike in all non-modal, non-sortal, non-intentional respects?

[35]It is an interesting question whether this difference implies that there are further higher-order states of affairs consisting of $<$Rab$>$ and the difference-making feature. I suspect not: arguably this intrinsic feature of $<$Rab$>$ is *essential* to $<$Rab$>$ (and so forth for $<$Rba$>$), and hence the intrinsic difference between $<$Rab$>$ and $<$Rba$>$ follows from their existence alone.

It also seems that <Rab> and <Rba> are not alike extrinsically. <Rab> has different causal powers than <Rba>.[36] That <Rba> exists in addition to <Rab> makes a difference to what causes what. So there are non-modal, non-sortal-based extrinsic differences between <Rab> and <Rba>. Both these differences seem to be sufficient to ground the modal differences. The friend of structure-making can reject P1.

Similar remarks apply to structural universals. Unlike *tropes*, which are putative entities that are both properties and particulars, universals that are intrinsic duplicates are numerically identical. It follows, then, that if there are two numerically distinct structural universals, they are not intrinsic duplicates, even if these universals are s-composed of exactly the same simple universals. These intrinsic differences suffice to ground their difference in modal profile, thereby undercutting P1 of the grounding problem.

Moreover, structural universals can differ from each other extrinsically even if they are s-composed of the same simple universals. For example, they will figure in different laws of nature, and will probably enjoy different locations in space-time. (Where structural universals are located will be discussed in section 4.4.) These extrinsic differences also appear sufficient to undercut P1.

An anonymous referee has suggested a reply on behalf of the friends of extensionality. The reply is based on the thought that *all there is to an object is its proper parts* (and perhaps the composition relation or relations that join these parts). This intuition lies behind the slogan that 'composition is identity'. This intuition supports extensionality: if all that there is to x is the *zs,* and all there is to y is the *zs*, then x must be y.[37] (Were they to be different, there would have to be something more to one of them than the *zs*.) And for a similar reason, the apparent intrinsic or extrinsic differences I have discussed must be merely apparent.

The friend of structure-making should not agree that a whole is nothing more than its parts. Any friend of compositional pluralism should deny composition as identity: there are at least two composition relations, but only one identity relation. If you find composition as identity compelling, you should reject structure-making across the board.

I do not find it compelling. Some wholes are something more than their parts. Elsewhere, I have argued against the view that composition is identity.[38] Here I merely note that this difference in views about composition is one fundamental difference among many between the friend of structure-making and a compositional monist like David Lewis [1991].

I tentatively conclude that the grounding problem does not motivate extensionality for structure-making, although more exploration of this issue is warranted.

[36]I thank André Gallois for pointing this out to me.
[37]See Sider [2007] for further discussion of the relation between 'composition as identity' and extensionality.
[38]I argue against composition as identity in McDaniel [2008].

4. Conceptual Constraints on Composition

One of the challenges facing compositional pluralists is to determine when a relation is a fundamental parthood relation. This strikes me as being a very difficult project, and it's one I can't hope to engage in here.[39] However, there are certain features that any parthood relation must have.

The theory of structure-making would be *conceptually* defective if s-parthood failed to satisfy some conceptually necessary condition on being a parthood relation. In what follows, I discuss five putatively conceptually necessary conditions on being a parthood relation, and determine whether s-parthood satisfies them. Briefly: all parthood relations are transitive, obey some kind of remainder principle, and have an irreflexive proper parthood relation definable in terms of parthood and non-identity.[40] There are necessary connections between the intrinsic properties of a part of an object and the intrinsic properties of the object: wholes inherit intrinsic properties from their parts. Finally, it is conceptually necessary that wholes in some sense inherit their locations from their parts.[41]

4.1 Transitivity

Any fundamental parthood relation is *transitive*.[42] We can introduce *defined* parthood relations that are not transitive. For example, one of the relations defined in section 2, *being an immediate part*, is not transitive.

If every fundamental parthood relation must be transitive, the *membership* relation that objects bear to classes is *not* a fundamental parthood relation. (There are many cases in which an element of a set is not an element of the set of that set.) *Set-formation*, then, is not a fundamental composition relation. Sets and their members seem to be distinct existences.

