

Abstract: It is often assumed that indeterminacy in mereological relations—in particular, indeterminacy in which collections of objects have fusions—leads immediately to indeterminacy in what objects there are in the world. This assumption is generally taken as a reason for rejecting mereological vagueness. The purpose of this paper is to examine the link between mereological vagueness and existential vagueness. I hope to show that the connection between the two forms of vagueness is not nearly so clear-cut as has been supposed.

1. Introduction

In recent work, there has been a fair amount of discussion of mereological vagueness¹, existential vagueness², and their relation to one another—see, e.g., [van Inwagen, 1981], [Lewis, 1986], [Sider, 2001], [Moreau, 2002], [Hawley, 2002], [Koslicki, 2003], [Smith, 2005], and [Merricks, 2005]. In much of this literature, mereological vagueness is rejected because it is supposed to bring along with it a commitment to existential vagueness and this later doctrine is held to be incoherent. Even where mereological vagueness is treated sympathetically in [van Inwagen, 1981], [Koslicki, 2003], and [Smith, 2005], it is assumed that mereological vagueness goes hand in hand with existential vagueness. With just one exception that I know of ([Moreau, 2002]), no philosopher has explicitly endorsed mereological vagueness without also endorsing existential vagueness.

Despite the prevalence of the assumption that proponents of mereological vagueness are also stuck with existential vagueness, no one has established a clear link between the two types of vagueness. In philosophical literature, the focus is typically on a particular form of mereological vagueness—*compositional vagueness*, where this is understood as indeterminacy in which pluralities of objects compose objects.³ [Lewis, 1986], [Sider, 2001], and [Smith, 2005] (and perhaps also [van Inwagen, 1981]) all seem to assume that the following claim holds:

If it is indeterminate whether the objects in the collection *C* compose an object, then there must be some indeterminately existing object which the members of *C* (indeterminately) compose.⁴ (*)

It would follow from (*) that existential vagueness is an immediate logical consequence of at least one form of mereological vagueness. But, as we will see in Sections 2 and 4 below and as has already been pointed out in both [Hawley, 2004] and [Merricks, 2005], it is not clear that (*) is true. On the contrary, in many natural examples of apparent compositional vagueness, it looks as though compositional vagueness stems from indeterminacy in mereological relations among determinately existing objects and *not* from any sort of mereological connection between determinately existing objects and indeterminately existing objects.⁵

It is the purpose of this paper to investigate the connection between mereological vagueness and existential vagueness in more detail than has been done so far. I agree with Sider and Lewis that existential vagueness is highly suspicious. But, as I claim in Section 2, mereological vagueness is not vulnerable to the same kinds of immediate difficulties as is existential vagueness. Moreover, not only does mereological vagueness have its own strong intuitive appeal, it also offers an alternative to such extremely unintuitive positions as nihilism (of the form proposed in [Unger, 1980]) or Lewis' and Sider's universalism. We should therefore be reluctant to dismiss mereological vagueness without a clear understanding of its purported deficiencies. In particular, we should be cautious about lumping it together with existential vagueness without establishing a definite link between the two positions.⁶

My investigation takes as its starting point a formal analysis of the parthood predicate (Section 3) and an abstract representation of mereological vagueness as indeterminacy in the interpretation of the parthood predicate (Section 4). My treatment of mereological vagueness has much in common with the supervaluationism of [Fine, 1975]. It is compatible with a linguistic understanding of mereological vagueness and offers an alternative to the multiple-degree treatments of mereological vagueness developed in [van Inwagen, 1981] and [Smith, 2005].

We will see that, even assuming quite strong mereological principles, mereological vagueness does not strictly entail existential vagueness. A more complicated and much less clear-cut potential path from mereological vagueness to existential vagueness is discussed in Section 5. But my final suggestion will be that the focus on the supposed link between mereological vagueness and existential vagueness is misplaced. The more central issue is whether the proponent of mereological vagueness can preserve the common-sense assumptions which motivate his theory while at the same time offering a systematic account of what sorts of objects are in the world and how, if not by having determinate parts at determinate times, objects are distinguished from one another.

2. Indeterminacy in Parthood Relations

In very many cases, questions of the form 'is x part of y at time t ?' have determinate and uncontroversial answers. For example, my cat Tibbles' head is definitely now a part of Tibbles and the Empire State Building is definitely not now (or at any other time) a part of Tibbles.

But it is not hard to find examples of apparent indeterminacy in parthood relations. Suppose that Tibbles has just lapped up some milk and that a certain carbon atom (call it CARB) has just passed through the wall of Tibbles' intestines on its way to being incorporated into one of Tibbles' cells. I take it that the claim 'CARB is now part of Tibbles' is neither clearly true nor clearly false. Five minutes ago, when CARB was floating in the milk bowl, CARB was definitely not part of Tibbles. And an hour from now, when CARB forms part of the membrane in one of Tibbles' liver cells, CARB definitely is part of Tibbles. But no moment in between these two times presents itself as the first moment at which CARB is part of Tibbles. In fact, there is a fairly wide range of intermediate times (including now) throughout which CARB's parthood relation to Tibbles is uncertain.⁷

Moreover, it is fair to assume that no amount of empirical investigation will resolve this mereological quandary. What could we possibly observe that would settle the question of whether CARB is now part of Tibbles? Biologists might, e.g., learn more about CARB's location in Tibbles at various times or CARB's interactions with other atoms as it passes through Tibbles, but information about these sorts of continuous changes cannot be used to pinpoint moment at which CARB suddenly becomes part of Tibbles.

We may of course insist that there is, nonetheless, a first moment at which CARB is part of Tibbles, even though we cannot discover what this moment is. More generally, we might insist that every claim of the form 'x is part of y at t' (with no vagueness introduced through 'x' and 'y') is either true or false, even where it is in principle impossible for us to determine the truth-value of the claim. This would be to endorse what I will call the 'Epistemological Solution' to the problem of vagueness in parthood relations. Here, indeterminacy is denied and vagueness is construed as insurmountable ignorance. This is the approach to vagueness advocated in [Williamson, 1994]. It also seems to be implicit in the brute fact treatment of composition in [Markosian, 1998].

But the Epistemological Solution is highly unappealing. In admitting determinate but cognitively inaccessible mereological relations among objects, we would endorse an insuperable distinction between things as they really are and things as they appear to be. We would be forced to accept a quasi-Kantian world in which the things-in-themselves (the cats, tables, people, and so on with determinate parts) are partially hidden from our view. But we have not yet seen any reason for positing this sort of disconnection between appearance and reality—why would we think that mereological relations are any more determinate than they appear to be? On the contrary, the picture of objects that is presented in the Epistemic Solution seems out of sync with our usual assumptions about objects. We assume that an object's properties generally change gradually. In particular, the relational properties in which mereological relations seem to be grounded—relative location, degrees of functional interaction, and so on—change continuously. There is no clear support for the assumption that there is a hidden first moment at which CARB is part of Tibbles.⁸

Other alternatives to mereological vagueness have been proposed. They are all even further removed than the Epistemological Solution from common-sense assumptions about objects. At one extreme, we might follow [Unger, 1981] in denying that there are any cats, clouds, mountains, people, or other common-sense objects. This approach, the Nihilistic Solution, dissolves the apparent mereological indeterminacy in the example of Tibbles and CARB by denying that Tibbles exists.

