The Concreteness of Objects

An Argument against Mereological Bundle Theory

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Introduction/Abstract

In a series of publications, L. A. Paul has defended a version of the bundle theory according to which material objects are nothing but mereological sums of 'their' properties. This 'mereological' bundle theory improves in important ways on earlier bundle theories, but here I present a new argument against it. The argument is roughly this: 1) Material objects *occupy space*; 2) even if properties have spatial characteristics, they do not quite *occupy* space; 3) on no plausible construal of mereological composition does a mereological sum of non-space-occupying entities occupy space; therefore, 4) material objects are not mereological sums of properties.

1 Mereological Bundle Theory and Its Attractions

The more you examine a material object, such as a table or a flower, the more properties of it you come to know. First you establish that the table is brown, rectangular, four-legged, and hard; later you discover that it is made of cherry wood, weighs 53 kilos, is 140 cm across, is manufactured in Taiwan, and is more precisely sienna-brown; ultimately you might learn what percentage of the table is carbon, oxygen, hydrogen, and so on, what the table's exact mass is, and the like 'scientific properties.' But however long you examine the table, you will never detect something that goes beyond the table's properties, say a bare substrate that 'supports' the properties.

According to the bundle theory of material objects, there is a very simple reason for this: all a material object *is* is the collection of its properties. Our table is nothing more than a bundle of table-y properties. Very generically, the bundle theory says this:

(**BUNDLE**) For any material object O, there is a bundle B of properties, such that O = B.

(**BUNDLE**) faces a number of immediate challenges, however. One way to bring out the attraction of *mereological* bundle theory, as developed notably by L. A. Paul (2002, 2006, 2017a, 2017b), is to consider the way it elegantly responds to these challenges.

Perhaps the first challenge (**BUNDLE**) faces is that it is unclear what a bundle is. It is perhaps most natural to construe bundles as *sets*. However, sets are typically understood as *abstract* objects, whereas tables are concrete (Hoffman and Rosenkrantz 1994: 61). By Leibniz's Law, O cannot be identical with B if O is concrete and B is abstract.

One might take bundles to be simply *pluralities*. On this construal, what the table is identical to is just the table-y properties P_1, …P_n 'taken together.' This approach faces its own embarrassment, however, insofar as it involves an identity on one side of which is a plurality and on the other side a single individual. This is quite puzzling: again, by Leibniz's Law, we might expect that if B is a plurality whereas O is a oneness, then B ≠ O. Although there are certainly live approaches to many-one identities (see Contoir and Baxter 2014), it is *mutatis mutandis* preferable for the bundle theory if it can avoid getting mired in this particular can of worms.

Mereological bundle theory offers a simple way out, construing bundles as mereological sums. Unlike sets, sums are not by nature abstract; on the contrary, a sum of concreta is itself concrete. At the same time, the sum of table-y properties is one whole: the whole is one, even though its parts are many. According to mereological bundle theory, then, the table's properties are *parts* of the table, and the table is the (one) whole which they jointly compose.

Peter Simons (1994: 563) has argued that if you break down an airplane to its various parts, you do not find its weight among them. As an objection to mereological bundle theory this would misfire, though, insofar as it presupposes that the airplane's only parts are *spatial* parts. In Paul's mereological bundle theory, the table's properties are neither *spatial* nor *temporal* parts of the table, but what Paul (2002) calls *logical* parts (Paul 2002). The notion of logical part certainly calls for elucidation, but one way to characterize logical parthood is in terms of the mereological axioms that govern its behavior (see Paul 2002: 585).

A second challenge (**BUNDLE**) faces concerns arbitrarily bundled properties. Imagine a world with only two tables: one brown and rectangular, the other beige and round. Intuitively, the bundles comprising (i) brownness and rectangularity and (ii) beigeness and roundness correspond to material objects, whereas the bundles comprising (iii) brownness and roundness and (iv) beigeness and rectangularity do not. But what separates the former pair from the latter?

In addressing this challenge, one's first instinct is to require that the properties be 'co-instantiated.' The problem here is that 'co-instantiated' seems to mean 'instantiated by the same object,' which presupposes that we already have objects. More commonly, bundle theorists identify objects with bundles of *compresent* (i.e., collocated) properties (Russell 1950: 128). But this has its own cost, insofar as 'compresent' seems to mean 'present in the same location,' which presupposes that we can identify locations independently of objects – something that relationalist about space will deny. (It would be a shame if bundle theory were viable only for philosophers who reject relationalism.)

The mereological bundle theorist has a much more straightforward response to offer, namely, *restricted composition* of properties. It is true that in Classical Mereology composition is unrestricted, such that for any plurality of *x*s, there is a sum that the *x*s compose. But non-classical mereologies that do not include the axiom of unrestricted composition are available as well, and so mereological bundle theory may avail itself of one of them. It is important in this context to underline a distinction between *pure* and *applied* mereology. The pure/applied distinction is familiar from mathematics: all consistent and complete mathematical systems are equally good from the 'pure' standpoint, but only some of them actually *apply* to – i.e., accurately *describe* – worldly phenomena. Euclidean geometry and Riemannian geometry are equally good as purely formal systems, but only the latter describes the spatial structure of the world. Likewise, although many purely formal mereological systems are possible, the mereological bundle theorist might insist that only those with restricted composition of properties describe the compositional structure of objects – as far as their logical composition from properties is concerned. The bundle theorist can of course allow that composition *of objects* is unrestricted, as long as the composition *of properties* is restricted.