If sets and their members are distinct, then the Humean must hold that there are no necessary connections between them on pain of inconsistency.[43] The Humean shouldn't simply *redefine* what it is for two things to be *distinct*

[39]The project might even be an impossible project. Perhaps there can be no non-trivial yet true analysis of what it is to be a parthood relation. This claim dovetails nicely with the view defended in McDaniel [2007], which states that there is no non-trivial yet true set of necessary and sufficient conditions for being a material simple, and with van Inwagen's [1990] general unease about the General Composition Question, which asks, 'What *is* composition?'.

[40]If proper s-parthood is both transitive and irreflexive, it follows that it is asymmetric. For this reason, I will not provide a separate discussion of whether proper s-parthood is asymmetric.

[41]One of the anonymous referees suggested that perhaps Armstrong does not believe that there are conceptual constraints on being a parthood relation. Although I don't think that there is any direct textual evidence for this interpretation, I am unaware of any evidence that directly rules it out. Note that something can be conceptually primitive and still subject to conceptual constraints. A concept is primitive just in case one cannot provide illuminating necessary and sufficient conditions for its satisfaction. It might be that s-parthood is primitive (I am inclined to think that it is) while there remain necessary conditions on its satisfaction.

I will argue in what follows that s-parthood does satisfy a number of putative constraints on being a parthood relation. If I am mistaken in thinking that these are genuine conceptual constraints, all the better for structure-making: even if the arguments that will come are faulty, we will not have a reason to reject the doctrine of structure-making. Moreover, even if the conditions to be discussed are not genuinely conceptually necessary conditions on being a parthood relation, it will be interesting to discover whether or not structure-making satisfies them. We will learn more about s-parthood by learning whether it is, for example, transitive, regardless of whether it is conceptually necessary that s-parthood is transitive.

[42]This claim was challenged by Rescher [1955]. For a defence, see Varzi [2006].

[43]On this point, see van Inwagen [1986] and Lewis [1991].

so that she can now *say* that a set and its members overlap. Such a move might save the *letter* of the Humean principle, but at the price of both ignoring the spirit of the principle, and rendering the new official-statement of the principle toothless. (I will briefly discuss one of Armstrong's responses to this worry about sets and their members in a moment.)

Similarly, Armstrong is justified in clinging to the Humean principle only if states of affairs and their 'components' really aren't distinct. This requires s-parthood to be a genuine parthood relation, and this in turn requires s-parthood to be transitive.

Is s-parthood transitive? Consider a state of affairs in which a structural universal is instantiated by a particular, such as the state of affairs *this water exemplifies* H_2O. Both the state of affairs and the structural universal have s-parts, but are the s-parts of the structural universal also s-parts of the state of affairs? For example, the state of affairs has the structural universal *being an* H_2O *molecule* as an s-part, and this structural universal has *being an oxygen molecule* as an s-part. Does it follow that the state of affairs has *being an oxygen molecule* as an s-part? Since intuition is more or less silent on these questions, we should let theory guide us: if there is a reason to believe in s-parthood, there is also a reason to believe it is transitive.

Intuition provides help in the case of conjunctive universals, which Armstrong [1989b: 113] treats as the simplest cases of structural universals. Consider an entity that exemplifies universals P, Q, and R. Accordingly, the following structural universals exist: P&Q&R, P&Q, Q&R, and P&R. P&Q&R is an s-fusion of P, Q, R, and P&Q is an s-fusion of P and Q. Intuitively, P&Q&R is also an s-fusion of P&Q and R. It is therefore reasonable to say that P&Q&R has P&Q as an s-proper part, as well as P and Q as proper s-parts. The transitivity of s-parthood seems most plausible when one considers conjunctive universals.

Let's briefly return to the topic of set theory, since some of Armstrong's past remarks on the mereology of sets are relatively explicit. According to Armstrong [1991], sets are states of affairs of a certain kind. Specifically, a unit set is a state of affairs that consists of its member and the property *unit-hood*. On this view, although the membership relation is *not* a parthood relation, it is partially analysable in terms of a parthood relation: x is a member of y just in case x and *unit-hood* s-compose an m-part of y. According to Armstrong, singleton sets are *mereologically atomic*—they have no proper m-parts—but they do have *s*-parts; Armstrong [1991: 190] writes, 'My contention will be that singletons are mereologically atomic, but are not absolutely atomic'. This remark is interesting, for it suggests that we *cannot* impute the following principle to Armstrong:

(S2M): If x is a proper *m*-part of y and y is a proper *s*-part of z, then x is a proper *m*-part of z.