A more common but equally radical approach is to accept that 'CARB is part of Tibbles now' is neither true nor false but to attribute this to indeterminacy in the referent of 'Tibbles' and not to indeterminacy in parthood relations. See, e.g., [Lewis, 1986, 1993] and [Heller, 1990] for examples of this position, which I will call the 'Vague Singular Terms (VST) Solution'. According to the VST Solution, there are millions of hunks of matter differing from one another by miniscule bits, no one of which is more qualified than the others to serve as the referent of 'Tibbles'. Although each of the millions of candidate referents of 'Tibbles' has precise spatiotemporal boundaries and determinate parts, the truth-value of 'CARB is part of Tibbles now' is indeterminate because some candidate referents have CARB as a part now and others do not.⁹

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The VST Solution denies that most (if any) common-sense methods of identifying objects succeed. We ordinarily assume that in appropriate circumstances a designation such as ‘the cat on the mat’ picks out a unique object—when the designation is used successfully, there is exactly one object which qualifies as a cat and is on the indicated mat. The VST Solution tells us that we never, even under the best circumstances, pick out a unique object in this way, because there is never exactly one object which is a cat located within a given spatiotemporal region.¹⁰ Moreover, the proponents of the VST Solution can offer no alternative procedure that might take the place of ordinary methods of identifying objects. It is not as though we could in practice ever distinguish any one of the precise candidate referents of ‘Tibbles’ by listing all of its parts. If the ordinary usage of terms like ‘Tibbles’ is too loose to ever nail down a precise referent, then there is nothing we can do to tighten it up.¹¹ In the end, the VST Solution leaves us with at least as much disconnection between the real world and our cognitive access to that world as does the Epistemological Solution.

The discussion above is not intended as a decisive dismissal of any of the alternatives to mereological vagueness. The point here is only that, in view of the very low intuitive appeal of these alternatives, mereological vagueness should not be written off too easily. Mereological vagueness deserves consideration because it appears to offer a much better fit with our ordinary assumptions about objects than its most promising rivals.

Unlike mereological vagueness, existential vagueness is not motivated by common-sense assumptions about objects in the world. When we talk about objects in non-fictional contexts, we normally assume that they definitely exist, even in cases where some of their properties appear to be indeterminate. In addition, there are good theoretical reasons for being suspicious of existential vagueness which do not apply to mereological vagueness. Most importantly, it is not clear how we can make sense of borderline existence. If an object is there (in the world), then there would seem to be no sense in which it is indeterminate whether it is in the world. On the other hand, where there is no object, there is nothing to serve as a borderline case of existence.¹²

Thus, it is hard to see how we are to understand the claim that the world includes objects whose existence is somehow indeterminate. But mereological vagueness is not burdened by this sort of immediate difficulty. To assume that two objects exist is not already to settle the question of whether and when one is part of the other. Thus, it makes sense to wonder whether there are objects in the world whose parthood relations are unsettled.

Notice further that there is no reason for thinking that the apparent mereological indeterminacy in typical common-sense cases like that of CARB and Tibbles leads to existential indeterminacy. The issue here is not whether CARB or Tibbles exists or the degree to which either of these objects exists. Rather, the proponent of mereological vagueness may assume that both of these objects definitely exist while claiming only that is indeterminate whether CARB is now part of Tibbles.

The CARB and Tibbles example also provides an apparent counterexample to the proposition (*), which had functioned as a premise in Lewis’s, Sider’s, and Smith’s arguments that compositional vagueness entails existential vagueness. If, as common sense suggests, it is indeterminate whether CARB is now a part of Tibbles, then it should

also be indeterminate whether CARB and Tibbles now compose any object at all. For, according to common sense, the only object which might include both Tibbles and CARB is Tibbles herself. On this assumption, indeterminacy in whether CARB is part of Tibbles is equivalent to indeterminacy in whether CARB and Tibbles compose anything, since CARB is part of Tibbles if and only if CARB and Tibbles compose Tibbles. And, according to common sense, CARB and Tibbles either compose Tibbles or nothing at all.¹³ In particular, common sense posits no *indeterminately existent* object that CARB and Tibbles might now compose. Such an object is not needed for the compositional indeterminacy, which stems from indeterminacy in the relations between CARB and Tibbles and not from any sort of link between CARB, Tibbles, and an indeterminately existent object.¹⁴

To sum up: We have seen so far that mereological vagueness fits more closely with common-sense assumptions about objects in the world than do the most likely alternative positions. In addition, our examination of one typical case of apparent mereological indeterminacy has revealed no reason for thinking that mereological vagueness leads to existential vagueness. In the next three sections, I will take a more detailed look at issues surrounding mereological vagueness and its connection to existential vagueness.

3. Mereology for Endurants

To consider issues related to mereological vagueness in more depth, we need a precise theory of parthood relations. In Section 4, I will characterize mereological vagueness as indeterminacy in the interpretation in the ternary predicate *...is part of...at instant...* (symbolized below as ' P '). In other words, we have mereological vagueness when there is more than one admissible way of assigning a class of ordered triples $\langle x, y, t \rangle$ (with x and y members of the object domain and t a member of the time domain) as an extension for P .

But not all interpretations of the parthood predicate are up for consideration. At a minimum, an admissible interpretation of the parthood predicate must: i) preserve the truth of all incontestable mereological claims (e.g., that Tibbles' liver is now part of Tibbles and the Empire State Building is never part of Tibbles) and ii) satisfy certain core mereological principles. For example, all admissible interpretations must make parthood (at a fixed time) transitive—if x is part of y at t and y is part of z at t , then x is also part of z at t . So, if j is an admissible interpretation and j assumes that CARB is part of Tibbles' liver now, then j must also tell us that CARB is part of Tibbles now.¹⁵

Formal theories of parthood relations (mereologies) have traditionally treated parthood as an atemporal binary relation.¹⁶ These mereologies are appropriate for domains of four-dimensional entities since it is characteristic of four-dimensional entities that they do not change over time.¹⁷ But common sense assumes that material objects change over time—in particular, that objects like Tibbles are constantly gaining and losing parts. Because the strongest appeal of mereological vagueness lies in its agreement with common sense, I will use a mereology which is appropriate for entities that change over time (i.e., endurants). However, I do not believe that the choice of a temporal rather than an atemporal mereology affects our general conclusions on the connection between

mereological vagueness and existential vagueness. I will make some brief remarks on why this is so in the following sections.

I present below one basic mereological theory, Mereology for Endurants (**ME**), and two additional ‘strengthening’ principles. **ME** is minimal in that it embodies only what I take to be uncontroversial restrictions on parthood relations. It is also the mereology that I endorse, since it allows that two objects may have exactly the same parts at a given time and I am a proponent of that the view that, e.g., a statue and the lump of clay from which it is formed are distinct objects that may share all of their parts at a given time. However, I do not wish my evaluation of the connection between mereological vagueness and existential vagueness to hang on such contentious issues, particularly since opponents of mereological vagueness generally assume much stronger mereological principles than those of **ME**. Thus, I will consider whether and how stronger mereological assumptions might affect the relation between mereological vagueness and existential vagueness.

ME is similar to the temporal mereology of [Simons, 1987, Part II] but is developed in standard predicate logic, uses slightly stronger axioms, and introduces temporalization through a single ternary time-relative parthood predicate rather than through multiple binary time-indexed parthood predicates.¹⁸ The domain of **ME** is divided into three disjoint sorts of entities: objects (over which the variables w, x, y, z range), time instants (over which the variable t ranges), and collections (over which the variables A, B, C range). Collections of objects are non-empty sets of objects. I use the term $\{x_1, \dots, x_n\}$ to denote the collection whose members are x_1, \dots , and x_n .

ME assumes two non-logical primitive predicates. One is the binary predicate ε which takes an object term as its first argument and a collection term as its second argument. I will assume **ME** includes axioms requiring that there are arbitrary collections of objects and that ε is interpreted as the relation which holds between object x and collection A if and only if x is a member of A . **ME**’s mereological primitive is the ternary predicate P which takes two object terms and one time instant term as arguments and where $P_t xy$ is read as:

x is part of y at instant t .

