Bundle Theory's Black Box:
Gap Challenges for the Bundle Theory of Substance

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Abstract My aim in this article is to contribute to the larger project of assessing the relative merits of different theories of substance. An important preliminary step in this project is assessing the explanatory resources of one main theory of substance, the so-called bundle theory. This article works towards such an assessment. I identify and explain three distinct explanatory challenges an adequate bundle theory must meet. Each points to a putative explanatory gap, so I call them the Gap Challenges. I consider three bundle-theoretic strategies for meeting these challenges. I argue that none of them goes very far. The upshot is that, absent other strategies for meeting the challenges, bundle theory involves a significant amount of stipulation. This black box makes bundle theory relatively weak with respect to its explanatory power—unless, of course, rival theories of substance are unable to do better.

Keywords Ontology · Constituent ontology · Substance · Bundle theory · Tropes · Universals

There are different versions[1] of the bundle theory, but each deploys the same explanatory strategy: Take objects to have metaphysical parts or constituents, and take the character of an object to be grounded in those parts. Note that these are not ordinary, spatial parts. A metaphysical part is not supposed to be something like the *seeds* in an apple. Rather, a metaphysical part might be the *shape* or *mass* of an apple. To deploy this general strategy is to adopt a *constituent ontology*.[2] The constituent

[1]The flexibility of bundle theory can be seen in the different versions developed and/or critiqued in Casulo (1988), Robb (2005), Rodriguez-Pereyra (2004), Simons (1994), and Van Cleve (1985).

[2]In the literature, constituent ontologies are contrasted with relational ontologies. For a helpful discussion of the differences between these two general ontological strategies, see Loux (2006a, b).

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ontologist, as it were, "constructs" or "cooks up" an object out of metaphysically more basic entities.[3] One is tempted to imagine a metaphysician throwing some of these basic ingredients into cauldron, and *poof*!—out comes an object. I'll return to this metaphor in a moment.

Different versions of constituent ontology result from different answers to the following questions:

(i) How many types of constituents are there?
(ii) What is the nature of those constituents?

The bundle theory holds that there is only one type of constituent: *properties*. On this view, properties are the only kind of ingredient that goes in the cauldron. The idea is that an object is nothing but a bundle of properties. That is, objects are bundles—wholes—whose constituents are all properties. Thus, the metaphysical constituents of the apple are properties like color, shape, size, mass, etc. According to bundle theorists, then, the answer to the first question is *one*. Bundle theorists disagree, however, over how to answer the second question—over the nature of the constituent properties.

On the one hand, some bundle theorists take properties to be universals. Universals are shareable properties—that is, properties capable of multiple instantiation. The view that properties are universals is often called realism, so I'll call the resulting bundle theory a "realist bundle theory". Bertrand Russell (1940) and, more recently, John O'Leary-Hawthorne and J. A. Cover (1998) have defended this view. On the other hand, other bundle theorists take properties to be particulars, or "tropes". A trope is a non-shareable property, a property incapable of multiple instantiation. Versions of trope bundle theory have been defended by several contemporary philosophers, including Keith Campbell (1990), Douglas Ehring (1997, 2011), Markku Keinänen (2011), Anna-Sofia Maurin (2002), L. A. Paul (2002), David Robb (2005), Peter Simons (1994, 1998, 2000), and Donald C. Williams (1953).

Bundle theory has been extensively criticized and repeatedly defended. Some of the criticisms have been exclusively aimed at realist bundle theory, though others take aim at both realist and trope versions. In what follows, I wish to critically examine bundle theory in general, and to do so form a neglected angle—by assessing its explanatory power. To get an intuitive sense for the issue, imagine, again, a metaphysician stooped over a cauldron, tossing in a bunch of properties—shape, size, charge, mass, etc. Ultimately, this is supposed to generate an object. That is, it isn't enough that properties *exist*. Something needs to *have* those properties, and, we commonsensically take there to *be* entities which are *not* properties. Thus, it is at least a desideratum, and arguably an adequacy criterion, that a bundle theory have some account of how properties go together to generate, or yield, something that is an entity it is own right, something that is an object—that is, something that is not itself a property, and something that is charactered in the ways specified by its constituent properties. There are three distinct explanatory challenges here. First, there is what I will call the *Generative Challenge*, which asks: how do you go from there being properties, to there being a new entity that has those properties as parts? Second, there is what I will call the *Non-Property Challenge*, which asks: how do you go from there