Here's a counter-example to S2M: my hand is a proper m-part of me; I am a proper s-part of my singleton; my hand is not a proper m-part of my singleton, since my singleton is m-atomic. The failure of S2M at least tells us

something about the ways that these two parthood relations interact, even if all that it tells us is that a general principle fails to hold.[44]

Unfortunately, the set theory of Armstrong [1991] is provably inconsistent.[45] We should consider a second case against S2M.

Armstrong [1997: 122] claims that 'atomic' states of affairs are literally atomic, i.e., m-atomic, whereas 'conjunctive' states of affairs, such as the state of affairs that a is F and b is G, are m-complex. That is, atomic states of affairs have no proper m-parts, whereas conjunctive states of affairs are m-fusions of atomic states of affairs. Consider an m-atomic state of affairs, such as the state of affairs that Fred is fun. This state of affairs has Fred as a proper s-part. Fred has his hand as a proper m-part. But Fred's hand is not a proper m-part of the state of affairs, contrary to S2M. So a state of affairs does not have proper m-parts simply in virtue of containing as an s-part something with proper m-parts.

4.2 Remainder

Any parthood relation must obey a *remainder* principle.[46] What kind of remainder principle can the friend of structure-making endorse? Consider the principle of subtraction:

(PS): If x is a proper s-part of y, then there is a z s-distinct from x such that x and z s-compose y.

Now consider the state of affairs in which I am to the left of you; this state of affairs has you as an s-part; but what is the complementary s-part of this state of affairs? If there is a remainder, then it seems that it is a state of affairs as well, since structure-making is the operation that builds states of affairs out of particulars and universals. But there is no state of affairs that consists simply in me and the *x is to the left of y* relation.

Perhaps the s-part is not a state of affairs but is instead an impure structural universal, such as *being to the right of me*.[47] But is this item even in Armstrong's ontology? Impure structural universals seem unneeded for any philosophical labour.

Perhaps the remainder is the mere *m*-fusion of myself and the relation *x is to the left of y*. This item is in Armstrong's ontology, at least in so far as the relation and I are. But the claim that this item is the remainder is unmotivated: the s-fusion of myself and the relation *x is to the left of y* does not exist, so why is the m-fusion of some items the s-remainder of some larger s-fusion?

[44]Perhaps this also shows us that m-parthood and s-parthood cannot be unified into a single parthood relation. I thank Peter Forrest, Jonathan Schaffer, and Jason Turner for helpful discussion on this point. This issue will be discussed in section 4.3, and along with further issues in section 5.
[45]See Rosen [1995] for details.
[46]See Simons [1987: 26–8] for a defence of this claim.
[47]Wetzel [2003] briefly discusses this option.

So either structure-making does not obey PS or sometimes this manner of composition produces entities that are not states of affairs or pure structural universals. But what, and when, and why, and how?

Perhaps we can dodge these sticky questions. PS is an extremely strong remainder principle. Many philosophers deny that the parthood relation defined on ordinary objects satisfies an analogous principle. Peter van Inwagen [1990] defends the view that some *xs* compose an object just in case the activity of these *xs* constitutes a life. According to van Inwagen, one of my proper parts is a simple cell. (It's allowed in van Inwagen's ontology in virtue of being alive.) However, van Inwagen would deny that I have a part that is that cell's mereological complement. Van Inwagen's metaphysics is strange but not conceptually incoherent; he is not abusing the concept of parthood.