Additional mereological predicates are defined in terms of ε and P . Some that will be brought up in the discussion that follows are:

$PP_t xy$ (x is a proper part of y at t) \equiv
 $P_t xy \ \& \ \sim P_t yx$ (x is part of y at t and y is not part of x at t)

$O_t xy$ (x overlaps y at t) \equiv
 $\exists z (P_t zx \ \& \ P_t zy)$ (there is some object z that is part of both x and y at t)

$FUS_t xA$ (x is at t a fusion of the collection A) \equiv
 $\forall y (y \varepsilon A \rightarrow P_t yx) \ \& \ \forall z (P_t zx \rightarrow \exists y (y \varepsilon A \ \& \ O_t zy))$
 (every member of A is part of x at t and every part of x at t overlaps some member of A at t)

$PR xt$ (x is present at t) $\equiv P_t xx$ (x is part of itself at t)

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FP At (A is fully present at t) =
 $\forall x (x \in A \rightarrow \mathbf{PR} \, xt)$ (every member of A is present at t)

SIM x (x is simple) =
 $\forall y \forall t (\mathbf{P}_t \, yx \rightarrow y = x)$
 (for any object y , if y is part of x at any time, then y is identical to x)

CMP x (x is composite) =
 $\sim \mathbf{SIM} \, x$ (x is not simple)

ME has four mereological axioms.

- (A1) $\mathbf{P}_t \, xy \rightarrow \mathbf{PR} \, xt \ \& \ \mathbf{PR} \, yt$
 (A2) $\mathbf{P}_t \, xy \ \& \ \mathbf{P}_t \, yz \rightarrow \mathbf{P}_t \, xz$
 (A3) $\mathbf{PR} \, xt \ \& \ \sim \mathbf{P}_t \, xy \rightarrow \exists z (\mathbf{P}_t \, zx \ \& \ \sim \mathbf{O}_t \, zy)$
 (A4) $\exists t \mathbf{PR} \, xt$

(A1) requires that if x is part of y at t , then both x and y are present at t . (A2) is a ternary counterpart of the standard transitivity axiom for parthood. It tells us that if x is part of y at t and y is part of z at t , then x is part of z at t . The supplementation principle (A3) requires that if x is present at t and is not part of y at t , then some object z is part of x at t and does not overlap y at t . (A4) says that every object is present at some time.

As mentioned in Section 1, many discussions of mereological vagueness focus on the circumstances under which the objects in a given collection compose something. For example, we might wonder about the conditions under which certain boards compose a larger wooden object or the conditions under which certain cells compose an organism. In **ME**'s terminology, we say that x_1, \dots, x_n *compose* x at instant t just in case x is a fusion of $\{x_1, \dots, x_n\}$ at t . More generally, the objects in collection A compose x at t just in case x is a fusion of A at t .¹⁹ For example, Tibbles' Liver and Tibbles compose Tibbles now—Tibbles is now a fusion of the collection $\{\text{Tibbles' Liver, Tibbles}\}$.

Notice that the conditions under which an object is a fusion of some collection (i.e. is composed of the members of some collection) are, in **ME**, perfectly straightforward. For *any* object x , there is a collection whose members compose x at time t if and only if x is present at t . Even if x is a simple, it is a fusion of the one-member collection $\{x\}$ whenever it is present.

By contrast, **ME** does not tell us much about the circumstances under which a given collection has a fusion. For our discussion of compositional vagueness in Section 4, it will be useful to introduce an additional predicate, **HAS-FUS**, which distinguishes collections that have a fusion at a given time.

HAS-FUS At (collection A has a fusion at time t) =
 $\exists x \mathbf{FUS}_t \, xA$ (some object is a fusion of A at t)

It follows from the axioms of **ME** that if A has a fusion at t , then A is fully present at t (i.e. $\mathbf{HAS-FUS} \, At \rightarrow \mathbf{FP} \, At$). But **ME** does not require that all fully present collections have fusions. Also, **ME** says nothing about how many fusions a collection may have at a

time. As mentioned above, **ME** is compatible with the assumption that, e.g., a given collection of molecules fuses to both a lump of clay and a statue at the same time.

The two additional mereological principles below strengthen **ME**'s restrictions on composition by either limiting the number of objects that may be fusions of a collection at a time or requiring that whenever a collection is fully present, there is at least one object which is its fusion. Note that, while neither principle is a theorem of **ME**, both are consistent with **ME**'s axioms.

Extensionality Principle (EP) $P_t xy \ \& \ P_t yx \rightarrow x = y$
(if x is part of y at t and y is part of x at t , then x and y are identical)

Universal Fusion Principle (UP) $FP At \rightarrow HAS-FUS At$
(if A is fully present at t , then some object is a fusion of A at t)

Taken together with **ME**'s (A2) and (A3), (EP) entails that any collection has at most one fusion at a time. This would tell us that if, e.g., a collection C of molecules now fuses to a statue, then C cannot now fuse to another object besides the statue (so either C does not fuse to the lump of clay now or the lump and the statue are identical). (UP) requires that every fully present collection has at least one fusion. According to (UP), there is an object which is now a fusion of Tibbles and the Empire State Building, an object which is now a fusion of Tibbles and the Taj Mahal, and so on. In any extension of **ME** which includes both (EP) and (UP), we can prove that any collection has a unique fusion whenever it is fully present.

Even stronger mereological axioms might be added to **ME**. For example, we might extend **ME** by adding an axiom requiring that, for every mapping of times to collections that are fully present at those times, there is what [Sider, 2001] calls a 'minimal diachronic fusion'—an object which is present only at times in the mapping's domain and is at each of those times a fusion of the corresponding collection of objects. Sider takes this principle to entail four-dimensionalism since it implies that for every object x and every time t at which x is present, there is a t -slice of x —an object which is present only at t and fuses to x at t . As I note in the next section, I do not see that this much stronger universal diachronic fusion principle presents any special difficulty for mereological vagueness beyond whatever difficulties are already involved in the synchronic universalist principle, (UP).

I close this section with a few words on the comparison between **ME** and the more familiar atemporal mereologies. The most obvious difference is that the atemporal mereologies tend to use binary mereological predicates where **ME** has ternary predicates. Thus, instead of a ternary overlap predicate taking two object terms and a time term as arguments, the atemporal mereologies use a binary overlap predicate taking two object terms as arguments. But another important difference is that the atemporal mereologies typically include no counterparts of the predicates **PR** and **FP** which link individuals to the times at which they are present and collections to the times at which they are fully present. This difference is important since, in the treatment of mereological vagueness that follows, vagueness in these durational predicates is a special case of mereological vagueness which appears to raise special difficulties. It may seem that things would turn out differently if we had started with a mereology that does not explicitly link individuals

to the times at which they are present. However, in order to make sense in his terms of the claims we ordinarily make about how objects change over time (and, in particular, gain and lose parts), the four-dimensionalist will have to introduce some sort of predicate linking objects to the times over which they extend. For example, the ...*exists at...* predicate is used in [Sider, 2001] to introduce instantaneous time slices for four-dimensional objects and a defined *temporal* parthood predicate. Sider's ...*exists at...* predicate is almost exactly analogous to **ME**'s *PR* (...*is present at...*). The only difference is that **ME**'s *PR* can be defined in terms of the temporalized parthood predicate *P*, while its counterpart in an atemporal mereology needs to be introduced separately. But vagueness in the presence predicate will raise the same sorts of difficulties for either the three-dimensionalist or the four-dimensionalist.

4. Mereological Vagueness

If parthood relations are indeterminate, this is either because there is more than one admissible interpretation of the parthood predicate (and, thus, no unique parthood relation) or because the (unique) interpretation of the parthood predicate is a fuzzy relation which may hold to intermediate degrees. The second alternative is assumed in the analyses of mereological vagueness of [van Inwagen, 1981, Section 17] and [Smith, 2005]. In both works, the parthood relation is represented as a mapping from pairs of objects (at times) to real numbers in the interval $[0, 1]$.²⁰ I will instead operate under the assumption that mereological vagueness is indeterminacy in the interpretation of the parthood predicate *P*. I prefer this treatment of mereological vagueness because I do not understand the motivation behind the multiple-degree approach. In particular, I do not see why there is any more reason for thinking that parthood relations hold to definite degrees than there is for thinking that parthood relations either definitely hold or definitely fail to hold. If we grant that it is indeterminate whether CARB is part of Tibbles now, what reason should we have for thinking that CARB is now part of Tibbles to a fixed degree between 0 and 1—why would CARB be part of Tibbles to degree 1/2 and not, say, to degree 51/100? Also, if we grant that there is no first moment at which CARB is part of Tibbles, I do not see why we should think that there is a first moment at which CARB is part of Tibbles to a degree higher than 0 or a first moment at which CARB is part of Tibbles to degree 1.