There is an independent question, of course, as to what principles govern – *restrict* – the composition of properties. A fully developed mereological bundle theory would have to include a story about this. But as Paul (2017a: 39) points out, one option – her favorite – is to embrace 'brutal composition' of properties. Because it has proven difficult to find a principled way to draw the distinction between sum-composing pluralities and non-sum-composing ones (Van Inwagen 1990), one option in the extant literature has been *primitivism* about composition: it is a brute fact that these pluralities over here compose a

sum and those over there do not (Markosian 1998). This kind of brutal composition can be recruited by the bundle theorist, especially given that some prominent traditional bundle theorists held anyway that the privileged relation that distinguishes object-constituting bundles from non-object-constituting ones is primitive (Goodman 1951).

A last major bundle-theoretic challenge worth discussing here is Max Black's (1952) two-sphere case. There is a possible world in which there are only two material objects – two qualitatively indistinguishable spheres that persist from the beginning of the world to its end. In fact, there are many such possible worlds. In some of them, space might be absolute, so that the two spheres actually have different *spatial* properties: one sphere is located in L_1 whereas the other is located in L_2. But unless it is a necessary truth that space is absolute, in *some* two-sphere worlds space is relational, so that the spatial properties (including relational spatial properties) of each sphere mirror those of the other. In those worlds, the two spheres would appear to have the exact same properties. Accordingly, there is only one bundle of properties in them, albeit two material objects. And this seems to suggest that neither object can really be *nothing but* that bundle of properties.

The extant literature contains a number of responses, including that the relevant worlds – at least as described – are not really possible (O'Leary-Hawthorne 1995). But a safer response, respecting the apparent possibility of the relevant worlds, distinguishes the two spheres by construing the properties being bundled as so-called tropes. Traditionally, properties have been construed either as *in re* universals, that is, entities which can be wholly present in different places at the same time; or as *ante rem* universals, that is, entities not present in *any place* and either not present at *any time* or present at *all times*.[1] A trope construal casts properties as 'individual accidents' or 'abstract particulars' (Williams 1953): entities such as this desk's roundness, that table's woodenness, and yonder flower's pinkness, which are each present in only one place at a time. Corresponding to these three construals of properties are three different kinds of bundle theory, identifying objects with bundles of ante *rem* universals, bundles of *in re* universals, or bundles of tropes. Mereological bundle theory does not as such have to commit to any one of these. However, a mereological *trope* bundle theory will diffuse the two-sphere problem most straightforwardly, since corresponding to the two spheres are two bundles of numerically distinct tropes: two sphericality tropes, two grayness tropes, and so on (see Campbell 1981: 482-3).

In its bid to expel material objects from the fundamental furniture of the world, assaying them instead as derivative upon properties, bundle theory belongs to a long ontological tradition of trying to shrink as much as possible the minimal base of reality. Its own history is illustrious, going back at least to Porphyry's *Isagoge* in the third century, with its first trope version showing up in the twelfth-century scholastic logician Gilbert of

Poitiers' work (Erismann 2014). Arguably, however, it is the recently developed mereological version of the theory that is most promising. Nonetheless, I will now argue, it faces a major challenge, to which no comfortable response is available. In the next section, I will present my basic argument against mereological bundle theory. In the subsequent sections, I will defend the argument's central premises.

2 The Space-Occupation Argument

One recurring but somewhat impressionistic complaint against bundle theory is that a collection of properties just does not seem 'substantial enough' to make up a material object (cf. Paul 2017a: 34). The thingy-ness of the object seems lost, so to speak. Now, put this way, the bundle theorist is entitled to reject the complaint as question-begging. The bundle theory *just is* the theory that a corporeal substance is a collection of properties; simply asserting that, no, a collection of properties is *not* corporeal, or *not* substantial, does not constitute new input to the dialectic.

The complaint, or one very like it, may however admit of a less question-begging articulation. The purpose of this section is to present such an articulation. The resulting argument is roughly this: 1) Material objects *occupy* space; 2) properties do not *occupy* space; 3) mereological sums of non-space-occupying entities do not occupy space; therefore, 4) material objects are not mereological sums of properties.

Material objects are concrete particulars. Their particularity consists in the fact that they can be wholly present in only one place at a time. What their concreteness consists in is a more controversial affair. Although the notion of concreteness is not my direct concern here, reflection on the fact that material objects are paradigmatically concrete entities is helpful in introducing the notion that does concern me – namely, that material objects *occupy space*.

Material objects have spatiotemporal properties, and this may be thought to constitute their concreteness. This is problematic, however: Chess was invented in India (spatial property) in the 6th century (temporal property), yet intuitively, chess – not this or that specific chess set, but chess as such – is an abstract entity (Rosen 2017).

It might be suggested that concreta are distinguished from abstracta in having not just spatiotemporal *properties*, but spatiotemporal *locations*. Intuitively, however, *tropes* have locations too, despite being *abstract* particulars (hence not *concrete* particulars).