A remainder principle that van Inwagen could accept is the following:

(WPS): If *x* is a proper part of *y,* then there are *zs* distinct from *x* such that *x* and the *zs* compose *y*.[48]

Does structure-making obey WPS? The example just discussed does not show that it fails to obey WPS. When you are subtracted from the state of affairs, the remainders are me and the universal *x is to the left of y*. There might be other examples that show that structure-making does not obey WPS, but it's hard to see what these could be. One initially plausible example is the structural universal *being a graphite molecule*. Graphite molecules are formed by bonding carbon atoms; no other element is needed. So one might think that the structural universal *being a graphite molecule* has no s-part that does not s-overlap *being a carbon atom*. But this is not correct: *being a graphite molecule* also has as s-parts *the bonding relations* that unite the carbon atoms when they compose particular graphite molecules, and these do not s-overlap *being a carbon atom*.

Perhaps the lesson we should draw is that any counter-example to (WPS) will have to be some kind of 'unstructured' structure. Consider, for example, the alleged universal *being some electrons*. If this universal exists, then every single electron instantiates it, and whenever there are many electrons, they jointly instantiate it. *Being some electrons* seems to have no s-parts s-disjoint from *being an electron*. However, why should the friend of structural universals believe in this entity? None of the arguments for structural universals provides a reason to believe that there are universals like these. There is no reason to think that s-parthood fails to satisfy a reasonable remainder principle.[49]

[48]We allow for there to be exactly one of the *zs*. (WPS) is a stronger remainder principle than *Weak Supplementation* (WS), which in Peter Simons' [1987: 28] formulation is the principle that, if *x* is a proper part of *y*, then *y* has some proper part that does not overlap *x*. WPS entails WS, but the converse does not hold. Structure-making obeys WS. I will show that it also obeys WPS. I suspect, but will not show, that WPS is the strongest remainder principle that structure-making obeys.

[49]The earlier discussion demonstrates that Armstrong should reject anything analogous to the Doctrine of Arbitrary Undetached Parts (DAUP) for s-composition. (Perhaps the best way to formulate the analogous doctrine is as follows: Let W be the s-sum of the *xs*. Then for all *ys* that are some of (but not all of) the *xs*, there is a *z* that is the s-sum of the *ys*.) For an argument against DAUP, see van Inwagen [1981].

4.3 Irreflexivity

We defined proper s-parthood in the usual way: *x* is a proper s-part of *y* just in case *x* is an s-part of *y* and *x* is not identical with *y*. All parthood relations must have a proper parthood relation definable in this way. Moreover, this proper parthood relation must be irreflexive: nothing can be a proper part of itself.[50]

Is proper s-parthood irreflexive? A worrisome case that it is not can be made. In order to assess this case, I must discuss an argument against states of affairs first sketched by Armstrong [1989b: 94] himself, and more fully developed by Damian Cox [1997]. I must also examine whether we should believe certain principles linking s-parthood and m-parthood.

Recall that Armstrong endorses:

(Truthmaker Maximalism): Every truth has a truth-maker.[51]

(Truthmaker Necessitarianism): If *s* is a truth-maker for *t*, then, necessarily, if *s* exists, then *t* is true. [Armstrong 2004b: 5–7].[52]

All truths need truth-makers. The problematic truths are general truths of the form *all Fs are Gs*. Armstrong posits *general* facts, which are s-composed of the following elements: the m-fusion of all of the Fs, a relation that Armstrong calls the *totalizing* or *alling* relation, and the property of being G.[53] So the state of affairs in which all dogs are cute decomposes into the mereological fusion of all dogs, the totalizing relation, and the property of being cute.[54]

Consider truths such as, all states of affairs exist, or all states of affairs have s-parts, or *these* are all the states of affairs that there are. These truths must have truth-makers, and it is these general states of affairs that are *about* all states of affairs—and hence about themselves—that raise worries about irreflexivity.

But do these states of affairs show that s-parthood is not irreflexive? Consider a property *P* had by all actual states of affairs. (Perhaps it is *being*

[50]See Simons [1987 26–8]. A parthood relation has a closely associated proper parthood relation that is transitive and irreflexive iff that parthood relation is anti-symmetric.

[51]Armstrong [1997: 141] tells us that this principle should never be abandoned in ontological inquiry.

[52]Some friends of truth-makers reject Truthmaker Necessitarianism. One such philosopher is D. H. Mellor [2003: 213–4]. For a recent defence of Truthmaker Necessitarianism, see Armstrong [2004b].

[53]See Armstrong [1989b: 92–7], Armstrong [1997: 196–201], Armstrong [2004b: 68–82], Cox [1997], and Russell [1985: 100–4] for a discussion of general facts.