But I should also mention, in case it is thought that I am overlooking an important perspective on the issue addressed in this paper, that I do not see that the degree-theoretic treatments of mereological vagueness have established any clear link between mereological vagueness and existential vagueness. Both van Inwagen and Smith think that through their commitment to mereological vagueness they are also committed to existential vagueness. However, in van Inwagen's case, the commitment to existential vagueness follows *not* from his commitment to mereological vagueness but instead from his endorsement of the following claims: i) all composite objects are organisms and ii) it is indeterminate which organisms there are.²¹ In [Smith, 2004], the degree of an object *x*'s existence at time *t* in possible world *w* is determined by adding, for each of *x*'s 'notional' parts, the degree to which the notional part is a concrete part of *x* at *t* in *w* multiplied by the degree of importance of that part for *x* at *t* in *w*. The degree of a notional part's importance is used in this computation in order to accommodate objects,

like Tibbles, which are determinately present even when some of their parts are indeterminate. But Smith does not explain how to compute this crucial degree of importance or why it should ever be the case that an object's indeterminate parts are important enough to put its degree of existence between 0 and 1.

The multiple-interpretation approach adopted here is associated with supervaluationism (especially with the specification space semantics of [Fine, 1975]) and is usually adopted in conjunction with the assumption that all vagueness is linguistic. Supervaluationists generally hold that vagueness is due entirely to our sloppiness in assigning names or predicates to the constituents of the world and not to any fuzziness in the world itself. However, in allowing that there is no unique parthood relation, we *may* seem to be committed to a fuzziness that extends beyond language to objects in the world. [Morreau, 2002] suggests one plausible way of linking multiple interpretations of mereological vocabulary to vagueness in the world. Here, different interpretations of the parthood predicate correspond to different ways of 'sharpening' inherently fuzzy objects.²² But notice that even *if* the proponent of mereological vagueness is committed to a form of indeterminacy that extends beyond language and into the world, the ontological vagueness to which he is committed would seem to be at most an indeterminacy in the way objects are structured and *not* an indeterminacy in which objects there are.

To represent vagueness in predicates (in particular, vagueness in the parthood predicate), I introduce here mathematical structures which I call 'open interpretation (OI) models'. OI models are similar to the specification spaces of [Fine, 1975]. But whereas Fine's specification spaces are designed to support reasoning over vague statements, I am only interested here in modeling different varieties of mereological vagueness, not in developing a logic for reasoning over vague mereological claims. Thus, I have no need for the hierarchies of increasingly specific *partial* interpretations which are characteristic of specification spaces. Instead, OI models include only alternative *full* interpretations of predicates in the underlying vocabulary.

Let **ME-L** be a formal language that includes the vocabulary of **ME**. **ME-L** includes the primitive relational predicates **P** and ϵ as well as the defined predicates **O**, **FUS**, and so on. **ME-L** may, in addition, include time, object, or collection constants and non-mereological predicates. For example, **ME-L** may include sortal predicates such as *...is a cat* or *... is a carbon atom*.

An *open interpretation model* (OI model) is an ordered triple $\langle \Delta, \mathbf{T}, \mathbf{I} \rangle$ where Δ is a non-empty set of individuals, \mathbf{T} is a non-empty set of times, and \mathbf{I} is a non-empty set of interpretation mappings. For any interpretation $i \in \mathbf{I}$, i maps:

1. Each object constant of **ME-L** to a member of Δ .
2. Each collection constant of **ME-L** to a non-empty subset of Δ .
3. Each time constant of **ME-L** to a member of \mathbf{T} .
4. ϵ to the set membership relation on $\Delta \times \wp(\Delta)$ (i.e. to the set of ordered pairs $\{ \langle x, A \rangle : A \subseteq \Delta \text{ and } x \in A \}$).
5. **P** to a subset of $\Delta^2 \times \mathbf{T}$ that satisfies (using the standard semantics for predicate logic with identity) axioms (A1) – (A4) of **ME** over the object domain Δ and the time domain \mathbf{T} .

6. Each defined mereological predicate (*O*, *PR*, *FUS*, and so on) to sets of tuples which are determined by the relevant definitions and the images under *i* of ϵ and *P*.

In addition, *i* maps:

- Each non-mereological unary object predicate of *ME-L* to a subset of Δ .
- Each non-mereological binary object predicate of *ME-L* a subset of Δ^2 .

And so on.

Notice that OI models allow for no indeterminacy in which objects exist or variation in the degrees to which objects exist. Objects are just the members of Δ and each of these individuals exists to the same degree. Also, OI models allow for no indeterminacy in which collections and times there are or in the interpretation of the collection-membership predicate ϵ .²³ By contrast, there will in general be many different relations satisfying *ME*'s axioms for a fixed choice of Δ and *T* and any of these relations might be assigned to *P* by one of the interpretations in *I*. Thus, OI models allow for variation in the interpretation of *P* that does not depend on indeterminacy in the object domain (or indeterminacy in which collections there are and which members these collections have).

However, at least two limitations of OI models should be kept in mind. First, the axioms of *ME* (or, for that matter, of stronger mereologies) must be understood as just *minimal* restrictions on admissible interpretations of the mereological predicates. They are formal restrictions and, as such, do not take into account the many intuitive (and often vague) restrictions on predicate interpretations which cannot be formulated as constraints on mathematical models. For example, any admissible interpretation of the parthood predicate must count Tibbles' head, Tibbles' torso, and so on (where just what additional definite parts are covered by 'and so on' is a vague matter) as parts of Tibbles now. Also, any admissible interpretation must be self-consistent in the way it assigns objects (or tuples of objects, times, or collections) to a predicate's extension. If *i* is an interpretation that counts CARB as part of Tibbles now and CARB* is another carbon atom standing in a relevantly similar relation (however this is spelled out in terms of, e.g., relative location, functional interdependence, and so on—again, we can assume that there is vagueness in this restriction) to another cat (CAT) at time *t*, then *i* must also count CARB* as part of CAT at *t*. We will see in Section 5 that it is these more nebulous constraints on admissible interpretations which seem to lead to trouble in some cases of mereological vagueness.

Another limitation of OI models is that they cannot be used to represent higher-order vagueness. In any given OI model, there is a determinate set of alternate interpretation functions. Thus, a fixed OI model makes sharp distinctions between i) the objects are part of Tibbles now on *all* interpretations in *I*, ii) the objects that are part of Tibbles now on *no* interpretation in *I*, and iii) the objects that are part of Tibbles now on *some*, but not all, interpretations in *I*. This is unfortunate, but I know of no proposal for treating higher-order vagueness that does not involve unwieldy complications or controversial ontological commitments.²⁴ On the other hand, I cannot see that higher-order vagueness has any bearing on the connection between mereological vagueness and existential vagueness. In the discussion that follows, we will have no reason to assume that any OI model includes *all* admissible interpretations of mereological predicates or, more

generally, that there is any determinate set of admissible interpretations of mereological predicates. If we allow that what counts as an admissible interpretation of the parthood predicate is vague in the ways suggested in the previous paragraph, then there will be no determinate set of admissible interpretations. (See, on this point, Keefe's suggestion that higher-order vagueness generally stems from indeterminacy in what counts as an admissible interpretation of vague vocabulary [Keefe, 2000, Ch 8].)

Given their limitations, what are OI models good for? Besides providing a framework for the analysis of an apparent problem case for mereological vagueness in Section 5, OI models offer abstract pictures of what mereological vagueness might look like in existentially determinate worlds conforming to certain general mereological rules. (And I take it as one mark against an easy dismissal of mereological vagueness on the grounds that it leads to existential vagueness that we can at least produce a coherent *abstract* picture of a mereologically vague but existentially determinate world.) I will use OI models in the remainder of this section to assess the logical connections between different varieties of mereological vagueness and to consider the extent to which mereological vagueness still seems reasonable in case fairly strong mereological principles should hold.

