

# Essential bundle theory and modality

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**Abstract** Bundle theories identify material objects with bundles of properties. On the traditional approach, these are the properties possessed by that material object. That view faces a deep problem: it seems to say that all of an object's properties are essential to it. *Essential bundle theory* attempts to overcome this objection, by taking the bundle as a specification of the object's essential properties only. In this paper, I show that essential bundle theory faces a variant of the objection. To avoid the problem, the theory must accept the contingency of identity. I show how this can be achieved in a coherent and well-motivated way, a way that isn't available to traditional bundle theories.

**Keywords** Essence · Modality · Bundle theory · Essential bundle theory · Material objects · Contingent identity · Counterpart theory · Metaphysics

## 1 Introduction

What are material objects, metaphysically speaking? We might try to reduce them to some other metaphysical category of being. We might tell a story on which (non-fundamental) material objects are built out of basic bits of matter. We might identify material objects with the area of spacetime they inhabit. Or we might treat them as primitive, so that there is no informative understanding of what they are in general. Bundle theories identify material objects with bundles of properties and, in so doing, reduce the category *material object* to the category *property*.

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Reductive approaches are attractive if the base category is better understood than the reduced category. Or it might be that the base category is better supported by scientific theorising than the reduced category. Or it might just be attractive to have one less fundamental category in our ontology. In the case of bundle theory, it's plausible that the second and third reasons apply. Fundamental science has predicates for mass, charge, and spin, and this speaks in favour of the ontological category *property*. It's far less clear that fundamental science has material objects as part of its ontology.

Bundle theories face a range of powerful objections. I'm going to focus on one here: that bundle theories seem to imply that material objects have no contingent properties. I'll call this the *modal problem*. The problem motivates a revision to bundle theory. *Essential bundle theory* (Barker and Jago 2017; Jago 2016) reduces material objects to bundles of properties, as any bundle theory does. But according to essential bundle theory, that bundle specifies the essence of the material object. The properties in the bundle are all essential to the object. (Throughout, I'll understand the concept of *essence* in a broadly Aristotelian sense, along the lines discussed by Fine (1994, 1995) and Lowe (2008, 2012), and not as an equivalent expression of *being necessarily such that*.)

My aim in this paper is to evaluate whether essential bundle theory genuinely escapes the problem. I won't consider arguments in favour of bundle theory in general or essential bundle theory in particular. I'll begin by setting up a version of the modal problem, as it affects traditional bundle theory (Sect. 2). I'll then show how a variant of the problem hits essential bundle theory (Sect. 3). A key premise in the argument is the necessity of identity (Sect. 4). We might reject this principle by accepting *counterpart semantics* (Sect. 5). But I do not think we should accept Lewis's (1968, 1971, 1986) own interpretation of counterpart semantics, in terms of similarity relations (Sect. 7). Instead, counterpart semantics has a very natural interpretation in terms of essential bundle theory (Sect. 7). I'll argue that this approach avoids the modal problem. Finally, I'll briefly indicate how far this approach takes us towards a general analysis of modality within essential bundle theory (Sect. 8).

## 2 The modal problem for bundle theories

Bundle theories of material objects are attempts at an ontological explanation of what material objects are. They reduce the category *material object* to the category *property*, with the aid of some *bundling* operation. Schematically, using ' $B(F_1, F_2, \dots)$ ' to represent a bundle formed of properties  $F_1, F_2, \dots$ : bundle theory identifies each material object with some  $B(F_1, F_2, \dots)$ , for some choice of properties  $F_1, F_2, \dots$ .

Traditionally, bundles play two roles at once. They provide the identity of a material object  $x$ , via an explicit identification of  $x$  with some bundle  $B(F_1, F_2, \dots)$ . They also provide an analysis of property possession, which is understood in terms of bundle membership. So traditional bundle theories accept the following theses:

(CONSTITUTION ROLE) Material objects are identified with bundles of properties, so that bundled properties *constitute* material objects.

(PROPERTY POSSESSION ROLE) An object  $x$  possesses property  $F$  if and only if  $F$  is a member of the  $x$ -bundle.

Just how the bundling operation should be understood is highly controversial. (Hawthorne and Sider (2002) discuss the issue in detail.) If we are to identify material objects with bundles, then the  $B$  operation must be something which produces unity from plurality. Saying ' $B(F_1, F_2, \dots)$ ' cannot merely mean that the properties  $F_1, F_2, \dots$  are  $B$ -related together, for then, it would make no sense for us to identify a material object  $x$  with  $B(F_1, F_2, \dots)$ . Rather, ' $B(F_1, F_2, \dots)$ ' is a term denoting an entity, one which is somehow built from  $F_1, F_2, \dots$  (Lewis (1991) allows a many-one notion of identity. But he also holds that any plurality forms a whole, so it remains the case that there is a single entity comprising  $F_1, F_2, \dots$ )

Both set-formation and mereological summation fit the bill: both deliver a unified entity from plurality. The set-term ' $\{F_1, F_2, \dots\}$ ' denotes an entity and so it makes sense to write ' $x = \{F_1, F_2, \dots\}$ '. But it is hard to argue that material objects are sets of entities. Mereological summation (composition) also delivers a unified entity from plurality. The mereological sum  $F_1 \sqcup F_2 \sqcup \dots$  is the whole whose parts are  $F_1, F_2, \dots$ . Taking bundles to be mereological sums of properties gives us *mereological bundle theory* (McDaniel 2001; Paul 2002, 2006).