What trope theorists have often suggested is that tropes are abstract because there can be many of them in the same place at the same time – they do not 'exclude each other' from the same space (e.g., the desk's brownness, its rectangularity, and its solidity are all in L).[2] In contrast, the desk itself is concrete, in that it cannot be in the same place as the chair or the computer at the very same time – these do 'exclude each other.' Concreta, on this view, are those entities of which there can be only one in a place at a time.

The problem with this approach is that it is incompatible with the (rather common) view that a material object and its matter are not identical, despite being perfectly collocated (see Baker 1997 and Fine 2003 among many others). On the assumption that both the material object and its matter (e.g., both the statue and the lump of clay of which it is made) are concrete, concreta can be collocated – i.e., located in the same spatial region at the same time – and thus fail to 'exclude each other.' This is not a problem for 'one-thingists' about the statue and the clay, of course. Nonetheless, 'two-thingists' can coherently claim that both the statue and the clay are concrete entities, and this means there must be some other notion of concreteness they are working with.

What underlies the intuition that both the statue and the clay-lump are concrete, even if they fail to 'exclude each other' spatially? I suggest that it is the fact that each *occupies* a portion of space. It is okay for two concrete entities to occupy the *same* region of space, so long as each occupies *some* region of space. What underlies this conception of concreteness is the idea that a concrete entity is not only *located* at a region, but *occupies* it. A statue does not only allow us to *locate* it through coordinates in space, it *fills up* the space delimited by those coordinates. Moreover, I would suggest, it is precisely because tropes, although *located* in space, do not *occupy* space, that we take tropes to be *abstract* rather than *concrete* particulars.

What does it mean to "occupy" a region? We can obtain an initial grasp of this notion by contrasting material objects with such particulars as tropes, states of affairs, and events. We are comfortable saying that the desk's trope of costing $70 plus tax is *located* where the table is, but it feels odd to say that the table's costing-$70-plus-tax trope *occupies* the space occupied by the table. Ditto for the *state of affairs* of the statue's costing $70 and the *event* of the statue being sold for $70. This is related to the fact that the statue is something you can grab with your hands and move from one region to another, whereas it is impossible to grab in one's hands a state of affairs, an event, or a trope – except, of course, by grabbing the associated material object. States of affairs, events, and tropes are all particulars, and accordingly have a location. But they differ importantly from material objects in their mode of being, insofar as they do not *occupy* the region at which they are located. This difference is captured by the conception of concreteness under consideration.

Offering a theoretical *analysis* of the occupation relation is a trickier issue. It is important to me to insulate the argument to follow from the dialectical vicissitudes likely to attend any specific analysis of the sort. But the following is clearly a central feature of space-occupying entities: every spatial proper part of the region occupied by the entity is occupied by some spatial proper part of the entity. If a $70 statue occupies region R, and P is a spatial proper part of R, then the statue has a spatial proper part that occupies P. (Note well: This is not to say that the statue must have a *physical* part that occupies P! A statue has many tiny empty spaces inside it – 'empty' in the sense that no physical object occupies them – but these are still *parts of the statue*, i.e., *spatial* parts.) Obviously, this is the case also for any material object collocated with the statue, such as the clay-lump, and is also the case with extended simples, if such there be: an extended simple has no physical parts but, being extended, certainly has spatial parts. In contrast, the same is not true of the statue's trope of costing $70: even if the trope is located in R, and therefore also in P, there does not seem to be a spatial proper part of the trope that is located exactly in P. Similar comments can be made about states of affairs and events.

It follows from what has been said so far that unlike tropes as standardly construed, it is essential to material objects such as tables, statues, and lumps of clay that they occupy space. No material object can exist without occupying some portion of space – indeed, it may belong to the very *mode of being* of material objects that they occupy space.

If one thing that distinguishes tropes from material objects is that material objects occupy space whereas tropes do not, then it is hard to see how any mereological sum of tropes could amount to a material object. When you put together four entities, each of which with a volume of one meter cube, you may produce a bigger entity whose volume is four meters cube. But if you put together four entities that do not have any volume, you have not started to make progress toward producing any entity with nonzero volume. Here, then, is a first anti-bundle argument:

1) Material objects occupy space;
2) Tropes do not occupy space;
3) A mereological sum of entities that do not occupy space does not occupy space; therefore,
4) Mereological sums of tropes are not material objects.

This argument bears two significant improvements.

First, if tropes do not occupy space, then plausibly universals do not either. This is obviously the case with *ante rem* universals, which are by definition altogether a-spatial.

But as I will argue in §3, it is also true of *in re* universals. So Premise 2 can be generalized to *all properties however construed*.

Secondly, the premises above are stated as *generics*.[3] But if we opt for a more precise formulation featuring quantifiers, we gain another degree of freedom: since the denial of (**BUNDLE**) is a mere existential, we can profitably demote Premise 1 to an existential, namely, that at least *some* material objects occupy space. It seems to me that the only reasonable way to deny this premise is by denying that there *are* material objects. That would be true either if there were no objects at all or if there were only *im*material objects. Perhaps one of these claims could be defended (some ontic structural realists defend the first, Berkeleyan idealists defend the second). But accepting either would only mean that the bundle theory of material objects *has no subject matter* – there is nothing it is a theory *of*. The aim of my argument, however, is to show that even if the bundle theory of material objects *has* a subject matter, it cannot be a correct theory of it. (Either way, the upshot would be that there is nothing of which the bundle theory is true.)