[3] Cf. Maurin's (2002) project of "thing-construction".

being properties, to there being a new entity that is itself an object and not a property? And third, there is what I will call the *Character Challenge*, which asks: how do you go from there being properties, to there being a new entity that is charactered in each of the ways specified by those properties? Because each of these points to a putative explanatory gap, collectively, I will call these the *Gap Challenges*.[4]

So, what does the trick? What binds the properties together and cooks them up into an object that is charactered in all the right ways? In the metaphor we can point to the cauldron. But what is the cauldron supposed to represent? What plays the role of the cauldron on bundle theory? There are legends about the so-called *Philosopher's Stone*—the mythical stone that turned junk like lead into gold. There is, apparently, no such Stone. But there does seem to be something similar that the bundle theorist needs. We might call it the *Philosopher's Cauldron*—it is the *object-maker* that cooks up objects out of only properties. The question, then, is this: What is the object-maker? That is, what plays the object-making role?

It is important that this question not be understood as presupposing that there must be *an entity* that plays the object-making role. In other words, the question should allow for a bundle theory on which, strictly speaking, there is no special constituent that is the object-maker. For example, many bundle theorists take properties to form an object in virtue of those properties *being related* in a certain way. Bundle theorists disagree, however, concerning whether a certain kind of intra-bundle *relationship* requires the bundle to contain a *relation* per se (i.e., a relational property). Here I follow E. J. Lowe (2006: 91f) in using "relationship" as a term that is neutral on the question of whether there are relations per se. In what follows, I will largely set aside questions concerning whether object-making relationships must be construed as constituent relations. I do so to focus on the explanatory power of candidate object-making relationships, or object-makers, for short.

However we understand the object-maker, it (or "it") is supposed to hold all the constituent properties together, and in virtue of doing so, yield or generate the object itself. Amongst bundle theorists, there are three main proposals concerning the nature of this relationship.

- *Co-location*: being at the same place is the object-maker.
- *Fusion*: a certain part-whole relationship is the object-maker.
- *Interdependence*: a certain interdependence relationship is the object-maker.

In what follows, I discuss each proposal in turn. I focus on whether fusion (Fusion as the Object-Maker) or interdependence (Property-Interdependence as the Object-Maker) is suited to play the object-making role. The lessons here will then be applied to co-location (Co-location as the Object-Maker). My overall conclusion will be that these principles provide a bundle theorist with little by way of explanatory resources

[4] In this paper I set aside a distinction between *thin*- and *thick*-character. Thin-characteredness consists in an object's being charactered in some specific way (e.g., being spherical), whereas thick-characteredness consists in an object's being charactered in multiple ways at once (e.g., being spherical, hard, and massive). Elsewhere I raise challenges for bundle theory's ability to account for thick-character (see Garcia, Trope Theory and Two Concepts of a Trope, unpublished, and Garcia, Tropes as Character Grounders, unpublished).

to meet the Gap Challenges. In the final section, I explain the dialectical significance of this conclusion (Bundle Theory's Black Box).

Fusion as the Object-Maker

It is widely believed that on a bundle theory, objects are mereological fusions of properties. Theodore Sider, for example, says that according to a bundle theory an object "…is exhaustively composed of (i.e., is a mereological fusion of) its universals. …Take [an object], and mereologically subtract away its universals. Is anything left? According to the bundle theory, no" (2006: 387). One advantage of fusion is that it provides a straightforward answer to the Generative Challenge: the mereological composition relation is such that, if it holds between properties *F* and *G*, then there is a third entity that has *F* and *G* as parts. The third entity is the *fusion* of *F* and *G*. Thus, fusion is an attractive candidate for the object-making relation.

Unfortunately, an appeal to fusion will not help a bundle theorist to meet the Gap Challenges. Or so I will now argue. Appealing to fusion carries with it the burden of either (i) accepting whatever ontology results from unrestricted composition or (ii) specifying an additional principle that restricts composition. I will consider each option in turn.