An OI model represents predicate vagueness as disagreement among its interpretations over what extension is assigned to the vague predicate. More precisely, we will say that the predicate R is vague over the OI model $\langle \Delta, \mathbf{T}, \mathbf{I} \rangle$ if and only if for some $i, j \in \mathbf{I}$, $i(R) \neq j(R)$. We will say that $\langle \Delta, \mathbf{T}, \mathbf{I} \rangle$ is *mereologically vague* if and only if \mathbf{P} is vague over $\langle \Delta, \mathbf{T}, \mathbf{I} \rangle$. In other words, $\langle \Delta, \mathbf{T}, \mathbf{I} \rangle$ is mereologically vague if and only if, for some $i, j \in \mathbf{I}$, $i(\mathbf{P}) \neq j(\mathbf{P})$.

Mereological vagueness is illustrated in the following simple OI model. Here, and in all other example models presented in this paper, I make use of the following notation for representing the set of parts assigned to the object $x \in \Delta$ at time $t \in \mathbf{T}$ under interpretation $i \in \mathbf{I}$:

$$\text{Parts}_{i-t}(x) = \{y : \langle y, x, t \rangle \in i(\mathbf{P})\}.$$

Example 1: Let $\Delta = \{a, b, c, F\}$, $\mathbf{T} = (0, 1)$, and $\mathbf{I} = \{i, j\}$ where

$$\text{Parts}_{i-t}(x) = \{x\}, \text{ for } x = a, b, c; 0 < t < 1$$

$$\begin{aligned} \text{Parts}_{i-t}(F) &= \{a, b, F\}, \text{ for } 0 < t < 0.5 \\ &= \{a, b, c, F\}, \text{ for } 0.5 \leq t < 1 \end{aligned}$$

$$\text{Parts}_{j-t}(x) = \{x\}, \text{ for } x = a, b, c; 0 < t < 1$$

$$\begin{aligned} \text{Parts}_{j-t}(F) &= \{a, b, F\}, \text{ for } 0 < t < 0.75 \\ &= \{a, b, c, F\}, \text{ for } 0.75 \leq t < 1 \end{aligned}$$

In Example 1, the simples a, b, c and the composite F are present at all times.²⁵ The interpretations i and j disagree only over the times at which c is part of F . According to i , c becomes part of F at time 0.5. According to j , c is not part of F until time 0.75. Here, F plays a role analogous to that of Tibbles, with c in the role of CARB. Just as it is indeterminate whether CARB is part of Tibbles during the interval throughout which CARB is gradually incorporated into Tibbles, so also it is indeterminate whether c is part of F between time 0.5 and 0.75.

Although the model above is mereologically vague, there is no sense in which any member of the domain Δ exists indeterminately. In particular, there is no indeterminately existing object which the simples a , b , and c compose even when it is indeterminate whether the collection $\{a, b, c\}$ has a fusion. The compositional vagueness here is due to vagueness in c 's relation to F —we do not need to assume that there is a half-existent object which the members of $\{a, b, c\}$ compose. Thus, principle (*) from Section 1 does not hold in OI models.

Mereological vagueness is indeterminacy in the interpretation of P . But the other mereological predicates may also be vague. The predicates O , PP , FUS , and $HAS-FUS$ are all vague over the Example 1 model. Notice that if *any* of the defined mereological predicates is vague over an OI model, then that model must be mereologically vague. This follows immediately from the fact that all of the other mereological predicates are defined in terms of P and (in the case of FUS , $HAS-FUS$, and FP) ϵ . Since the interpretation of ϵ is fixed within a given OI model, the interpretation of the defined predicates can vary only if the interpretation of P does.

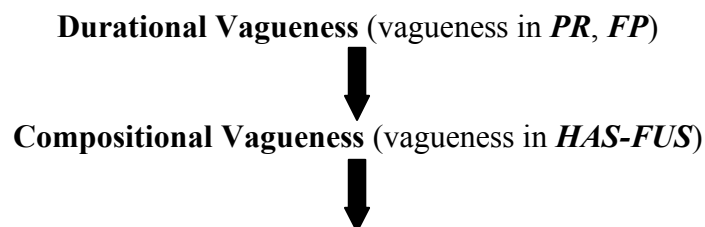
On the other hand, not all of the defined predicates are vague on every mereologically vague model. The following predicates are *not* vague in Example 1: PR (*present*), FP (*fully present*), SIM (*simple*), CMP (*composite*). The only predicates of ME other than P that are vague on *all* mereologically vague models are O (*overlap*) and FUS (*fusion*). For the remaining predicates, it is useful to distinguish the following two special cases of mereological vagueness:

$\langle \Delta, T, I \rangle$ is *durationally vague* if and only if PR (or, equivalently, FP) is vague over $\langle \Delta, T, I \rangle$

$\langle \Delta, T, I \rangle$ is *compositionally vague* if and only if $HAS-FUS$ is vague over $\langle \Delta, T, I \rangle$

Example 1 shows how we might have mereological vagueness without durational vagueness. The indeterminacy in c 's parthood relation to F does not depend on indeterminacy in the times at which objects in this model are present. Also, although CARB and Tibbles might plausibly have vague durations, the indeterminacy in whether CARB is now a part of Tibbles is clearly independent of any indeterminacy in the times at which these objects are present—we may assume that Tibbles and CARB are both definitely present throughout the interval during which their mereological relation is indeterminate. In Example 2 below, I will present an OI model that is mereologically vague, but neither compositionally vague nor durationally vague.

The logical relations between the different kinds of vagueness are illustrated in the following diagram. It shows that on OI models, durational vagueness entails compositional vagueness, which, in turn, entails mereological vagueness.²⁶



Mereological Vagueness (vagueness in *P*, *O*, *FUS*)

The logical relations between these different levels of vagueness would have been roughly the same if we had used, instead of **ME**, an atemporal mereology with a counterpart of our **PR** (something like the *exists at* predicate of [Sider, 2001]) for restricting interpretations in OI models. In this case, we could also have mereological vagueness without either durational vagueness or (on the assumption that the atemporal mereology does not include a universal-fusion axiom) compositional vagueness. The only difference for the atemporal case is that durational vagueness would not necessarily entail mereological vagueness unless special constraints required that indeterminacy in an object's duration always corresponds to indeterminacy in its parts.

In our OI models, interpretations of the parthood predicate are only required to satisfy the relatively weak axioms of **ME**. Though some philosophers consider axioms (A1)-(A4) adequate formal restrictions on interpretations of the parthood predicate, others (in particular, such opponents of mereological vagueness such as Sider and Lewis) think that stronger mereological principles hold. It is thus worthwhile to consider whether, at least in the context of OI models, mereological vagueness is compatible with stronger mereological constraints.²⁷

In fact, both interpretations in Example 1 satisfy the Extensionality Principle (EP) of Section 3. (Recall that EP prohibits distinct objects from having the exactly the same parts at a time and, together with the axioms of **ME**, implies that no collection can have more than one fusion at a time.) The indeterminacy in *c*'s mereological relation to *F* does not depend on there being distinct objects which share all of their parts at any time. Similarly, there is no reason for thinking that indeterminacy in CARB's relation to Tibbles depends on there being any coincident objects.

It is not hard to construct mereologically vague OI models whose interpretations satisfy the universalist principle, (UP), or both (EP) and (UP). In the mereologically vague model labeled Example 2, all interpretations satisfy (UP) as well as axioms (A1)-(A4). This model shows that mereological vagueness does not entail compositional vagueness—the predicate **HAS-FUS** is *not* vague in Example 2. The interpretations in the mereologically vague model labeled Example 3 satisfy both (EP) and (UP) in addition to (A1)-(A4).