Combining these two improvements, we obtain the following anti-bundle argument:

1) Some material objects occupy space;
2) No properties occupy space;
3) No sum of entities that do not occupy space occupies space; therefore,
4) Some material objects are not sums of properties.

Call this the *space-occupation argument*. One may offer the space-occupation argument as a way to 'dress up in words' the pretheoretic intuition that collections of properties are not 'substantial enough' to constitute a material object. But the argument has whatever force it has regardless of whether it captures accurately that intuition.[4]

It is important to distinguish the space-occupation argument from a nearby argument that would be a simple instance of the fallacy of composition. Thus, the following is clearly fallacious:

1) Some tables are visible;
2) No particle is visible; therefore,
3) Some tables are not sums of particles.

This is clearly a fallacious argument, and so would this be:

1) Some material objects occupy space;
2) No properties occupy space; therefore,
3) Some material objects are not sums of properties.

But the space-occupation argument is of course very different from this last argument – it contains an extra premise, to the effect that no sum of entities that do not occupy space occupies space. This renders it perfectly valid. Indeed, the following is also a perfectly valid argument:

1) Some tables are visible;
2) No particle is visible;
3) No sum of entities which are invisible can be visible; therefore,
4) Some tables are not sums of particles.

There is no fallacy in this argument, of composition or otherwise. The only problem with it is that it contains a manifestly false premise – the third. But as I argue in §4, the corresponding premise in the space-occupation argument – that no sum of entities that do not occupy space occupies space – is highly plausible.

The remainder of this paper offers a sustained defense of the argument's premises: of Premise 2 in §3 and Premise 3 in §4. I do not pursue a defense of Premise 1 (i.e., that some material objects occupy space), since as noted the only reasonable way to deny it is by denying that the bundle theory of material objects has a subject matter.

3 Space-Occupying Properties?

In this section, I consider the mereological bundle theorist's options for denying that properties do not occupy space. This would probably be Paul's approach to the space-occupation argument. In general, it is Paul's consistent aim to reject any ultimate object-property dichotomy, that is, to collapse the distinction between objects and properties, identifying a single nature shared by both (i) the kinds of entities philosophers traditionally consider to be objects and (ii) those they traditionally consider to be properties. If objects and properties have a single nature, there should be no obstacle to 'generating' the former by summing the latter.

The issue, from our perspective, is whether this can really be done. If it is true that objects occupy space whereas properties, although *located* in space, do not *occupy* it, then this would appear to constitute an obstacle to collapsing the object-property distinction and generating objects from properties.[5] It is thus natural for the mereological bundle theorist to seek an account of properties as occupying space after all. In this section, I consider first the prospects for space-occupying tropes, then the prospects for space-occupying universals.

It might be suggested that all a bundle theorist needs, in order to ensure that a bundle of properties occupies space, is the claim that one of the properties therein bundled is the property of occupying space. However, this faces the following dilemma: does the property of occupying space occupy space or not? If it does not occupy space, it is unclear how merely bundling it with other entities which do not occupy space could make it the case that the bundle occupies space. It must be part of the suggestion, then, that the property of occupying space occupies space. We must realize, though, that this in no way falls out of the nature of the property. The nature of the property of being blue is not that it is blue; indeed, on most views properties are colorless. What the nature of the property of being blue is is that *whatever instantiates it* is blue. Because an object has the property, the *object* is blue – whether or not the property is. Given this, to claim that the property of occupying space occupies space, the bundle theorist would have to argue that the property of occupying space *self-instantiates*. But this is perplexing at many levels. Properties do not in general self-instantiate (*pace* Giberman 2014: 456-7). A table's property of costing $70-plus-tax does not itself cost $70. In our formal economy there is no recognized way to purchase properties, however construed (except perhaps when bundled). So there would have to be some special reason why the space-occupation property has this peculiarity that only it is self-instantiating.

The better option, it would seem, is to hold that *all* properties, by their nature, instantiate the property of occupying space – that is, that properties are in fact space-occupying entities. Some trope theorists seem to construe tropes in a way that suggests they very much occupy space. This is perhaps most explicit in Keith Campbell's work:[6]

> Form and volume are not tropes like any others. Their presence in any particular sum of tropes is not an optional, contingent, matter… Form [i.e., shape] and volume are therefore best considered not as tropes in their own right at all. Real tropes are qualities-of-a-formed-volume. The distinctions we can make between color, shape, and size are distinctions in thought to which correspond no distinctions in reality. (Campbell 1981: 486)

This approach does not treat an object's volume as a trope among others, but instead considers volume an aspect or dimension of every trope. The table's brownness trope is a brown table-shaped volume; the table's solidity trope is a solid table-shaped volume; the table's 53k-weight trope is a 53k table-shaped volume; and so on.