[54]One of the anonymous referees has brought to my attention the following serious problem for Armstrong's account of general facts. Since the mereological fusion of all the Fs is identical to the mereological fusion of all the m-parts of the Fs, Armstrong's view seems to imply that 'All Fs are Gs' entails 'All m-parts of Fs are Gs'. I suggest the following modification. Instead of taking the totalizing relation to be a two-place relation between a sum and a property, take the totalizing relation to be a multigrade relation between some things and the property they totalize. Suppose that the xs are not the ys but the m-sum of the xs is the m-sum of the ys. (The m-sum of my atomic m-parts is identical with the sum of my molecular m-parts, but my atomic m-parts are not my molecular m-parts.) It might be the case that the xs totalize a property that the ys do not. Intuitively, this is the case with the example just mentioned: all dogs are cute, but not all m-parts of dogs are cute.

One worry about this response is that the totalizing relation appears to be a genuine universal and Armstrong [1997: 85] is uncomfortable with multigrade universals. However, since the points I want to make seem unaffected by this problem, I will press on.

a state of affairs, a property Armstrong [1989b: 93] seems willing to accept.) Consider the proposition that all states of affairs have *P*. This proposition has a truth-maker, which must be a general state of affairs. Call it 'Bob'. According to Armstrong, Bob s-decomposes into an m-fusion of all the states of affairs, the totalizing relation, and *P*. Thus an s-part of Bob is the m-fusion of all states of affairs, and Bob is a proper m-part of this fusion. So Bob is a proper m-part of something that is a proper s-part of Bob.

This doesn't yet show that proper s-parthood is not irreflexive. Proper s-parthood is not irreflexive if the following is true:

(M2S): If x is a proper m-part of y and y is a proper s-part of z, then x is a proper s-part of z.

M2S is similar to S2M. We've noted that Armstrong is committed to rejecting S2M. It seems that he must also reject M2S, given his account of general facts. Bob does not provide a counter-example to irreflexivity without M2S.

Is Armstrong out of the woods? Let us introduce a generalized part-concept, *g-parthood*. We define g-parthood by first defining the logical disjunction of s-parthood and m-parthood: let us say that x is a *d-part* of y iff either x is an m-part of y or x is an s-part of y. D-parthood is *not* transitive. Suppose that w is an m-part of x and that x is an s-part of y. (Let w be my hand; let x be myself; let y be the atomic state of affairs of my having some property.) It follows that w is a d-part of x and that x is a d-part of y. But w need not be an s-part of y (given the failure of M2S), and w is not an m-part of y, since y is m-atomic. So w is not a d-part of y.

We now define g-parthood as the transitive closure of d-parthood. Once we've introduced the notion of a g-part, the notions of proper g-parthood, g-overlap, g-summation, etc., can be introduced as well. And since g-parthood is transitive, proper g-parthood must *not* be irreflexive. But this fact is not worrisome; in general, as noted earlier, *defined* or *non-basic* parthood relations need not satisfy the same axioms as fundamental parthood relations. We noted earlier in section 2 that non-basic parthood relations might, e.g., fail to be transitive, for example, but no basic parthood relation can fail to be transitive. And g-parthood is obviously a cooked-up, defined parthood relation. G-parthood could not reasonably be taken to be *the* fundamental parthood relation; any metaphysical system that takes s-parthood and m-parthood seriously must embrace compositional pluralism.

So Armstrong can claim that both proper m-parthood and proper s-parthood are irreflexive. However, this does not seem to be Armstrong's preferred response to this worry.[55] Armstrong's preferred response is to postulate an infinite sequence of increasingly higher-order facts of totality. It's not clear whether this solution works: if there is the proposition that *all* states of affairs have *P*, then this proposition must have a truth-maker. Does Armstrong deny that there are propositions that, so to speak, quantify over all the states of affairs that there are? Armstrong's remarks on this issue are

[55]Cox [1997] persuasively argues that this is the route Armstrong should take. Other friends of facts, such as D. H. Mellor, reject the demand for *general facts*. Presumably the concern about irreflexivity raised here will not worry these friends of (some) facts. See Mellor [2003: 213–5].

unfortunately unclear. And it might be that even if this solution is satisfactory from a technical standpoint, the resulting ontology is unacceptable; Cox [1997: 55–9] presents a nice argument for this latter point.