Example 2: Let $\Delta = \{a, b, c, F, \underline{G}, \underline{H}, \underline{K}, \underline{L}\}$, $\mathbf{T} = (0, 1)$, $\mathbf{I} = \{i, j\}$ where

- Parts_{*i-t*}(*x*) = {*x*}, for *x* = *a*, *b*, *c*; 0 < *t* < 1
- Parts_{*i-t*}(*F*) = {*a*, *b*, \underline{G} , *F*}, for 0 < *t* < 0.5
- Parts_{*i-t*}(*F*) = {*a*, *b*, *c*, \underline{G} , \underline{H} , \underline{K} , \underline{L} , *F*}, for 0.5 ≤ *t* < 1
- Parts_{*i-t*}(\underline{G}) = {*a*, *b*, *F*, \underline{G} }, for 0 < *t* < 0.5
- Parts_{*i-t*}(\underline{G}) = {*a*, *b*, \underline{G} }, for 0.5 ≤ *t* < 1
- Parts_{*i-t*}(\underline{H}) = {*b*, *c*, \underline{H} }, for 0 < *t* < 1
- Parts_{*i-t*}(\underline{K}) = {*a*, *c*, \underline{K} }, for 0 < *t* < 1
- Parts_{*i-t*}(\underline{L}) = {*a*, *b*, *c*, \underline{G} , \underline{H} , \underline{K} , *F*, \underline{L} }, for 0 < *t* < 1

Mereological Vagueness and Existential Vagueness

$$\begin{aligned} \text{Parts}_{j-t}(x) &= \{x\}, \text{ for } x = a, b, c; 0 < t < 1 \\ \text{Parts}_{j-t}(F) &= \{a, b, \underline{G}, F\}, \text{ for } 0 < t < 0.75 \\ \text{Parts}_{j-t}(F) &= \{a, b, c, \underline{G}, \underline{H}, \underline{K}, \underline{L}, F\}, \text{ for } 0.75 \leq t < 1 \\ \text{Parts}_{j-t}(\underline{G}) &= \{a, b, F, \underline{G}\}, \text{ for } 0 < t < 0.75 \\ \text{Parts}_{j-t}(\underline{G}) &= \{a, b, \underline{G}\}, \text{ for } 0.75 \leq t < 1 \\ \text{Parts}_{j-t}(\underline{H}) &= \{b, c, \underline{H}\}, \text{ for } 0 < t < 1 \\ \text{Parts}_{j-t}(\underline{K}) &= \{a, c, \underline{K}\}, \text{ for } 0 < t < 1 \\ \text{Parts}_{j-t}(\underline{L}) &= \{a, b, c, \underline{G}, \underline{H}, \underline{K}, F, \underline{L}\}, \text{ for } 0 < t < 1 \end{aligned}$$

Example 3: Let $\Delta = \{a, b, c, F, G, \underline{H}, \underline{K}, L\}$, $\mathbf{T} = (0, 1)$, $\mathbf{I} = \{i, j\}$ where

$$\begin{aligned} \text{Parts}_{i-t}(x) &= \{x\}, \text{ for } x = a, b, c; 0 < t < 1 \\ \text{Parts}_{i-t}(F) &= \{a, b, F\}, \text{ for } 0 < t < 0.5 \\ \text{Parts}_{i-t}(F) &= \{a, b, c, G, \underline{H}, \underline{K}, F\}, \text{ for } 0.5 \leq t < 1 \\ \text{Parts}_{i-t}(G) &= \{a, b, G\}, \text{ for } 0.5 \leq t < 1 \\ \text{Parts}_{i-t}(\underline{H}) &= \{b, c, \underline{H}\}, \text{ for } 0 < t < 1 \\ \text{Parts}_{i-t}(\underline{K}) &= \{a, c, \underline{K}\}, \text{ for } 0 < t < 1 \\ \text{Parts}_{i-t}(L) &= \{a, b, c, \underline{H}, \underline{K}, F, L\}, \text{ for } 0 < t < 0.5 \end{aligned}$$

$$\begin{aligned} \text{Parts}_{j-t}(x) &= \{x\}, \text{ for } x = a, b, c; 0 < t < 1 \\ \text{Parts}_{j-t}(F) &= \{a, b, F\}, \text{ for } 0 < t < 0.75 \\ \text{Parts}_{j-t}(F) &= \{a, b, c, G, \underline{H}, \underline{K}, F\}, \text{ for } 0.75 \leq t < 1 \\ \text{Parts}_{j-t}(G) &= \{a, b, G\}, \text{ for } 0.75 \leq t < 1 \\ \text{Parts}_{j-t}(\underline{H}) &= \{b, c, \underline{H}\}, \text{ for } 0 < t < 1 \\ \text{Parts}_{j-t}(\underline{K}) &= \{a, c, \underline{K}\}, \text{ for } 0 < t < 1 \\ \text{Parts}_{j-t}(L) &= \{a, b, c, \underline{H}, \underline{K}, F, L\}, \text{ for } 0 < t < 0.75 \end{aligned}$$

Example 2 is similar to Example 1 in that it is here also indeterminate when the simple c becomes part of the composite F —in both models, one interpretation says that c becomes part of F at 0.5 and the other says that c is not part of F until 0.75. Example 2 differs from Example 1 in including more composite objects. Each of the four additional composites \underline{G} , \underline{H} , \underline{K} , and \underline{L} is permanently a fusion of exactly one of the multiple-member collections of simples $\{a, b\}$, $\{b, c\}$, $\{a, c\}$, and $\{a, b, c\}$. When it is indeterminate whether c is part of F , it is also indeterminate which of the ‘aggregates’ F coincides with. On interpretation i , F coincides with \underline{L} (the aggregate of a , b , and c) between 0.5 and 0.75. On interpretation j , F coincides with \underline{G} (the aggregate of a and b) between 0.5 and 0.75.

In Example 3, it is again indeterminate whether the simple c is part of the composite F between 0.5 and 0.75. And, as in Example 2, there are enough composites to fuse each of the four multiple-member collections of simples at each instant. But since both interpretations in Example 3 satisfy the extensionality principle (EP), neither interpretation can have F coinciding at any time with any of the additional composites. Thus, whereas in Example 2 we had been able to maintain determinate permanent fusions (conceived as mere aggregates of simples) for each of the multiple-member collections simples, the extra composites in Example 3 can fuse simples *only* when F is not a fusion of the same collection of simples. The result is that, in addition to the mereologically

vague composite F , we have also in Example 3 two durationally vague composites, G and L .

It is also possible to construct mereological vague OI models whose interpretations satisfy stronger mereological axioms, such as the diachronic fusion principle defended in [Sider, 2001].

It should be clear by now, though, that there is a limit to the usefulness of abstract models in our investigation of mereological vagueness. OI models illustrate a minimal formal sense in which mereological vagueness is independent of existential vagueness and compatible with a variety of mereological principles. But, at least in the cases of Examples 2 and 3, we should wonder whether it is possible to make sense of the situations sketched in these models in terms of plausible relations among objects in the world. I do think that the sort of picture hinted at in Example 2 has some appeal. Here, we have a two-level world consisting of, on the one hand, precise aggregates of simples and, on the other hand, mereologically vague common-sense objects like Tibbles. But before we could make sense of either this picture or that of Example 3 in concrete detail, we would first need to decide exactly which sorts of objects there are in the world and how they are distinguished from one another and identified over time.

And this is where detractors and proponents of mereological vagueness should sharply disagree. Detractors of mereological vagueness think that all objects are distinguished by having at each time a precise allotment of parts, from the simples on up. Detractors of mereological vagueness should, of course, hold that it is not possible to make sense of *any* of the example models above in terms of plausible relations among objects in the world. By contrast, proponents of mereological vagueness hold that objects may be distinguished from one another in ways that do not presume precise allotments of parts. But how exactly this is supposed to work (and whether it allows for situations like those represented in Examples 2 and 3) is an open question which the proponent of mereological vagueness needs to address. For example, he may, like [van Inwagen, 1981], hold that composite objects are distinguished by their lives or he may propose a more inclusive ontology that allows for more common-sense objects than just organisms. I will suggest at the end of this paper that the most serious challenge to mereological vagueness is the difficulty in coming up with a systematic account of objects that does not assume that all objects have determinate parts at determinate times. For now, though, I note only that even the strong principles UP and EP present no obstacle to mereological vagueness at the abstract level of formal mereological restrictions.