One the one hand, suppose that composition is unrestricted. This option is problematic for two reasons. First, not only would unrestricted composition yield a bloated ontology, it would yield an ontology bloated by entities that are ontologically on par with ordinary objects. This would result in an ontology that is significantly more implausible (counter-intuitive, costly, etc.) than the ontology normally thought of as resulting from unrestricted composition. In other words, it is one thing to allow that for every two entities whatsoever, there is a third entity that is their fusion. But it is another thing to allow that for every two entities whatsoever, there is a third entity that is their fusion and is ontologically on par with ordinary objects. To avoid this bloat, the bundle theorist will need to specify a further principle that restricts fusion, and doing so implies that appealing to fusion alone won't suffice to meet the Gap Challenges.

The second problem for unrestricted composition is worse. Suppose that fusion of properties is unrestricted and, for the sake of argument, suppose also that fusion by itself suffices to generate objects. Unfortunately, this would result in fusions of incompossible properties and thus objects that are charactered in impossible ways. For example, there would be the fusion of cubicity and sphericalness, and the fusion would be an object that is both cubical and spherical. Thus, on pain of absurdity, fusion must be restricted by an additional principle if fusion is supposed to play a role in generating objects out of properties.

In sum, it seems that *by itself*, fusion is a poor candidate for playing the object-making role. This raises an important question. Can bundle theory appeal to fusion plus some additional restrictive principle? In other words, if fusion by itself won't suffice as the part-whole relation that generates objects, the natural move would be to supplement fusion with an additional principle. This is option (ii) above. Here, fusion is not sufficient to play the object-making role; rather, it is fusion plus some additional principle that restricts composition.

The prospects of this move depend upon whether and how the parts of a fusion determine the kind of thing that the fusion is. Unfortunately, however, there are good

reasons to accept the following property-fusion principle, or PF: *a fusion of properties must itself be a property.*

In a moment I offer support for PF. But first I'll note its significance. If PF is true, then, with respect to meeting the Gap Challenges, any appeal to fusion is a dead end. This is because the bundle theorist is trying to generate an object out of properties, and an object is not itself a property. But, if PF is true, then any appeal to fusion—even if it is restricted by some further principle—will guarantee that the result is another property and *not an object.* Thus, an appeal to fusion by the bundle theorist, even as only a necessary condition, would seem to backfire as a strategy for meeting the Non-Property Challenge.

So PF, if true, would bar the bundle theorist from any appeal to fusion. But what can be said in favor of PF? Well, at least this: *that PF is a tacit principle at work in several nearby metaphysical disputes.* I'll mention three sources of support for PF.

First, and somewhat ironically, support for PF can be found in the work of Williams, a trope bundle theorist. According to Williams, "everybody agrees that a [fusion] is of the same type with its terms" (1953: 10). He appeals to this principle in order to secure the *particularity* of a bundle of properties by taking the bundle to be a fusion of *particularized* properties (or tropes). Unfortunately, Williams doesn't seem to notice that while the principle he appeals to would also guarantee that the fusion is a *property.* In other words, if, as he says, the fusion is of the same type as its terms, then if the terms are properties, then so is the fusion.

A second source of support for PF can be found in the mereological bundle theory developed by L. A. Paul (2002). On this view, objects are fusions are properties. Moreover, on Paul's view, the property of *being identical to Socrates* is an *improper* part of Socrates (Paul 2002: 581). It follows that Socrates is a property. Thus, if Paul is right, then a bundle theorist who takes fusion to be the object-maker will thereby ensure that the bundle itself is a property and not an object.

A third source support for PF is the dispute over so-called structural universals.[5] Central to this dispute is David Lewis's claim that a realist about universals cannot analyze a complex property, like *being methane*, as a *fusion* of simpler properties (1986). According to Lewis, however, the problem *isn't* that a fusion of properties can't itself be a property. In fact, it is clearly tacitly assumed by participants in this debate that a fusion of properties *would* be a property. According to Lewis, the problem for the realist lies elsewhere. Roughly, the problem is the fact that any given universal cannot count as more than one part of any given fusion. This raises a problem for any realist who wants to take a property like *being methane* to be a fusion of several universals, including *four* hydrogen universals. But the details here are beside the point. The point is that *in that dispute*, the participants take for granted that a fusion of properties would itself be a property. In other words, the debate is predicated on PF. Note also: if there were a problem with PF, then there would be a more fundamental problem for the realist than the one raised by Lewis. In other words, if a fusion of properties is not itself a property, then the problem Lewis raises for the realist is moot. Thus, if there were doubts about PF, you would expect those doubts to be expressed by participants in the dispute over structural universals. The

[5] The *locus classicus* for this debate is the exchange between D. M. Armstrong (1986), John Bigelow (1986), and David Lewis (1986).

fact that PF is taken for granted in the dispute over structural universals strongly underscores its intuitive plausibility.