It is questionable whether Campbell-style voluminous tropes – call them *v-tropes* – have what it takes to 'make up' material objects. If a blue balloon is being inflated, we would like to say that there is a single material object that expands. If this material object is partially constituted by a blueness trope, then we should be able to say that that blueness trope expands. But since volume is essential to *v*-tropes' identity conditions, we must see

the inflation instead as a process of continuous destruction and replacement of an infinite series of instantaneous blueness tropes.

More importantly, it seems to me that depending on how *v-tropes* are exactly construed, they are either concrete particulars or not really intelligible. To see why, consider a solid brown round table. Its solidity trope is a solid table-shaped volume, according to Campbell. Let us now ask: What is this *v*-trope's color? Two potential answers present themselves: either (a) the solidity *v*-trope is brown or (b) it is colorless.[7] Both answers are highly problematic, however.

It is, in truth, quite hard to see how the solidity *v*-trope could be colorless. The solidity *v*-trope, on the present conception, is a certain volume of space, and volumes of space are the kinds of thing where color properties are instantiated. They are colorful things. Indeed, as we look in good lighting at the relevant table-shaped volume of space, the visual experience we enjoy is as of brown. What could be meant by the claim that this volume is colorless despite the testimony of our eyes? I think the idea must be that just as the statue and the clay are collocated but distinct, the solid table-shaped volume and the brown table-shaped volume are collocated but distinct; and because they are distinct the solid table-shaped volume is not itself brown. But while it seems coherent to say that there are two distinct *objects* collocated in the same volume of space, it is of questionable coherence to say that there are two distinct *volumes of space* in the same . . . what? It is important to appreciate the difference between embracing co-occupation of regions of space and embracing a kind of doubling *of space itself*. It is the latter that seems to be presupposed by the notion that the solidity table-shaped volume is not brown.

Suppose, then, that the solidity *v*-trope is brown. Then it would seem that the trope under discussion is not really a solidity trope but a solidity-cum-brownness trope. Next, though, we will ask whether this solidity-cum-brownness trope is round or shapeless, and if the answer is again that it is round, then in truth this is a solidity-cum-brownness-cum-roundness trope. The process will continue until we end up with a single *v*-trope for the whole table: a volume of space which is solid, brown, round, … [insert all other properties of the table]. At this point, though, the theory is no longer a bundle theory, but a theory proposing a specific ontological assay of familiar material objects, namely, that they are variously-qualified volumes of space.

Might the *v*-trope theorist resist this by claiming that the solidity *v*-trope is *essentially* solid and only *accidentally* brown and round, whereas the brownness *v*-trope is essentially brown and only accidentally solid and round? This would maintain the plurality of distinct *v*-tropes, which could then be mereologically bundled into a material object.

However, in this conception it is no longer clear why *v*-tropes are not themselves material objects. Just like the table itself, the solid table-shaped volume has determinate color, determinate weight, and more generally is qualitatively fully determinate. At the same time, it occupies space and can be wholly present in only one place at a time. In this scenario, the solid table-shaped volume and the brown table-shaped volume are qualitatively indistinguishable and differ only in which qualities are essential to them. In this respect they are rather like the statue and the clay-lump: two fully qualitatively determinate space-occupants that happen to coincide in space but have different essential properties (e.g., the statue is essentially goat-shaped, whereas the clay is only accidentally so). As we have seen, though, the statue and the clay-lump are collocated material objects, and it would seem we should say the same of the solidity *v*-trope and brownness *v*-trope: they are collocated material objects.

(To be sure, in the present conception there is a *plenitude* of coinciding *v*-tropes – perhaps one for every possible distribution of essentiality and accidentality across the qualities instantiated in any given volume. But this kind of plenitude can be applied to concrete objects themselves and in fact has been recently argued to effectively be implied by any kind of statue-clay pluralism – see Bennett 2004, Leslie 2011, and Fairchild 2019 inter alia.)

If tropes are material objects, then naturally, mereological sums of tropes can occupy space. But that would no longer offer a reductive account of material objects in terms of something that is not material objects. It would just offer a reductive account of some material objects in terms of others. It would no longer attempt to assay concrete particulars in terms of entities from a different ontological category. It thus would not threaten the notion that material objects are part of the world's ontological bedrock – part of the fundamental furniture of reality.

I conclude that Premise 2 of the space-occupation argument cannot be seriously challenged by appealing to space-occupying tropes, at least not if mereological bundle theory hopes to assay material objects in terms of entities that are not material objects. What about resisting the premise through appeal to space-occupying *universals*? Obviously, *ante rem* universals by definition cannot occupy space; but perhaps *in re* universals may be allowed to occupy the spaces in which they are located?[8]

I think the distinctive mode of being that *in re* universals claim for themselves makes this exceedingly difficult to envisage. Recall that by definition *in re* universals can be *wholly* present in different places at the same time. Now suppose for reductio the conjunction of the following two claims: (a) brownness is wholly present in different places

at the same time and (b) brownness *occupies* the space in which it is present. Then since brownness is *wholly* present in non-overlapping regions R and R* at the same time, it occupies *in its entirety* both R and R* at the same time. For instance, brownness *in its entirety* fills up the region occupied by my desk. The whole of brownness can therefore be found in this region, which is inside my office. If the whole of *x* can be found in some region R inside my office, though, then presumably none of *x* can be found to fill up some region in my neighbor's kitchen. But lo and behold, in this case it turns out that some of *x also* occupies some portion of my neighbor's kitchen's space, namely, the portion filled by his brown cutting board. In fact, *all* of *x* is *entirely* confined to the neighbor's kitchen – while at the same time being entirely confined to my office. In consequence, and given that the distance between my office and my neighbor's kitchen is exactly one mile, we can say that the entity we are interested in – brownness as a space-occupying *in re* universal – lies at exactly one mile from itself.