5. Mereological vagueness, durational vagueness, and existential vagueness

So far, the only potential limitation we have uncovered for mereological vagueness is that it *might* not combine naturally with *both* universalism and extensionalism. But notice that even here, the difficulty is in reconciling the claim that objects have indeterminate parts with the assumption that objects stand at each time in a one-to-one correspondence with the collections of objects which are their parts. If this is a difficulty for mereological vagueness, it is one that appears to have nothing to do with existential vagueness. (If we have trouble imagining how a model like that of Example 3 might represent actual objects in the world, I cannot see how it would help to add half-existent

objects to the model.) Thus, even if we were to accept both universalism and extensionalism (which we have no particular reason to do), we have seen no reason for thinking that mereological vagueness leads to existential vagueness.

I think that if there is a path from mereological vagueness to existential vagueness, it involves durational vagueness and not just, as is generally alleged, compositional vagueness. Recall that in prototypical cases of mereological vagueness, such as that involving CARB and Tibbles, there is apparent compositional vagueness which does not seem to lead to any existential vagueness. (It is indeterminate whether CARB and Tibbles compose any object now, but there is no reason for thinking that CARB and Tibbles compose an indeterminately existing object.) But those who argue that compositional vagueness leads to existential vagueness often have in mind a different kind of case of compositional vagueness. We *could* hold, e.g., that it is indeterminate whether certain boards compose a larger wooden object, not because the relation between one or more of the boards and a determinately existing larger wooden object is vague, but because it is indeterminate whether there is ever any larger wooden object at all in the vicinity of the boards. (Imagine, for example, that the boards have been left in a roughly table-like shape without ever being fastened together. We may not know what to say if someone asks whether there is a wooden object composed of the boards.)

This sort of case of compositional vagueness would certainly seem to lead to existential vagueness, but it is not clear why the proponent of mereological vagueness must accept that there are any such cases of compositional vagueness. Why could the proponent of mereological vagueness not hold that compositional vagueness is limited to cases involving only determinately existing objects and, like any other opponent of existential vagueness, accept that there is a fact of the matter (perhaps perpetually unknown to us) as to whether the boards compose anything? True, the reasons in favor of compositional indeterminacy in the board example look like our reasons for favoring indeterminacy in the CARB and Tibbles case—just as we have no idea of any empirical investigations that could establish whether CARB is now a part of Tibbles, so also we have no idea of any empirical investigations that could establish whether there is a larger wooden object in the vicinity of the boards. But there are two important differences between the cases. First, insofar as indeterminacy in the board case leads directly to existential vagueness, we have an overriding theoretical reason for denying the apparent indeterminacy in this case which we do not have in the CARB and Tibbles case.²⁸ Second, I do not see that there is such clear common-sense support for existential indeterminacy in the board case as there is for mereological indeterminacy in cases like that of CARB and Tibbles. It is one thing to hold that the application of predicates to determinately existing objects is indeterminate. I think that common sense makes this sort of assumption all of the time, especially in the case of quintessentially vague predicates such as *tall*, *red*, or *bald*. It is another thing to hold that the world includes indeterminately existing objects. I do not see that anyone ever assumes that there are indeterminately existing objects in non-philosophical contexts, not even as a way of resolving compositional questions in cases like that of the boards.

But I think that a denial of existential vagueness in cases like that of the boards is harder to maintain if we endorse, not only mereological vagueness involving *determinately present* objects, but also durational vagueness. Objects like Tibbles, though determinately existent, appear to have indeterminate durations. Just as there seems to be

no fact of the matter about exactly which atoms are parts of Tibbles now, it also seems that there is no fact of the matter about exactly which times Tibbles is present—and, in particular, no first moment at which Tibbles is definitely present. Similarly, in the case of most common-sense objects—tables, bicycles, people, and so on—there seems to be not only indeterminacy in which parts make up these objects at times when they are definitely present, but also indeterminacy in exactly when the objects are present. And the problem is that, if we allow a point in its formation when it is indeterminate whether an object is already present, there will surely be corresponding cases of ‘uncompleted objects’—cases in which an exactly similar process of object formation starts out, but never proceeds past an indeterminate-presence stage. In these sorts of cases, it is tempting to conclude that an indeterminately existent object is the product of the uncompleted object formation process.

We can get a clearer idea of how this might work by using OI models to analyze apparent cases of durational vagueness. Suppose that Henry builds a table named TABLE. Henry starts construction at time t_1 and finishes an hour later at t_2 . At t_1 , when, say, Henry is just getting out his tools, TABLE is definitely not yet present. At t_2 , after Henry has hammered in his last nail, TABLE is definitely present. But, just as there is no apparent first moment at which CARB is part of Tibbles, there would also seem to be no first moment at which TABLE is present. No point in the continuous building process distinguishes itself as that at which TABLE suddenly appears in the world.

The following OI model represents this sort of case of durational vagueness.

Example 4: Let $\Delta = \{a, b, c, \text{TBL}\}$, $\mathbf{T} = (0, 1)$, and $\mathbf{I} = \{i, j\}$ where

Parts $_{i-t}(x) = \{x\}$, for $x = a, b, c$; $0 < t < 1$
 Parts $_{i-t}(\text{TBL}) = \emptyset$, for $0 < t < 0.5$
 Parts $_{i-t}(\text{TBL}) = \{a, b, c, \text{TBL}\}$, for $0.5 \leq t < 1$

Parts $_{j-t}(x) = \{x\}$, for $x = a, b, c$; $0 < t < 1$
 Parts $_{j-t}(\text{TBL}) = \emptyset$, for $0 < t < 0.75$
 Parts $_{j-t}(\text{TBL}) = \{a, b, c, \text{TBL}\}$, for $0.75 \leq t < 1$

Here, simples a , b , and c are present at all times on both interpretations. TBL is a composite which is on both interpretations composed of all three simples between times 0.75 and 1. The two interpretations disagree on when exactly TBL’s life begins. According to i , TBL appears at 0.5. According to j , TBL is not present until 0.75. In this model, TBL is a simpler analogue of TABLE with a , b , and c corresponding to the boards of which TABLE is composed.

So far, so good. When focusing on such typical cases of apparent durational vagueness in isolation, we still have no reason for introducing existential vagueness. There is no reason to think that TABLE, Tibbles, or any other familiar object somehow exists only partially just because its duration is indeterminate.

But trouble crops up when we look beyond the determinately existent but durationally vague object to cases that look similar just up to a point at which it is still unclear whether our object is present. Suppose that Henry is a master carpenter and that his apprentice Walter is instructed to mimic each of the master’s steps as he performs

them between t_1 and t_2 . At t_1 , Walter starts out in unison with Henry. But he knocks his thumb with his hammer and stops at t^* , a moment at which it is still indeterminate whether TABLE is present. Let us suppose that at t^* both Henry's boards and Walter's boards are in exactly the same roughly table-ish configuration, but that Walter's boards, unlike Henry's boards, never progress beyond this state.

This situation could be represented in a very complicated OI model $\langle \Delta, \mathbf{T}, \mathbf{I} \rangle$ whose object domain includes every object in the vicinity of Henry and Walter during their construction adventure, whose time domain expands over t_1 and t_2 (including all times in between), and whose interpretations assign extensions not only to mereological predicates but also to sortal predicates such as *table*. Since it is indeterminate whether TABLE is present at t^* , \mathbf{I} includes interpretations i and j where i tells us that TABLE is present at t^* and j tells us that TABLE is not yet present at t^* .