So much for whether and how an appeal to fusion will help to meet the Gap Challenges. Although fusion may help the bundle theorist meet the Generative Challenge, this help would seem to be a poisoned chalice. If composition is unrestricted, taking fusion to be the object-maker leads to incompossibly charactered objects. If composition is restricted, then fusion alone does not play the object-making role; rather, it is fusion plus a principle that restricts composition. However, this latter approach is also problematic. Given PF, the fusion of properties yields another property, not an object. Thus, whether restricted or not, fusion would not seem to help the bundle theorist meet the Gap Challenges.

Property-Interdependence as the Object-Maker

I will now consider another strategy for answering the Gap Challenges. There are different ways to develop this general strategy, but the basic idea is to take some sort of intra-bundle dependence or interdependence relation to play the object-making role. I will assess the prospects of this strategy by considering how it fares within a *trope* bundle theory. I do so for three reasons. First, as far as I know, this strategy has been deployed *only* by trope bundle theorists. Second, for reasons that should be apparent below, the strategy is probably a non-starter for a realist bundle theory. And third, if—as I argue below—the strategy does not help a trope bundle theory to meet the Gap Challenges, then it will not help a realist bundle theory either.

Peter Simons (1994, 1998, 2000), Anna-Sofia Maurin (2002), and Markku Keinänen (2011) have developed trope bundle theories on which intra-bundle dependence relations play a crucial role. Fortunately, in order to assess the merits of this strategy for meeting the Gap Challenges, I can forgo a discussion of the fine-grained details of these views.[6] Instead, I will do two things. First, I will focus on so-called Nuclear Bundle Theory, which postulates various types of intra-bundle dependence relations. I will argue that these dependence relations do not help the bundle theorist meet the Gap Challenges. Second, I will consider whether *any* sort of dependence relation could play the object-making role.

Crucial to Nuclear Bundle Theory is the proposal that tropes are—as a matter of primitive fact—variously existentially interdependent. According to Simons, tropes are such that each "by its nature requires" the existence of distinct token tropes and/or types of tropes (Simons 2000: 153). The "and/or" in the latter claim marks the idea that a dependence relation between two tropes will be either *rigid* or *generic*. In a case of *rigid dependence*, the existence of a trope depends upon the existence of a distinct *token* trope. Suppose, for example, that m_1 is a mass trope of 1 kg and c_1 is a -e charge trope. If c_1 rigidly depends on m_1, then necessarily, c_1 exists only if m_1 exists. Notice that no other token 1 kg mass trope will satisfy the existence needs of c_1. Even if m_1 and m_2 are exactly similar 1 kg tropes, c_1's existence requirements cannot be satisfied by m_2. In a case of *generic dependence*, the existence of a trope depends upon the

[6] Elsewhere I develop more detailed criticisms (Garcia, Problems for the Nuclear Theory of Substance, unpublished).

existence of a distinct *type* of trope. To change the example, suppose that c_1 (only) generically depends on m_1. If so, then necessarily, c_1 exists only if some mass trope or other exists. That is, the existence of *any* mass trope will satisfy the existence needs of c_1. By means of the formal relations of rigid and generic dependence, the Nuclear Bundle Theory aims to construct substances from tropes.

I will now argue that the dependence relations postulated by Nuclear Bundle Theory do little to help the trope theorist meet the Gap Challenges. Indeed, the problem here is similar to the one we saw concerning fusion, in that an appeal to dependence relations seems to yield the wrong sort of result.