4.4 Inheritance Principles

In a recent paper, Theodore Sider [2007] argues that the following principle is conceptually true: if x is a part of y and that x has intrinsic property F, then y has the intrinsic property *having a part that has F*. If Sider is correct, a relation R is a parthood relation only if x bears R to y and x has an intrinsic property F, then y has the intrinsic property *bearing R to something that is an F*.

A related constraint is that any parthood relation should be preserved by intrinsic duplication. If R is a parthood relation, and x bears R to y, then for any z, if z is an intrinsic duplicate of y, then there is some w such that w is an intrinsic duplicate of x and w bears R to z.

Both constraints are satisfied by s-parthood, given the appropriate re-conceiving of the notion of duplication in the context of compositional pluralism:

> x *and* y are duplicates if and only if there is a one-one correspondence C between their g-parts that
>
> (i) preserves s-parthood, i.e., for all v *and* w that are g-parts of x, v is an s-part of w iff C(v) is an s-part of C(w),
> (ii) preserves m-parthood, i.e., for all v *and* w that are g-parts of x, v is an m-part of w iff C(v) is an m-part of C(w), and
> (iii) preserves perfectly natural properties and relations, i.e., for all g-parts of x, $x_1 \ldots x_n$, $x_1 \ldots xn$ instantiate perfectly natural property or relation F iff C(x_1) … C(x_n) instantiate F.[56]

This analysis ensures that (i) s-parthood is preserved by duplication, (ii) if an object has an s-part that is F, then that object has the *intrinsic* property, *having an s-part that is F*, (iii) the intrinsic properties of a thing's s-parts partially determine the thing's intrinsic character, and (iv) m-fusions and s-fusions of duplicates are not themselves duplicates.

Sider [2007] also claims that wholes inherit their spatial locations from their parts: if the *xs* compose y, and the *xs* are collectively located in space-time region R, then y is exactly located at R. This constraint seems reasonable when we restrict our attention to material objects. (Of course the chair is located at the region that is the sum of the locations of its legs, top, and back.)

Do structures inherit their locations from their s-parts? Consider the structural universal *being* H_2O. Its s-parts are hydrogen, oxygen, and the bonding relation. Each s-part is instantiated at regions where being H_2O is not instantiated. But the fusion of the regions where hydrogen, oxygen, and the bonding relations are instantiated does not seem to be identical with the fusion

[56] I thank Jason Turner for providing me with incisive criticisms of my previous attempts at formulating the notion of duplication.

of the regions where being H_2O is instantiated. Universals are located at all and only the regions at which they are instantiated. Since the s-parts of structural universals are instantiated in places where the structural universal is not instantiated—some hydrogen atoms are not part of water molecules—a structural universal's location is not inherited in the sense intended by Sider.

Similarly for states of affairs: it's natural to think that a state of affairs is located where (and only where) its constituent *particulars* are located. A fact's constituent universals are located where the constituent particulars are located, but might also be located at other places. If this is correct, then the region occupied by the state of affairs will typically be a proper sub-region of the union of the regions occupied by the s-parts of the states of affairs.

One might bite the bullet. Intuitions about where structural universals or facts are in space-time are weak, and whether or where these entities are located seems irrelevant to the assessment of whether they are fit to perform the tasks they are called on to do.[57]

Alternatively, one might meet the objection halfway. Although structural universals and states of affairs do not inherit their location in the sense intended by Sider—the location of a structural universal or state of affairs is not the *union* of the locations of its s-parts—nonetheless, the location of a structural universal or a state of affairs is *constrained by* or *supervenes on* the locations of its s-parts in the following ways. There can be no difference in the location of a structural universal or state of affairs without there being a difference in the location of its s-parts. Second, the location of a structural universal or state of affairs is always a (proper or improper) sub-region of the union of the regions of its s-parts. Perhaps this is enough to ensure that s-parthood satisfies the location requirement discussed by Sider.[58]

Perhaps there are other conceptually necessary conditions on being a parthood relation that s-parthood could be accused of not satisfying, but I don't know what they could be. Foes of structure-making: the ball is now in your court.