Many aspects of this approach are unclear. Even so, we can run a problem for the approach. Each material object is identical to a bundle of properties. But a property bundle is the bundle it is because of the properties thereby bundled. The properties constituting the bundle provide its identity. Remove one property instance and you have a different bundle. Not so for material objects, which typically could have been many different ways. So it is hard to claim that material objects are bundles.

A key principle in this argument is that the properties found in a bundle are necessary to it: that, if property  $F$  is a constituent of bundle  $B$ , then it's necessary that  $F$  is a constituent of  $B$ . That's clearly justified if bundles are sets, since sets have their members of necessity. Is it true of mereological sums also? Is it in general true that, if  $x$  is a mereological part of  $y$ , then it is necessarily so? Many philosophers think that this principle of *mereological necessitarianism* is true. (The principle is usually called 'mereological essentialism', using the modal sense of 'essence'.)

Armstrong (1978, pp. 37–38) and Baxter (1988) argue that objects sharing a part are thereby partly identical and that identity (whether full or partial) is necessary wherever it holds. Or relatedly, one might hold that 'composition is identity' (Lewis 1991), allowing for a many-one notion of identity holding between parts and whole. Then parthood will hold of necessity just in case identity does. A more moderate view is that parthood is, in important ways, akin to identity (Sider 2007), such that we should not take one but not the other to hold of necessity.

A different source of justification can be found in the analogue between formal extensional mereology and set theory. Both rely on a principle of extensionality, which seems to say that sets/wholes are defined in terms of their members/parts. If it is because of this principle (and what else could it be?) that we take a set's members to be necessary to it, then we should say the same about wholes and their parts. And indeed, if one attempts a reduction of set theory to mereology, as Lewis (1991) does, then one is committed to mereological necessitarianism.

It is instructive to ask what we would need to add to classical mereology in order to derive mereological necessitarianism. To formulate mereological necessitarianism, we need a quantified modal logic. Suppose we choose the combination of propositional modal logic (KT) and classical quantification theory. Then, to derive mereological necessitarianism, we need add only the principle that terms ‘ $x \sqcup y$ ’ (‘the sum of  $x$  and  $y$ ’) are rigid designators whenever ‘ $x$ ’ and ‘ $y$ ’ are. This principle is very plausible. To deny this is to allow that we could have put  $x$  and  $y$  together and thereby obtained something *other* than the sum we in fact get. This is hard to accept, given that we want to say that the sum of  $x$  and  $y$  is determined by (and has its identity fixed by)  $x$  and  $y$  only. We can code the rigidity of sum-terms by adding  $\exists z \Box(z = x \sqcup y)$  as an axiom. Then, as Uzquiano (2014) shows, mereological necessitarianism is a theorem. The argument above will then go through and traditional bundle theory will be committed to saying, absurdly, that material objects have all of their properties necessarily.

One response is that this formal system (through its combination of classical quantification and KT) also proves the converse Barcan formula and, as a consequence, the necessity of existence ( $\forall x \Box \exists y x = y$ ). These are contentious principles and the bundle theorist may argue that we should reject them, in favour of a *free* quantified modal logic (plus classical mereology). Nevertheless, such systems still prove:

(RMN) If  $x \sqsubseteq y$  ( $x$  is a part of  $y$ ) then necessarily,  $x \sqsubseteq y$  if both  $x$  and  $y$  exist.

This principle is bad news for bundle theorists. They hold that properties (whether universals or tropes) are not dependent on their bearers for their identities or their existence. Properties are ontologically prior to the particulars that possess them. On this picture, a qualitative property like *being wholly red* or *being wholly blue* may have been possessed by (i.e., been a part of) some particular other than the one which in fact possesses it, as in this model:

$$w_1 : \begin{array}{l} \text{blue} \sqsubseteq a \\ \text{red} \sqsubseteq b \end{array} \qquad w_2 : \begin{array}{l} \text{red} \sqsubseteq a \\ \text{blue} \sqsubseteq b \end{array}$$

But since  $\text{red} \sqsubseteq a$  in  $w_2$  and  $\text{red}$  exists in  $w_1$ , (RMN) entails that  $\text{red} \sqsubseteq a$  in  $w_1$  too. So  $a$  is both wholly red and wholly blue in  $w_1$ , which is impossible. (The argument can be run with any pair of incompatible properties, so nothing turns on the choice of colour properties.)

In short, we have good reason to think that traditional bundle theory is deeply problematic.

### 3 Essential bundle theory

Essential bundle theory is an attempt to overcome the modal problem, without abandoning a bundle theory entirely. It rejects PROPERTY POSSESSION ROLE and, in its place, accepts:

(NATURE THESIS) Property bundles specify the nature or essence of the material object in question. Material object  $x$  is essentially  $F$  if and only if (an instance of)  $F$  is a part of  $x$ 's bundle.