To be clear, I am not claiming to fully understand what the last few sentences are saying. Rather, I am claiming that these are some of the sentences we would need to understand in order to make sense of a space-occupying *in re* universal. And my point is not simply that *in re* universals' ability to be wholly present in different places at the same time involves certain oddities – this has been pointed out already (see, e.g., O'Leary-Hawthorne 1995 on immanent/*in re* universals' non-zero distance from themselves); my point is rather that combining these oddities with the notion that *in re* universals occupy the space at which they are present – and in consequence occupy in their entirety the space at which they are wholly present – makes the resulting entities scarcely intelligible.[9]

With this I close my defense of Premise 2 of the space-occupation argument. Next we take up the defense of premise 3.

4 Composition, Fundamental Science, and Fundamental Ontology

Might there be something about the operation of fusing that somehow *generates* the space-occupying character of its product? It is important to keep in mind here that despite the "productive" sound of the word "fusing," all it means in the mereological context is *summing*. And it is unclear how summation could radically transform the nature of the items summed. Paul is not confused about this:

> Do not be tempted by the fallacious idea that fusing is what somehow 'makes' the ordinary object . . . chunky or substantial. That's not how fusing works: it makes many into one, it doesn't make non-substances into substances or abstract things into concrete ones. (2017a: 42)

So for Paul, denying Premise 3 of the space-occupation argument is a non-starter. Nonetheless we should consider whether *someone else* might explore this way of defending mereological bundle theory.

In §2, this premise was presented, basically, as an a priori claim: it is armchair reflection which instructs that mereological summation of entities that do not occupy space cannot yield an entity that does occupy space. But a mereological bundle theorist might object that contemporary physics portrays a picture of the material world where tables and flowers are ultimately composed of entities whose relationship to spacetime is much more ambiguous.

'This is an area into which fools rush at their own risk,' warns Simons (1994: 569). Still, some superficial remarks may prove useful. In particular, I would like to suggest that while contemporary physics offers a 'surprising' portrait of the fundamental physical level(s), no evidence can be found in contemporary physics that fundamental particles *do not occupy space*.

One of the few things contemporary physics tells us *clearly* is that tables are made of elementary particles. In particle physics' Standard Model, these particles are of two kinds: (i) *fermions*, notably electrons and up and down quarks, which (very roughly) are like units of matter, and (ii) *bosons*, such as photons, which (again very roughly) mediate interactions between units of matter. Now, some bosons are massless, and this might raise the suspicion that they do not occupy space. But all fermions have nonzero mass, and this ought to raise the corresponding suspicion that they do occupy space.

The ontological oddity of fermions concerns not their space-occupation but their *individuality* (see French 1989). If you have two children, the probability that you have two daughters is .25, the probability that you have two sons is .25, and the probability that you have one daughter and one son is .5. The reason the last option is double as probable is that it amalgamates two distinct possibilities: that your first child is a daughter and your second a son, and that your first is a son and your second a daughter. Oddly, this is not how things work with particles. Suppose you have two particles each of which can be either here or there. You might expect a similar probability distribution: the probability that both are here would be .25, the probability that both are there would be .25, and the probability that one is here and one is there would be .5. But in quantum mechanics, the three scenarios are assigned *equal* probability. What this means is that quantum mechanics does not recognize two numerically distinct states of affairs, one where particle Jimmy is here and particle Johnny is there and another where Johnny is here and Jimmy is there. And if there is no difference between the states of affairs of *x* being in L and *y* being in L, this can only mean that *x* and *y* are not distinct individuals.[10]

However, note that these legitimate concerns about the *individuality* of particles do not entail anything about their status as *space-occupants*. Even if we strip the two fermions of their status as individuals on these grounds, it does not follow that they do not *occupy space*. It is perhaps indeterminate whether this fermion is here or there, but either way it occupies some space – some space there if it is there, some space here if it is here.

One way to think of the philosophical lesson here is this: What quantum mechanics brings out is that being an individual requires more than just being a space-occupying concrete particular; it requires also that permutations of space-occupying concrete particulars could constitute distinct states of affairs. Because some particles do not in fact satisfy this additional requirement, they do not qualify as individuals. But they still occupy space, as befits their status as concrete particulars and indeed as material objects.