5. Reconceiving Distinctness

Recall the argument from Humean recombination that motivated Armstrong to claim that a state of affairs and its constituents are not distinct. The fact that Fred is fun exists only if Fred is fun. There is a necessary connection between two existences. So these must not be two *distinct* existences.

We can understand *distinctness* in two ways:

(D1): x is distinct from y just in case (i) x has no s-part in common with y and (ii) x has no m-part in common with y.

(D2): x is distinct from y just in case x has no g-part in common with y. (In other words, x and y are g-distinct.)

[57]For example, how could the *location* of a fact be relevant to whether it is suitable to be a truth-maker?

[58]These problems are generated by the universal constituents of structures. Were one to adopt a trope-theoretic version of the theory of structures, worries about location would not arise. Each particular structural trope would be located where its constituent tropes are located; each fact would be located where its constituent objects and trope are located.

D1 and D2 are not equivalent, so a choice must be made. Armstrong should choose D2. Here is a case showing that D1 and D2 are not equivalent and that D2 is preferable to D1.[59] Consider a conjunctive state of affairs, such as the state of affairs Fred is fun and Phil is Fun. Call this state of affairs 'Conj'. The existence of Conj entails the existence of Fred. So Conj and Fred must not be distinct.

But note that Conj is the m-fusion of the fact that Fred is fun and the fact that Phil is fun. Both of these facts are m-atomic; they have no proper m-parts. Fred is not an m-part of the fact that Fred is fun. So Conj and Fred do not have an m-part in common. Moreover, Conj and Fred have no s-parts in common. Conj is an m-fusion of something that has s-parts. But this does not mean that Conj itself has s-parts. And Fred certainly has no s-parts, since Fred is neither a state of affairs nor a structural universal.

So, if D1 is the correct account of distinctness, Conj and Fred are distinct, and we have a counter-example to the Humean principle.

Note, however, that although Fred and Conj do not s-overlap and do not m-overlap, they do g-overlap. Fred is an s-part of an m-part of Conj, and hence is a g-part of Conj. So if D2 is the correct account of distinctness, Conj and Fred are not distinct. Armstrong should accept D2 as his account of distinctness.

A worry remains. G-distinctness is a 'cooked-up' relation, not metaphysically fundamental. One might worry that appealing to this g-distinctness when explaining which necessary connections are permissible violates the spirit of Humeanism in much the same way that re-conceiving the notion of distinctness so that sets and their members are not distinct violates the spirit of Humeanism.[60]

I feel the weight of this worry, but I think it can be soothed. Say that a relation is a *pure compositional relation* iff it can be wholly analysed via the fundamental notions of parthood (whatever they may be) and logical vocabulary. Some of the parthood relations discussed in section 2, such as causally integrated parthood and functional parthood, are not pure compositional relations. A conception of distinctness in which two things fail to be distinct when one is a set containing the other is a conception of an impure relation. It is not unprincipled for the Humean to appeal *only* to pure compositional relations when stating her account of the permissible exceptions to the principle of recombination.

The compositional pluralist has a rich set of pure compositional relations. Both m-distinctness and s-distinctness are pure compositional relations. But note that g-distinctness is also a pure compositional relation.[61] So it is fair game for the Humean to appeal to it.

6. Concluding Remarks

I conclude that Armstrong's compositional pluralism is defensible. This doesn't mean that the friend of structures is in the clear. The theory of

[59]I thank Brad Skow for bringing this case to my attention, and for raising the problem discussed here.
[60]I thank an anonymous referee for pressing me with this worry.
[61]One might worry that the notion of transitive closure is a set-theoretical notion. But it can be defined without set-theory by appealing to the logic of plurals. See Boolos [1985] for details.

structures is neither ontologically sparse nor ideologically lean: the acceptance of two *sui generis* composition relations implies that this is the case.[62] Perhaps the benefits structures bring are not worth the theoretical costs. As Armstrong has said concerning other matters, this is to be decided in the end game.[63]

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[62]On weighing ontology and ideology in metaphysical inquiry, see Quine [1951], Lewis [1970], and Oliver [1996].

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