The guiding idea is that, if identification with a bundle gives us the identity of a material object, then the properties in that bundle are what fixes that object's nature. They determine what the object is. Change the properties involved and we would have some other material object. So those properties are not accidental to the object in question. They are essential to it and not merely in the sense that they are necessary to the object. They are essential in the Aristotelian sense that they are a part of the object's being what it is. The bundle gives the object's essence (in *roughly* the sense of essence discussed by Fine (1994, 1995) and Lowe (2008, 2012)). The object's accidental properties are accounted for in some other way. This is a picture, not an argument. But it is persuasive, on the assumption that we are to identify material objects with bundles of properties.

This move, motivated by this simple thought, reaps a number of benefits. One is a solution to the *grounding problem*. The problem is to account for the different properties of distinct but coincident objects, such as a person and their material body. I discuss the solution offered by essential bundle theory elsewhere (Jago 2016). The advantage that's relevant here concerns the modal problem, which essential bundle theory seems to resolve easily. It accepts that, if a material object  $a$  is identified with a bundle  $B(\dots, F, \dots)$ , then it is necessary that  $a$  is  $F$ . But this is no longer problematic, for in identifying  $a$  with  $B(F_1, F_2, \dots)$ , we treat  $a$  as being essentially  $F_1$ , essentially  $F_2$  (and so on) and hence necessarily all those ways. The argument from Sect. 2 is blocked at the start, for we can't infer from  $a$ 's being  $F$  to  $a$ 's being identified with some bundle  $B(\dots, F, \dots)$ . For that, we would need to assume that  $a$  is essentially  $F$ ; and then the conclusion, that it is necessary that  $a$  is  $F$ , is unproblematic.

To see whether essential bundle theory really does escape the objection, we need the full details of the theory. I'll argue below that (a variant of) the objection still bites.

Essential bundle theory has two building blocks: properties, which we can think of as universals, and spacetime regions. The spacetime regions (or the points of which they are composed) are primitive and not reducible to the category of properties. So this is not a *pure* bundle theory: some things in the ontology are not reducible to bundles of properties. Material objects are then built from *property instances*, such as *this bit of charge over here*, or *that bit of redness over there*. A key theoretical notion of essential bundle theory is *instantiation*, which takes a property-type (universal)  $F$  and a spatiotemporal region  $r$  and delivers the property instance  $F^r$ ,  $F$ -in-region- $r$ , which is an entity in its own right. This is not a state of affairs, *that*  $r$  possesses  $F$ . *Instantiation* is a theoretical notion, capturing the idea that we find the same property-type in different locations. *Having* or *possessing* a property, as in a predication ' $a$  is  $F$ ', is a different notion. At this stage in the metaphysical construction, there are universals, spacetime regions, and property-instances, but no material objects to bear those properties.

(One could instead treat property-instances as primitives of the theory. One then needs an account of when two instances  $x$  and  $y$  are instances of property-type  $F$  and when they are instances in the same region  $r$ . So long as we can associate each property-instance with both a unique property-type  $F$  and a unique region  $r$ , we can express the theory.)

Essential bundle theory then takes a material object to be mereological sum of non-modal, non-sortal property instances, satisfying certain conditions. The sums must

be consistent; all the instances must share the same spatiotemporal region; and the bundle must be suitably closed (Barker and Jago 2017). Very roughly, the idea is that bundles containing an instance of *is red* also contain an instance of *is coloured*, but may contain an instance of *is coloured* without containing any of its determinates. Modal and sortal properties are excluded from bundles, as these properties are analysed in terms of bundle-membership.

This is a very brief sketch of the theory. My aim here isn't to evaluate the arguments in its favour. (For full details of the theory and the arguments in its favour, see Barker and Jago 2017 and Jago 2016.) Rather, I want to investigate whether the theory is successful in overcoming the modal problem from Sect. 2. If it is, then there is a strong case that bundle theorists should adopt essential bundle theory. Arguments for bundle theory in general can then be turned into arguments for essential bundle theory in particular, simply by noting the severity of the modal problem for other bundle theories. But if essential bundle theory is not successful in overcoming the modal problem, then it is hard to see how it makes any progress on traditional bundle theories.

We've got enough of the details of the theory to see how a variant of the modal problem emerges. According to essential bundle theory, a material object  $a$  is identified with a bundle  $B$  (a mereological sum) of property instances,  $F_1^r, \dots, F_n^r$ , all associated with the same region  $r$ . According to the theory, a property instance  $F^r$  is, by definition, located in region  $r$ . That is of the essence of the instance and so it is necessary that  $B^r$  is located in region  $r$ . The problem then goes as follows.