A distinct challenge might be thought to hail from superstring theory, according to which tables and flowers are ultimately made of one-dimensional entities interacting within a ten-dimensional space. Since one-dimensional entities have no volume and so do not occupy space, superstring theory may rightly be taken to imply the constitution of space-occupiers by collections of non-space-occupiers. The problem, however, is that superstring theory has remained resolutely and fantastically evidence-free for over four decades. And although absence of evidence is not evidence of absence (at least in sufficiently large-scale systems), the fact that after so many years there is still no trace of certain particles that superstring theory must hypothesize in order to work has led many physicists to despair of it. Given this predicament, it is simply false that superstring theory *offers evidence* of space-occupiers built out of non-space-occupiers. What it offers are elegant speculations to that effect.[11]

The last move I want to explore on behalf of the mereological bundle theorist is that of retreating from the thesis that material objects *are* mereological sums of properties to the more fashionable-sounding claim that mereological sums of properties *ground* material objects.[12] This is a potentially good move, as the grounding of space-occupiers by sums of non-space-occupiers is not as immediately suspicious as the *identity* of space-occupiers with sums of non-space-occupiers; and at the same time, if material objects are grounded in sums of properties, then they are not among the ungrounded grounds of reality, the fundamental furniture of world.

(This dialectical situation has a certain historical precedent. Leibniz scholars have been confronted with an interpretive conundrum due to passages in which Leibniz seems to equate bodies with aggregates of monads. Given that monads are immaterial and bodies material, the notion that aggregates of the former could constitute the latter has perplexed

interpreters. The going interpretive hypothesis is that Leibniz could not possibly hold that bodies *are* aggregates of monads, and must therefore have had in mind that they rather *result*, or *emerge*, from monads – see, e.g., Jolley 2005: 77. Clearly, Leibniz scholars think that identifying bodies with monad-aggregates is too elementary a mistake to attribute to Leibniz. Some ontological daylight must be introduced between the two, though without compromising the basic thought that the existence of bodies ontologically depends on the existence of monads.)

What are we to make of such a ground-theoretic mereological bundle theory? There is no question, of course, that it affords extra room for maneuver. Still, there are two features commonly (though not universally) attributed to grounding that should give us pause, suggesting that a space-occupier could not in fact be grounded in a sum of entities none of which occupies space.

The first feature is that grounding is supposed to undergird *explanation* (Fine 2001: 15): if *x* grounds *y*, then *y* admits of a certain type of distinctively metaphysical explanation in terms of *x*.[13] We understand why {Socrates} exists when informed that Socrates exists, we understand why the desk is brown when informed that it is sienna-brown, and so on. Accordingly, if the ground-theoretic mereological bundle theory is true, then we should be able to explain the fact that there is a table here in terms of the fact that properties $F_1, \ldots, F_n$ are mereologically fused here. We should be able to understand *why* there is a table here given that the right fusion of properties occurs here. However, if the space-occupation argument is sound, this is not at all the case. If the table occupies some space and none of the properties does, we *cannot* in fact see why there should be a table here given that there is the fusion of properties here. On the contrary, we are faced with a clear *explanatory gap*: it is mysterious how a space-occupying entity could arise from the coming-together of so many non-space-occupying entities. What this suggests is that the retreat to a ground-theoretic version of mereological bundle theory is only helpful if we can independently overcome the space-occupation argument. But if we can, of course, retreat becomes unnecessary.

A second central feature of grounding is that it casts the grounded as *nothing over and above* the ground (Rosen 2010: §10), where this implies that adding grounded entities to one's ontology does not worsen one's ontological debit score (Schaffer 2015). Add up the costs of all the ungrounded entities in a certain theory of the world, and you have the full ontological cost of the theory. This feature of grounding suggests that grounded entities cannot be profoundly, categorically different from grounds. For adding categorically different entities to one's ontology *should* affect the theory's ontological cost. But now consider: if you start out with an ontology in which nothing occupies any space, and then decide to add to it entities the very mode of being of which is to occupy space, this seems

intuitively like a substantive addition that ought to affect the ontological cost of your overall theory.

These considerations suggest to me that the retreat from an identity to a grounding formulation holds no genuine promise for the mereological bundle theory of material objects. In particular, as long as the mereological bundle theorist has not explained how summing non-space-occupiers could yield a space-occupying entity, the resulting explanatory gap undermines a grounding connection. This concludes my defense of Premise 3 of the space-occupation argument, and thus of the argument as a whole.

Conclusion

The argument of this paper is at bottom simple: properties do not occupy space whereas material objects do, and summing entities that do not occupy space cannot magically secrete anything that does occupy space. This argument's conclusion is admittedly entirely negative, but it aliments a suspicion more positive in character: namely, that material objects, being uniquely space-occupying, cannot be 'built up' from any other types of entities and must consequently be taken as part of the fundamental furniture of the world. For any attempt to anchor the existence of material objects in more fundamental entities would run into the following dilemma: either those putative fundamentals would not occupy space, in which case it would be unclear how they could underlie the existence of material objects; or they would occupy space, in which case it would be unclear why they are not themselves material objects. Either way, it would seem that space-occupying entities must be posited as part of the fundamental make-up of reality.[14]

To say that material objects are part of the fundamental furniture of the world is not to say that *all* of them are: the existence of *some* material objects may well be grounded in that of other material objects. Still, the category of material object would have to be considered fundamental, insofar as *some* material objects would be among the ungrounded grounds of reality. This is consistent with either (a) a polycategorial ontology that admits properties and perhaps other entities alongside material objects or (b) a monocategorial ontology in which properties and other entities are 'built up from' material objects. My own sympathies lie with (b) – essentially, a form of what has historically been called 'nominalism' – but that goes far beyond what I have tried to argue for here. The argument here was that mereological bundle theory cannot work until an account is provided of how space-occupying entities may be 'generated' by the summation of non-space-occupying entities.[15]

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[1] I use the term 'entity' not for concrete particulars but in the most generic way possible, to stand for the ontological *summum genus*.