I'll begin by considering how rigid dependence fares as the object-maker. Suppose that two tropes, sphericity$_1$ and hardness$_1$, are mutually rigidly dependent and thereby form bundle B. For the moment, set aside the Character Challenge and assume that sphericity$_1$'s being a part of B guarantees that B is spherical, and that hardness$_1$'s being a part of B guarantees that B is hard. Notice that because sphericity$_1$ and hardness$_1$ are mutually rigidly dependent, necessarily, the existence of one entails the existence of the other. It is here that trouble arises. The trouble is that within the framework of a constituent ontology, the fact that sphericity$_1$ and hardness$_1$ are mutually rigidly dependent gives us a good reason to *identify* sphericity$_1$ and hardness$_1$. In a moment, I will offer these reasons. But for now, note that if this is right, then taking the tropes in a bundle to be mutually rigidly dependent guarantees that the bundle itself is a *property*. This means that an appeal to mutual rigid dependence is a non-starter for the trope theorist who wants to ensure that the bundle is not itself a property. In other words, an appeal to rigid dependence will be of no help in answering the Non-Property Challenge.

But what reason is there to think that if sphericity$_1$ and hardness$_1$ are mutually rigidly dependent, then sphericity$_1$ is identical to hardness$_1$? The pressure to identify character-grounding constituents that stand in such an interdependence relation seems especially strong for a constituent ontologist. This is because her general strategy is to explain the character of an object by construing the object as having a constituent/whole structure and postulating constituent properties as that which explains why the whole is charactered as it is. Now, as a general rule, considerations of parsimony forbid the constituent ontologist from positing more structure—that is, character-grounding constituents—than is needed to account for the character of an object. To do so would be explanatorily superfluous with respect to accounting for the character of objects. With this in mind, consider again the example of sphericity$_1$, hardness$_1$, and B, the bundle they constitute.

As we've seen, because sphericity$_1$ and hardness$_1$ are mutually rigidly dependent, necessarily, the existence of one entails the existence of the other. Recall that I am setting aside the Character Challenge and thus assuming that if a trope is a part of a bundle, then the bundle is charactered in the way specified by that trope. Thus, sphericity$_1$'s being a part of B guarantees that B is spherical. But because these tropes are mutually rigidly dependent, the existence of sphericity$_1$ *also* guarantees that B is hard. Notice, then, that the existence of sphericity$_1$ *ensures* that B is charactered in *every* way specified by the constituent parts of B that are mutually rigidly dependent. Thus, as a character-grounding constituent, sphericity$_1$ has the same *content* as hardness$_1$ (and *any* trope with which sphericity$_1$ is mutually rigidly dependent). But if sphericity$_1$ and hardness$_1$ have the same content—if they suffice the ground the

same character—then there is no need to maintain their distinctness. That is, the constituent ontologist should reject the original assumption that sphericity$_1$ is non-identical to hardness$_1$. More generally, she should deny that, strictly speaking, there is a *plurality* of character-grounding constituents in B. In sum, if B's character-grounding constituents are mutually rigidly dependent, then postulating a *plurality* of such constituents would seem to be explanatorily superfluous with respect to grounding B's character.[7] If the foregoing is correct, then B has only *one* constituent, a single trope in virtue of which B is multiply-charactered. And, if mutual rigid dependence entails the identity of its terms, then it is formally a reflexive relation, much like *being self-identical*. As a result, it is difficult to see how mutual rigid dependence could generate a new entity at all. It is, in other words, not going to help the bundle theorist meet the Generative Challenge.

Furthermore, if mutual rigid dependence doesn't yield a new entity, and if its terms are identical, then the *result* of mutual rigid dependence is itself a trope. In this way, taking the tropes in a bundle to be mutually rigidly dependent ensures that the bundle has a single property as its constituent. Thus, because the property is an improper part of the bundle, the bundle just is the property. In this way, taking the tropes in a bundle to be mutually rigidly dependent ensures that the bundle is itself a property. Thus, for a trope bundle theorist, appealing to mutual rigid dependence, like appealing to fusion, generates the *wrong kind* of entity. Such an appeal will not help the bundle theorist meet the Non-Property Challenge.