Suppose  $a$  is, as a matter of fact, located in region  $r$ . Then, for some  $F_1^r, F_2^r, \dots$ , we have  $a = F_1^r \sqcup F_2^r \sqcup \dots$ . That is, each  $F_i^r$  is a part of  $a$  and they (and their proper parts, if they have any) are all of  $a$ 's parts. But given that we should accept mereological necessitarianism (Sect. 2), each such  $F_i^r$  is necessarily a part of  $a$  (and nothing that isn't in fact a part of  $a$  could have been). So, necessarily,  $a = F_1^r \sqcup F_2^r \sqcup \dots$ . But it is also necessary that each such  $F_i^r$  is located in region  $r$ . So it is necessary that  $a$  is located in region  $r$ . Each material object is 'modally stuck': wherever it is in time and space, it is necessarily there. We cannot accept that.

The objection isn't the familiar objection against four-dimensional theories that, according to the theory, objects do not move. (Sider (2003) discusses the issue in general.) Rather, the objection is that the path through time and space a material object takes is deemed a necessary feature of that object. It could not have taken another path: it could not have started its life a little earlier, nor ended its life a little later, nor been anywhere else at a given moment of its existence, according to the theory. I could not have been in Utrecht, rather than Amsterdam, right now. That is an unacceptable consequence. If the theory cannot avoid it, we must reject the theory.

#### 4 The necessity of identity

A key premise in this argument, as in the original modal argument from Sect. 2, is the necessity of identity. I argued in Sect. 2 that, given the necessity of identity, it is hard to avoid mereological necessitarianism. But if we allowed cases of contingent identity, the argument would not go through. For if either  $a$  or  $b$  could have been something

else, then it is easy to see how the sum of  $a$  and  $b$  could have been something else. That is, if  $a = c$  but it's possible that  $a \neq c$ , then it's possible that  $a \sqcup b \neq c \sqcup b$ , even though, in fact,  $a \sqcup b = c \sqcup b$ .

Essential bundle theory requires us to reject mereological necessitarianism, which in turn requires us to reject the necessity of identity. Essential bundle theory requires identity to be contingent (in at least some cases). Some true identity statements involving two singular terms, of the form ' $a = b$ ', must be possibly false. But can we make sense of contingent identity at all? Doesn't logic alone require such identities to be necessarily true, if true at all? Let's see.

Here's an argument for the necessity of identity. Suppose  $a = b$ , but contingently so. Then  $b$  has the property of being contingently identical to  $a$ . Since  $a = b$ ,  $a$  also has that property. It follows that  $a$  is contingently identical to  $a$  and so  $\diamond a \neq a$ . But  $a = a$  is a logical truth, hence necessarily true, and so  $\neg \diamond a \neq a$ : contradiction. By *reductio* and propositional logic, if  $a = b$ , then necessarily,  $a = b$ .

Since arguments like this can often take the appearance of a cheap trick, let's set it out carefully. Suppose we have a true contingent identity:

$$(1) a = b \wedge \diamond a \neq b$$

From the second conjunct, we can abstract the complex predicate  $\lambda x \diamond a \neq x$  and infer that it holds of  $b$ :

$$(2) (\lambda x \diamond a \neq x)b$$

Given  $a = b$  and Leibniz's Law, we infer that  $a$  satisfies the same logically complex predicate as  $b$ :

$$(3) (\lambda x \diamond a \neq x)a$$

from which we infer

$$(4) \diamond a \neq a$$

which is equivalent to  $\neg \Box a = a$ . But we can infer  $\Box a = a$  from the necessitation rule (from  $\vdash A$  to  $\vdash \Box A$ ), given that  $a = a$  is a logical axiom. So, by *reductio* on (1), we infer

$$(5) \neg(a = b \wedge \diamond a \neq b)$$

which is equivalent to

$$(6) a = b \rightarrow \Box a = b.$$

The argument makes essential use of Leibniz's Law, which is suspect in modal contexts. We cannot infer from 'it's not necessary that I am the lecturer' and 'it is necessary that the lecturer is the lecturer' to 'I am not the lecturer'. But the inference above used Leibniz's Law outside the scope of any modal operator. It had the form:  $Fb, a = b$ , therefore,  $Fb$ .

The argument seems convincing. Any attempt to make sense of contingent identity will, at the very least, have to diagnose where the argument breaks down.

## 5 A model of contingent identity

*Counterpart theory* (Lewis 1968) offers a great deal of flexibility in interpreting modal talk. The basic idea is that we analyse how  $a$  might have been by looking at how counterparts of  $a$  are at other possible worlds. The semantics adds a counterpart relation between elements of the domain at worlds, taking the form: individual  $x_2$  at world  $w_2$  is a counterpart of  $x_1$  at world  $w_1$ . If the domains of distinct worlds never overlap (as Lewis requires), then we can simplify and say that  $x_2$  is a counterpart of  $x_1$ .

Possibility is then given its semantic analysis via existential quantification over worlds and counterparts therein; necessity via universal quantification over worlds and counterparts therein. More precisely, where each ' $c_i$ ' is a constant or unbound variable:

(S $\diamond$ ) ' $\diamond A(c_1, \dots, c_n)$ ' is analysed as: for some accessible world  $w$  and  $w$ -counterparts  $c'_1, \dots, c'_n$  of  $c_1, \dots, c_n$  (respectively),  $A(c'_1, \dots, c'_n)$ .