[2] There is another strand in trope theory that construes abstractness as a certain type of incompleteness – tropes are abstract because they are only fragments of being. However, as Donald Williams himself noted, strictly speaking this leads to the conclusion that 'everything but the World All is abstract in this broad sense' (1953: 14).

[3] Typically, generics are produced with so-called bare plurals, as in 'Dogs have four legs.' The fact that some dogs are three-legged makes the universally quantified claim 'All dogs are four-legged' false, but depending on how many and which dogs are three-legged, the fact that some dogs are three-legged is consistent with the truth of the generic 'Dogs are four-legged.' What the correct semantics for generics is is a lively area of debate in both linguistics and philosophy (see Leslie and Lerner 2016); we need not take a stand on it here.

[4] Some attempts to address the insubstantiality worry may manage to address other aspects of what we expect substances to be like, but fail to recover this aspect of concreteness. Simons (1994), for instance, attempts to recover existential independence of substances within a trope-bundle framework. Even if Simons succeeded, however, this would not yet capture the aspect of space-occupation.

[5] Consider for example the option of interpreting bundle theory as holding that objects turn out to be really just complex properties. (This is an odd way to interpret bundle theory, since there is no role for bundling in it at all, but let us bracket that issue.) If the thought is that reflection on the very notion of a material object instructs us that there is no object-property dichotomy because the

notion of an object is really just the notion of a complex property, this is certainly false. The very subject-predicate structure of our language and thought indicate clearly a presumption of dichotomy. If the thought is instead that ontological investigation instructs us that the ultimate nature of objects is just the nature of complex properties, this would be more plausible but would run straight into the problem raised by the space-occupation argument: if a material object occupies space, whereas a complex property does not, it is unclear how they could share a nature.

[6] More recently, Giberman (2014) has proposed an account of tropes that casts them as space-occupying entities. However, Giberman's idea of a trope is highly heterodox, insofar as he understands tropes to be not *abstract* particulars but *concrete* particulars (2014: 455). This construal suggests that the kind of entity he has in mind is very different from the kind of entity most trope theorists have had in mind. I will return to the possibility of construing tropes as concrete particulars at the end of my discussion of Campbell.

[7] Campbell himself does not seem to take a stand on this. Giberman (2014) appears to construe tropes along the (b) option.

[8] This would make them *concrete universals*, as opposed to the abstract universals they are typically taken to be. Trope theorists also allowed for entities they called concrete universals, but they had in mind something quite different: properties such as being Socrates and being Quine.

[9] In a different but somewhat related context, Cody Gilmore (2003) has proposed that apparent two-place spatial relations, such as '*x* is a mile from *y*,' are in reality four-place relations, in this case '*x* in location L_x is a mile from *y* in location L_y.' It is not clear how to apply this to '*x* is a mile from *x*' (where this does *not* mean 'a part of *x* is a mile from another part of *x*'). But even if we knew how to apply it, a bundle theorist could not make use of it unless, as noted in §1, she could identify locations independently of objects – which she may not wish to do.

[10] This phenomenon sometimes inspires the kind of 'ontic structural realism' according to which the only entities that are real at the fundamental physical level are the relations between particles, such as the distance between the particle here and the particle there (Ladyman and Ross 2007). Sometimes the view goes as far as to deny that there are really particles which serve as relata, sometimes it states (more modestly) that the particles exist but only as junctures in a web of relations, hence as derivative rather than fundamental entities.

[11] The attraction of superstring theory, it is worth noting, is mostly armchair-ish. The motivation for it has to do with a certain disunity in our fundamental understanding of the universe, namely, the fact that of four fundamental forces current physics posits, three are accounted for beautifully by quantum mechanics but the fourth (gravity) eludes quantum-mechanical explanation. Superstring theory offers an elegantly unified treatment of all four forces, but as noted it suffers from complete absence of empirical evidence.

[12] Typically, the relevant notion of grounding is construed as primitive and unanalyzable, picking out a sui generis asymmetric non-causal determination relation between facts, in which the fundament is *ontologically prior* to the terminus (Fine 2001).

[13] There are many debates about the nature of the relevant kind of explanation, as well as on its precise relationship to grounding. I bracket these debates here, hoping the point I want to make is neutral on them.

[14] Alternatively, the very existence of material objects could be denied. This would of course be a much more radical view (though certainly one defended by some metaphysicians, e.g. Ladyman and Ross 2007), and not one in which sums of properties are used to account for material objects. This view is not subject to the space-occupation argument, since as noted my target is only views on which material objects can be assayed in terms of bundles of properties, not views on which there are no material objects.

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