Readers familiar with the details of Nuclear Bundle Theory will be wondering whether these untoward conclusions can be avoided if we take bundles to have the sort of two-tiered structure originally proposed by Simons (1994). More specifically, on Nuclear Bundle Theory it is possible that there be a substance constituted by two collections of tropes: a *nucleus* and a *halo*. A nucleus consists of mutually rigidly dependent tropes. In a two-tiered substance, one or more nuclear tropes (and so the nucleus, by transitivity) has *generic* requirements not met by nuclear tropes. All the generic requirements of the nuclear tropes are met by halo tropes. Halo tropes, in turn, are rigidly (but one-sidedly) dependent only on their nucleus (Simons 2000: 243). Together, a nucleus and halo constitute a collection such that each trope in the collection has its existential needs (rigid or generic) met within the collection.

In accord with this proposal, suppose that O is an object that involves nucleus N and halo H. Now, if the above argument is correct, and mutual rigid dependence collapses its terms into a single trope (etc.), then N is *itself* a single trope. Because there are no distinct tropes in N, there are no mutually rigidly dependent tropes in N. Given the two-tiered structure, this means that there are no tropes in O that are mutually rigidly dependent. That is, *every* object-making relation involved in the generation of O is *weaker than* mutual rigid dependence. But if so, mutual rigid dependence cannot play the object-making role, and so does not help the bundle theorist to meet the Gap Challenges.

I've been arguing that there are good reasons to think mutual rigid dependence isn't suited or even capable of playing the object-making role. I will now consider whether an appeal to *any* sort of dependence relation can do the trick.

There are a variety of dependence relations, but the point I wish to make can be made about all of them. Recall that the Gap Challenges ask the bundle theorist to

[7] This point was developed in conversation with Michael Loux.

explain how tropes go together to yield a new entity that is not a property and that is charactered in the ways specified by those properties. Thus, the question at hand is this: Is there *any* type of dependence relation that will do the trick?

Suppose there exist two properties, F-ness and G-ness. (For the point I wish to make, it does not matter whether these are tropes or universals.) Suppose also that they stand in some specific type of dependence relation R. Now, if their standing in R generates a new entity, it seems most plausible to take that new entity to be a state of affairs, namely, *F-ness's standing in R to G-ness*. For example, if R is an asymmetrical dependence relation, then the resulting entity would seem to be the state of affairs, *F-ness's depending on G-ness*. It might seem, then, that a dependence relation *does* help the bundle theorist meet the Gap Challenges. After all, it succeeds in generating a new entity—a state of affairs. And one might argue that such an appeal meets the Non-Property Challenge, on the grounds that the entity it generates—a state of affairs—is not a property. This leaves the Character Challenge, which asks how the agglomeration of specific characteristics yields an entity which itself is charactered in all the ways specified by those characteristics. Unfortunately, it seems that *this* challenge cannot be met by an appeal to dependence relations. This is because a state of affairs like *F-ness's depending on G-ness* need not itself be F. Less abstractly, if sphericity stands in a dependence relation to hardness, then the resulting state of affairs is *sphericity's depending on hardness*. But the latter only *involves* sphericity; the state of affairs is not itself spherical.

Of course, the above example is rather simplified. For example, it doesn't involve the kind of system proposed by Nuclear Bundle Theory, a system of mutual interdependence relations holding directly and indirectly between numerous properties. But suppose we complicated the example by introducing new properties and various types of dependence relations between those properties. And, suppose some new entity is generated as a result. No less than in the previous simplified example, it would seem most plausible to take the new entity to be a fact or state of affairs. Although such a state of affairs would be difficult to describe and would *involve* its constituent properties, it is difficult to see why the state of affairs would be *charactered* in all the ways specified by those properties.

So it seems that the lesson here can be generalized. Postulating dependencies between properties—whether tropes or universals—is most plausibly taken to yield state of affairs *involving* those properties, not entities *charactered* by those properties. Thus, it seems that an appeal to dependence relations will not help the trope theorist meet the Gap Challenges.

Note that the argument in this section suggests that even if the previous argument is wrong—if mutual rigid dependence *doesn't* entail the identity of its terms—it would still seem that mutual rigid dependence generates only a state of affairs. And, more to the point, the state of affairs would not seem to involve anything that is charactered in the requisite ways.

Co-location as the Object-Maker

This bring us to the third candidate for playing the object-making role—co-location. I will conclude this article with a few comments as to why co-location is ill-suited to be the object-maker.