(S $\square$ ) ' $\square A(c_1, \dots, c_n)$ ' is analysed as: for all accessible worlds  $w$  and all  $w$ -counterparts  $c'_1, \dots, c'_n$  of  $c_1, \dots, c_n$  (respectively),  $A(c'_1, \dots, c'_n)$ .

(For Lewis (1968), these analyses take the form of a translation scheme, from QML to the language of counterpart theory.)

For Lewis, counterpart relations are based on similarity. There could have been two people, each exactly as similar to me as the other. Then, according to Lewis, both are my counterparts. So an entity can have more than one counterpart in a given world. This feature generates contingent identity statements:

$$(7) a = b \wedge \diamond a \neq b$$

is analysed (translated) as

$$(8) a = b \wedge (\exists w \exists x \in f_a w \exists y \in f_b w (x \neq y))$$

where  $f_a$  is the function from worlds  $w$  to the set of  $a$ 's counterparts at  $w$ . This sentence is satisfiable: just suppose  $a = b$  in  $w$ ,  $c \neq d$  in  $u$ , and  $f_a u = \{c, d\}$ . Nevertheless,  $\square a = a$  remains valid. Its translation is

$$(9) \forall w \forall x \in f_a w (x = x)$$

which is first-order valid.

*In some sense*, this is a possibility in which  $a$  is not  $a$ . For if  $b$  has the property of being possibly not identical to  $a$  and  $a = b$ , then  $a$  must have that property too. This seems problematic, for (by logic alone)  $a$  is necessary self-identical and so it seems we cannot allow that  $a$  has the property of being possibly not identical to  $a$ . This is the argument we met in Sect. 4. Assuming that  $a$  has the property of being necessarily identical to  $a$  and that  $a = b$ , we can substitute ' $b$ ' for ' $a$ ', inferring that  $b$  has the property of being necessarily identical to  $a$  and hence that, necessarily,  $b = a$ . (I'll come back to whether we should accept this in Sect. 7.)

There are several ways we can modify counterpart theory to avoid the worry. One is to insist that each entity has at most one counterpart in each world. But this is unmotivated and, if counterpart relations are similarity relations, then we cannot avoid



an entity having multiple counterparts in the same world (Lewis 1968). Hazen (1979) sketches a more sophisticated alternative. Lewis's own (1971) revision of counterpart theory makes use of multiple counterpart relations, arising from the different aspects in which things may be similar or dissimilar. If I am both a person and a body (as Lewis thinks), then I have both *personhood*-counterparts and *bodyhood*-counterparts. It is then consistent to hold (i) I am my body; (ii) I (qua person) could not have been a non-person; and (iii) my body (qua body) could have been. These are consistent, since different counterpart relations are operative in (ii) and (iii): 'could' is not constant in its semantic role. The argument for the necessity of identity from Sect. 4, once phrased in terms of counterparts, will involve equivocation on 'counterpart' and so isn't valid.

## 6 Modality as similarity?

Lewis's counterpart theory thus gives us a model of contingent identity. It would be straightforward to apply Lewis's approach wholesale to the traditional bundle theory. (Paul (2006) presents a bundle theory which uses counterpart theory to account for modal properties.) A bundle theory could identify a material object  $a$  with a bundle  $B$ , but deny that  $a$  is necessarily identical to  $b$ . The bundle theorist may claim that there is one measure of similarity which compares entities bundle-wise. Since bundles are identified by the properties thereby bundled, she might take this bundle-counterpart relation to be the identity relation, so that each bundle of  $F_1, \dots, F_n$  is necessarily the bundle of  $F_1, \dots, F_n$ . But even if she does this, she may still invoke other counterpart relations broader than identity and associate these with uses of ' $a$ '. If she does this, ' $a = B$ ' will come out contingent.

Essential bundle theory could take a similar approach, with aspects of similarity restricted by the bundled properties. That is, a measure of  $F$ -wise similarity is appropriate for material object  $a$  only if  $a$  includes property  $F$  in its bundle. (This is to guarantee that essences constrain *de re* modality.) However, if the general approach is viable, then essential bundle loses much of its advantage over traditional bundle theory.

Does Lewis's explanation give us a plausible understanding of modality and hence a genuine understanding of contingent identity? I don't think it does. Suppose we take the analysis of counterpart relations in terms of similarity to be a fully general principle, so that modality reduces, ultimately, to facts about similarity. This will give clearly incorrect results. In many contexts, the numbers 3 and 5 count as similar. Suppose Anna and Bec are bemoaning their bank balances: Anna has just £3 until she's paid and Bec has £5. Cath, a high earner and prolific saver, has £10,000. Anna's and Bec's balances are comparatively similar, when set against Cath's, and so (in that context) 3 and 5 themselves count as similar numbers. So, in that context, 3 and 5 will be counterparts of one another.

This gives the disastrous result that, in that context, 3 could have been 5. So (in that context)  $3 + 3$  could have been 10. (More carefully: in that context, 'it is possible that  $3 + 3 = 10$ ' is true.) For, in that context, 3 has some counterpart which, when added to itself, results in some counterpart of 10 (which 10 is, since it always exists

and always resembles itself.) But there is no context at all in which it's possible that 3 added to itself is 10. In all contexts, that result is impossible.

Note that this argument did not turn on some bizarre, carefully constructed context. Anna and Bec's shared context is commonplace and mundane. The argument cannot be rejected by focusing on the details of the case. Rather, a Lewis-style counterpart theorist must restrict the similarity principle. It should certainly exclude numbers. Should the general principle say that necessary existents are excluded? That seems circular, since the project of counterpart theory is in part to say what is necessary. Should it say that non-spatiotemporal existents are excluded? That fits well with Lewis's metaphysics.

But this principle too is troublesome. It applied to sets, of which we'd like to say that they have their members of necessity. But assume that we're in a context in which Anna and Bec (who need not be worldmates) are relevantly similar, so as to count as counterparts of one another. In that context, it will be true that Anna could have been the sole member of {Bec}. In that sense, sets will not have their members of necessity.

Worse still, consider the proposition  $p$  that *Anna is F*. Necessarily,  $p$  is true iff Anna is  $F$ . Given counterpart theory, this implies that, for any possible world  $w$  and counterpart  $x$  of Anna's at  $w$ ,  $p$  is true at  $w$  iff  $x$  is  $F$ . Now suppose  $w$  is a world at which Anna has two counterparts, Bec and Cath. It follows that Bec is  $F$  iff Cath is. Generalising, any entity may have multiple counterparts at a world only if those counterparts are indistinguishable (Dorr 2005). But this cannot be right, since Lewis explicitly allows that entities may have qualitatively distinguishable counterparts at some world. (And he must say that, if the counterpart relation is to be understood in terms of similarity.) Worse, if we substitute  $\lambda x \text{ Bec} = x$  for  $F$ , we get:  $(\lambda x \text{ Bec} = x)\text{Bec}$  iff  $(\lambda x \text{ Bec} = x)\text{Cath}$  at  $w$  and hence that  $\text{Bec} = \text{Cath}$ , contradicting our assumption that Bec and Cath are distinct.

The restriction of the counterparts-via-similarity principle to concrete entities produces unacceptable results. But, as we saw, the approach is indefensible without some such restriction. It is thus very difficult to maintain that modality boils down to similarity.

## 7 Justifying contingent identity

My suggestion is that Lewis's presentation of counterpart theory involves elements which can and should be separated. First, there's the semantic machinery: counterpart relations and the analysis of '□' and '◇' in terms of them. Then there's all the rest: a plurality of concrete possible worlds, world-bound individuals, the Humean denial of necessary connections, and the understanding of counterpart relations in terms of similarity (Lewis 1971, 1986). I suggest we can make sense of counterpart theory without any of that. Kripke semantics makes no such philosophical demands; neither should counterpart *semantics*.

Here's the counterpart semantics I prefer. There's a single counterpart relation, which relates entities-in-worlds. The relation is reflexive, symmetrical, and transitive: it's an equivalence relation. Modal operators are analysed as in  $(S\Diamond)$  and  $(S\Box)$  in Sect. 5, just as Lewis says they are. This generates an S5 logic of *de re* modality. In particular, what's true of  $x$  is necessarily possible for  $x$ ; what's necessary for  $x$  is necessarily

necessary for  $x$ ; and what's possibly necessary for  $x$  is necessary for  $x$ . (This is in contrast to the Lewisian theory, on which none of these principles hold: see Lewis 1968, pp. 123–124.)

Here's the philosophical interpretation of counterpart semantics I prefer. A thing's counterparts are all those things which share its essence. This 'same essence' criterion underpins the counterpart relation's being an equivalence. If everything has an individual essence, a haecceitistic property of *being that very thing*, then nothing shares anything else's essence. In that case, the counterpart relation is identity, the semantics reduces to Kripke semantics, and there are no contingent identities.

Individual essences (of material objects, at least) are not compatible with essential bundle theory. It is an attempt to construct material objects from more metaphysically basic ingredients: property instances. Those property instances must ultimately be constructed purely from fundamental properties. But all such properties are qualitative. Or rather, if any are non-qualitative, they are properties of being such-and-such spacetime point, or being such-and-such abstract entity. That is a commitment of essential bundle theory (Barker and Jago 2017). Such properties cannot be combined to give non-qualitative identity properties of non-fundamental material objects. So, for at least the non-fundamental material objects, essences are purely qualitative.

One might seek, somehow, to modify essential bundle theory on this point. But I don't see how this plausibly could be achieved. One impediment is Sider's notion of the *purity* of fundamental reality, that

the fundamental truths involve only fundamental notions. When God was creating the world, she was not required to think in terms of nonfundamental notions like city, smile, or candy. (Sider 2011, p. 120)

That principle seems eminently reasonable. But fundamental non-qualitative properties specifying (say) my identity violate the principle. For if there is a specific fundamental property of *being  $x$* , for any non-fundamental  $x$ , then there is a fundamental truth about  $x$ 's identity, which involves the non-fundamental notion of  $x$ . Quite generally, fundamental reality is the stuff of the fundamental laws. There should be no mention of you, or me, in amongst the story of mass, charge, spin, and so on.