Traditionally, co-location has been the cauldron of choice for cooking up objects out of properties. And, to be sure, there is something rather intuitive about the idea. You look at a carrot, for example, and you notice that the carrot is propertied in several ways—it is shaped, sized, colored, etc.—and that the carrot is entirely in one location. This naturally suggests that the co-location of properties plays an important role in generating an object out of those properties. Perhaps it is not surprising, then, that bundle theorists often appeal to co-location. Williams, for example, takes objects to be "concurrence" fusions of tropes, where "concurrence" is the limiting value of location (1953: 8). However, although sometimes a *label* connoting the idea of co-location is still used,[8] more recent trope theorists seem to be wary of appealing to co-location in their accounts of individuals. This wariness is warranted and due to the controversial and opaque nature of space itself.

The problem is this. For an appeal to co-location to have any explanatory force, it needs to be spelled out in terms of a specific view about the nature of space. Unfortunately, such views are notoriously controversial. Thus, the worries that attend a given view of space will be inherited by a bundle theory that understands co-location in terms of that view. Notwithstanding this point, it doesn't seem that either of the main rival views about the nature of space will be of help to the bundle theorist. First, suppose we answer the Gap Challenges by appealing to co-location understood on a substantival view of space. The worry here is that a location will ultimately be either (a) something like a bare particular—i.e., a constituent in the bundle that underlies all the properties that are said to be at that place—and so violate the all-constituents-are-properties constraint of a bundle theory, or (b) the very sort of thing for which we were trying to give an account—namely, an object that has properties. Neither of these options seems workable. Second, suppose we understand co-location on a relationalist view of space. The problem here is that on such a view, objects are logically prior to locations. Thus, co-location cannot play the role of the object-*maker*. In sum, whether on a substantival or relational view of space, co-location is ill-suited to play the object-making role.

There is a further problem with co-location. This problem is similar to the one already noted concerning dependence relations: The result (if there is one) of the co-location of two properties is most plausibly taken to be a state of affairs involving those properties, but not a state of affairs charactered in the ways specified by those properties. If sphericity and hardness are co-located, it seems that (at most) there exists the state of affairs, *sphericity's being at the same location as hardness,* or *sphericity and hardness being at the same location*, etc. But again, although such a state of affairs is not a property, it is also not charactered in the ways specified by its constituent properties. The state of affairs, *sphericity and hardness being at the same location*, is not itself spherical or hard. Thus, co-location isn't sufficient to yield an object.

[8] Although Maurin devotes a third of her monograph, *If Tropes*, to "compresence", this material is devoted to developing a specific type of *dependence* relation. In fact, it is only at the end of the book that she addresses the issue of spatiotemporal location: "We have…found that the whole complicated matter of the compresence of tropes raises spatiotemporal questions again and again. Simply pondering the notion of 'compresence' (togetherness—presence in the same place) raises some" (2002: 176). It is not clear how this parenthetical comment is supposed to fit into her official construal of compresence as a type of dependence relation that holds between tropes.

Bundle Theory's Black Box

My primary aim has been to assess the explanatory power of bundle theory by considering various strategies for meeting the Gap Challenges. To this end, I've considered the three main types of intra-bundle relationships appealed to by bundle theorists: fusion, dependence relations, and co-location. I have argued that these principles provide a bundle theorist with little by way of explanatory resources to meet the Gap Challenges. Absent alternative strategies for meeting these challenges, it would seem that bundle theory requires a significant amount of explanation-by-stipulation. That is, it seems that the bundle theorist must ultimately take it to be a *primitive* fact that the explanatory gaps are traversed—that it is simply *axiomatic* on her view that properties go together to generate non-properties which are charactered in the ways specified by those properties. If so, then on bundle theory, object-making is an explanatory black box. Or, to return to the previous metaphor, bundle theory requires a philosopher's cauldron—a rather mysterious affair whereby objects are cooked up out of only properties. This makes bundle theory relatively weak with respect to its explanatory power—unless, of course, rival theories of substance are unable to do better.[9] Whether or not other theories of substance can do better must be addressed elsewhere.

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[9] Rivals include a substance-attribute theory (e.g., Lowe (2006)) and austere nominalism (described in Carroll & Markosian (2010) and Loux (2006b)).

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