If everything has an essence, but not an individual essence, then the counterpart relation is an equivalence but not identity. There's no reason to think each essence has just one instance in each world. It seems plausible to me that there is something it is to be a reproduction of a *Wassily* chair and that all reproductions (or perhaps all those made by the same manufacturer) have exactly the same essence. It may be objected that the material origin of an artefact is essential to it, so that two reproduction chairs made from numerically distinct parts cannot have the same essence. But this strict principle is hard to maintain. I've recently had my reproduction *Wassily* reupholstered. It's still the chair it was. At some point, I'll have parts of the chrome tubing replaced and it'll still be the same chair. Eventually, there'll be more replaced parts than original ones, but my chair will remain. Any principle of essentiality of material origins for artefacts needs to allow for this flexibility. (See Roca-Royes 2016 for discussion.) Once the principle is suitably flexible, there is nothing to rule out a world with multiple counterparts of my chair, each having the same essence.

I don't want to take a stand on which principle (if any) one should accept on the essentiality of material origins. There are other delicate issues surrounding the essences of artefacts and of non-fundamental material objects in general. Again, I don't want to take a firm stand. Essential bundle theory is intended as a general framework for understanding non-fundamental material objects and their essences. It sets out, quite generally, how those essences are constructed. But it leaves open which properties are to be found in a given entity's essence and is thus compatible with a wide range of views on how a given thing essentially is. It allows (but does not entail) that each chair has a highly specific (although qualitative) essence. On that view, one chair could have been another only if both (possible) entities are alike in that highly specific way.

Essential bundle theory also allows (but does not entail) the far more relaxed view that each chair is essentially a material artefact with the general purpose of supporting human-sized beings in sitting upright (and that's it). On that relaxed view, each chair has the same (very general) essence. If that's so, then any chair could have been any other. Probably, the truth lies somewhere between these extremes. I don't wish to take a stance here, except to say that a chair is essentially a chair. Each chair has only other chairs as counterparts and so no chair could have been a penguin, or a natural number. Similarly, I don't want to take a stance on what your essence, or mine, is. One picture is that there's some complex property of *personhood*, or perhaps *humanity*, which we all share and which exhausts our essence. If that's so, then I could have been you and you me. But neither of us could have been a poached egg.

As I'm accepting single-counterpart-relation counterpart semantics, I accept that a true identity  $a = b$  is contingent, whereas  $a = a$  is necessary. So I face the objection from Sect. 4, that  $a$  and  $b$  have different properties and so cannot be identical after all. Since it's possible that  $a \neq b$ ,  $b$  has the property  $\lambda x a \neq x$ . Since  $a = b$ ,  $a$  must have that property too. (This was the argument that, in Sect. 5, prompted us to look at revisions to Lewis's 1968 theory.)

I accept this argument. What I deny is that, as a consequence, the logical truth  $a = a$  fails to be necessary. It's true that  $a$  has the property of being possibly other than  $a$ . That's true of  $a$  however we denote it. But it doesn't follow that  $a$  is possibly non-self-identical, or that it lacks the property of being necessarily self-identical. Being possibly non-self-identical is the property  $\lambda x \diamond x \neq x$ . Nothing has that property. Being necessarily self-identical is the property  $\lambda x \Box x = x$ . Everything has that. We must be careful to distinguish  $\lambda x \lambda y \diamond x \neq y$ 's holding of the pair  $aa$  (which it may) from  $\lambda x \diamond x \neq x$ 's holding of  $a$  (which is impossible).

Lewis (1971, p. 206) agrees with this point, noting that

(10) My body and my body are such that they might not have been identical today, when rendered as  $(\lambda x \lambda y \diamond x \neq y)bb$ , comes out true on counterpart semantics. But, he says, this is 'for an irrelevant reason'. Lewis might have been one of identical twins and so, 'my body therefore does have two different counterparts in certain worlds' (1971, p. 206). But he thinks a variant of the Leibniz Law argument against contingent identity can be run, by factoring out this kind of case. His amended argument goes as follows:

(11) I and my body are such that (without any duplication of either) they might not have been identical today.

(12) My body and my body are such that (without any duplication of either) they might not have been identical today.

Lewis's thought is that the 'without any duplication of either' clause should, in effect, restrict the available worlds to ones with no more than one counterpart of me. As we've seen, such worlds do not support contingent identity statements. The worry then is that, since (12) is unsatisfiable and can be inferred from (11) plus the assumption that I and my body are identical, we must reject the latter.

I'm not sure how best to understand the 'no duplication' clause. Since we're assuming that I and my body could have been distinct, Lewis can't intend it as an all-out ban on multiple counterparts (qua things most resembling me) in a world. For if my body and I go separate ways in world *w*, then there are plausibly two things there best resembling me: that possible person and that possible body. We *could* then analyse the situation in terms of multiple counterparts. But we could also stick with one, relating me to both that possible person and that possible body. If this is the story in general, then the 'no duplication' clause will falsify (11) as well as (10). But then, the argument poses no threat. We retain the possibility of me and my body being distinct, but *only* via 'duplication'.

It seems clear that this isn't how Lewis understands his 'no duplication' clause. He intends it to rule out his 'twins' scenario and other cases of physical duplication. But if the clause is less restrictive than in the previous paragraph, then it will admit worlds in which I (and my body) have multiple counterparts. That alone is enough to satisfy both (11) and (12). So however the clause is understood, I don't feel the pressure of Lewis's argument.

Lewis's idea must have been that worlds with multiple counterparts of me are the exception, rather than the rule, and that those abnormal worlds should not be allowed to influence our stance on contingent identity. Perhaps there's something in that. Possibilities in which there are multiple entities, each of which resembles me just as well as the others and better than any other things, do seem somewhat strange. That plays into what we say about modality only on the assumption that *de re* modality is ultimately about similarity, an assumption I've already rejected.

On the picture I'm suggesting here, worlds with multiple counterparts of something are the norm. If the essence of a given table is something shared by all tables (or at least, all tables of a particular kind), then every world containing tables (of that kind) will contain multiple counterparts of our chosen table. That's not a world of table-duplicates: those tables may vary considerably in their accidental features (as they do in our world). Similarity does not come into it, on the picture I'm suggesting. So we are entirely justified in considering worlds containing multiple counterparts of some thing—the usual case—when assessing the contingency of identity.

## 8 Modality in essential bundle theory

This picture begins to explain how my *de re* necessary properties outrun my essence. All my counterparts are such that  $1 + 1 = 2$  and so it is *de re* necessary for me to be such that  $1 + 1 = 2$ . But this is no part of my essence, which says nothing about the lives of numbers. Similarly, it's *de re* necessary for me to be such that you are a person

if you exist. That's because all my counterparts are such that any counterpart of you in the same world is human. But it's no part of my essence that you're human.

Given what I've said here, many modal questions remain unanswered. In particular, we don't yet know which bundles can co-exist with which. A principle of free recombination of bundles seems implausible. For an artwork-bundle to exist, we need a plurality of person-bundles to exist also. There are existential dependencies between bundles. (That's not to say that there are necessary connections between *distinct* entities, for these need not be wholly distinct bundles. It's plausible that something in the specification of *being an artwork* involves the existence of a community of people interacting in certain ways. Elsewhere (Jago 2018a, b) I develop a theory of non-fundamental properties along these lines.)

These existential dependencies aren't explained by anything I've said here. So an account of which bundles can or must co-exist with which remains up for grabs. That is the question of *de dicto* modality: which possible worlds exist? It's a question for another day. What I've done here is to show how to identify material entities across possible worlds: the question of *de re* modality.

One may worry that I've exchanged one dark notion for one that's even more obscure: counterparts-via-similarity for essences. But essential bundle theory is designed to de-mystify essences. Ontologically, essences are just mereological sums of properties meeting certain conditions, which we can specify in non-modal terms. There are no primitive properties of the form *being essentially F*. We don't need to introduce mysterious new entities to understand essences: we need only to accept mereological summation on properties. One may object to that on the grounds that only material entities are parts of other entities (Simons 1987). I don't think that's right, but let's agree for argument's sake. No worries, since material entities are identified with sums of property *instances*, which are material, spatiotemporally located entities. If abstract universals never sum together, there are no unified entities we can call essences. But we can still talk about a thing's essential properties:  $x$  (a sum of property instances) is essentially  $F$  just in case  $x$  has an instance of  $F$ -ness as a part and  $x$  and  $y$  are counterparts just in case they share all their essential properties.

## 9 Conclusion

Those attracted to a bundle theory of material objects should worry about their central identity statement, *a material object is a bundle of properties*, when combined with PROPERTY POSSESSION ROLE (Sect. 2). Essential bundle theory aims to avoid the problem by taking the bundle in question to specify the object's essential properties (Sect. 3). But a variant of the modal problem remains. If  $a$  is located in region  $r$ , then  $r$  partly fixes the  $a$ -bundle's identity, seemingly implying that, of necessity,  $a$  is located in  $r$  (Sect. 3).

Bundle theorists (whether of the traditional or the essential variety) must reject the necessity of identity. Counterpart semantics offers a clear model of contingent identity (Sect. 5). If we accept Lewis's theory wholesale, then the identification of a material object with a specific bundle will be a contingent matter. It could have been some

other bundle. On that picture, there is little reason to opt for essential bundle theory over the traditional picture.

I argued that we should not accept Lewis's analysis of counterpart theory, with counterpart relations based on similarity (Sect. 6). Modality is not, at bottom, about similarity. Essential bundle theory offers a more plausible interpretation of counterpart semantics: the counterpart relation is the same-essence relation (Sect. 7). This is an equivalence relation, broader than identity, and there is just one counterpart relation. This delivers contingent identity, without denying the necessity of any logical law. This account provides answers specifically about *de re* necessity, but remains silent on many aspects of *de dicto* necessity (Sect. 8). For a complete account of modality, we would need to understand which essences are compossible with which: a question for another day.

The immediate question of this paper was: can essential bundle theory overcome the modal problem? The answer is that it can, in a principled and illuminating way, and in a way that traditional bundle theory cannot straightforwardly accept. That provides a strong reason to prefer essential bundle theory over the traditional approach.

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