Though at odds with one another, i and j must each be internally consistent in that, besides preserving the axioms of **ME**, each interpretation, taken independently, makes similar assignments to predicate extensions in similar cases. Thus since, according to i , TABLE is already present at t^* , i should also tell us that there is a table of Walter's making (call it WABLE) which is present at t^* . After all, Walter and Henry have manipulated their boards in exactly the same way between t_1 and t^* and their boards are in exactly the same configuration at t^* . But since $WABLE \in \Delta$, it follows from axiom (A4) of **ME** that j must assign WABLE a non-empty duration. What time could j take to be the start of WABLE's duration? Since Walter stops construction at t^* , if we suppose (as it seems we must) that WABLE's presence is definitely an immediate result of Walter's building activities, WABLE must be present at least by t^* on any interpretation. But if TABLE and WABLE are both tables, then j should have them appear at the same stage in their construction process and, according to j , TABLE does not appear until after t^* .

It is easy enough to see how existential vagueness could get us out of this dilemma. If WABLE were a member of i 's domain of objects but *not* a member of j 's domain of objects, then WABLE could appear at exactly the same time as TABLE on interpretation i and not appear at all on interpretation j . Interpretation j would differ from interpretation i both in having TABLE appear later (between t^* and t_2 instead of between t_1 and t^*) and in not recognizing that WABLE exists.

Unfortunately, there is no such easy solution for the proponent of durational vagueness who refuses to accept existential vagueness. If there is no indeterminacy in which objects exist, then all interpretations must assume the same object domain. However, I do not think the proponent of durational vagueness is entirely without hope of avoiding existential vagueness. There are alternative strategies that *might* accommodate durational vagueness here without invoking existential vagueness. But none of these strategies is unproblematic.

For example, we might hold that WABLE definitely exists but is not determinately a table. Whether or not we endorse durational vagueness, there would seem to be independent grounds for holding that the predicate *table* is vague and that WABLE is a borderline table. We could thus assume that i and j disagree on whether WABLE is in the extension of *table*. Interpretation i assigns both WABLE and TABLE to the extension of *table* and has WABLE appear at exactly the same stage of construction as does TABLE. Interpretation j excludes WABLE from the extension of *table* and has WABLE appear

before TABLE. On this approach, the discrepancy in j 's accounts of TABLE's and WABLE's durations is not problematic since, presumably, non-tables enter the world under different conditions than do tables.

But there are at least two difficulties with this proposal. First, if WABLE is not determinately a table, then what is it? In any case, WABLE is *not* a mere aggregate of simples (along the lines of the entities introduced in the discussion of Example 2 at the end of the previous section) that counts as a table on some interpretations of the table predicate, but not on others. For WABLE, we are assuming, is produced through Walter's manipulation of his boards, just as TABLE is produced through Henry's manipulation of his boards. But aggregates of simples are not produced through a rearrangement of existing objects—their presence depends only on the presence of their component simples and not on the arrangement of these simples. Also, if WABLE is similar enough to typical tables to count as a borderline table and if, as our proponent of durational vagueness assumes, tables are the sorts of things that generally have indeterminate parts and durations, then it seems that WABLE should also have indeterminate parts and an indeterminate duration. But if there are any aggregates of simples, they are presumably precise objects.²⁹

Second, whatever WABLE is (or, at least, whatever interpretation j takes WABLE to be), it would seem that j must, in the interests of self-consistency, recognize a corresponding object which is produced by Henry at the same time Walter produces WABLE. Call this object HABLE. If it is difficult to make sense of WABLE, it is even more difficult to make sense of HABLE. Note, to begin with, that HABLE is not identical to TABLE—on interpretation j , TABLE appears after t^* , while HABLE appear along with WABLE at or before t^* . But, while WABLE remains forever in its sort-of-table-like state, HABLE has all of its boards firmly fastened together by t_2 . What might either interpretation make of HABLE's progress (in particular, does HABLE ever become a table and, if not, why not?) or say about its relation to TABLE? It would seem to be a disaster for mereological vagueness to have to admit that there are two exactly coinciding tables at t_2 . The primary motivation for preferring mereological vagueness over either the Vague Singular Terms (VST) Solution or the Nihilism Solution lies in our intuition that common-sense designators like 'the table that Henry made' generally succeed in picking out unique objects.

I am not convinced that a borderline table solution cannot be made to work in the case above. Whether or not this line of defense can be worked out will depend on what account the proponent of mereological vagueness can give of awkward objects like WABLE and HABLE. Alternatively, the proponent of mereological vagueness *might* either deny that WABLE is even a borderline table (this would at least make it easier to deny that HABLE eventually becomes a table) or deny that Walter builds anything at all between t_1 and t_2 (thus, ridding himself of both WABLE and HABLE). Or, he might deny durational vagueness altogether. This last move would be a bit hard to swallow—our reasons for thinking that TABLE's duration is indeterminate are almost exactly analogous to our reasons for thinking that CARB's relation to Tibbles is indeterminate. But if durational vagueness is after all tantamount to existential vagueness, then we have an overriding reason for rejecting durational vagueness that does not apply in general to mereological vagueness.

What is clearly needed from the proponent of mereological vagueness, no matter which course is adopted, is some account of exactly what sorts of objects there are in the world and how they are distinguished from one another and identified over time. Mereological vagueness is motivated by strong intuitions about what objects there are in certain prototypical cases—that there is exactly one object which is a cat and is on Tibbles' mat right now or exactly one object which is a table and built by Henry between t_1 and t_2 . But these sorts of intuitions are notoriously gappy. Besides the prototypical cases, there are many others in which common sense has no clear answer as to what there is. Even if we reject durational vagueness, we still need some account of what objects are at hand in difficult cases like that of Walter's unfinished construction. The problem for the proponent of mereological vagueness is *not* that he is automatically committed to indeterminately existent objects in each of these unclear cases—in the absence of any special commitment which entails existential vagueness, he is as free as any other opponent of existential vagueness to hold that there is no real, but at worst only apparent, existential indeterminacy. The problem is, rather, that it is not easy to see how to account for the unclear cases in a way that harmonizes with what is said in the clear cases. For, unlike his opponents, the proponent of mereological vagueness denies that familiar common-sense objects are individuated through their having at each time determinate parts. Thus, he is not free, as his opponents are, to account for what there is in awkward cases by introducing precise aggregates of simples (either in the synchronic sense of Example 2 or in the sense of Sider's minimal diachronic fusions) to serve as borderline instances of common-sense concepts. If the proponent of mereological vagueness admits arbitrary aggregates of simples into his ontology at all, these precise objects must be too different from the prototypical imprecise tables, cats, and so on to count as borderline tokens of common-sense types—otherwise, he is in danger of ending up with multiple cats on the mat after all.

As a brief final note, we might wonder whether, despite the misgivings expressed in Section 4, we might have avoided the complications encountered in the TABLE example if we had used degrees of parthood and degrees of presence to treat mereological and durational vagueness instead of taking a supervaluationist approach. I cannot see that a degree-theoretic approach to vagueness would help in this case. We would have had a presence relation that assigns TABLE an intermediate degree of presence over an interval of times surrounding t^* . But then, since Walter's boards are in exactly the same state as Henry's up until t^* , there should be some wooden structure of Walter's making whose degree of presence corresponds to TABLE's up to t^* . Thus, we would again have something like WABLE and we would be hard-pressed to explain how this WABLE could ever be determinately present unless it were merely a borderline table. We would then have reason for thinking that Henry also should have constructed a borderline table and that this object (HABLE) must be distinct from TABLE. And so the discussion would proceed more or less as it has above.

Also, an atemporal mereology with a counterpart of ME's presence predicate would, as noted in Section 4, also be able to distinguish mere indeterminacy in parts from indeterminacy in the times through which a four-dimensional object persists. A four-dimensionalist would have the same sorts of special difficulties with durational indeterminacy as a three-dimensionalist. In the example discussed above, we *could* treat

TABLE as a four-dimensional object whose temporal extent is indeterminate. But then we would have exactly the same sorts of worries about whether Walter has constructed any object and, if so, what this object is and what the different interpretations can say about its temporal extent.

6. Conclusion

My conclusion is that the purported connection between mereological vagueness and existential vagueness has been a bit of a red herring. There is no simple, direct path from mereological vagueness to existential vagueness. Even assuming strong mereological principles, we can still make sense of mereological vagueness in abstract models without assuming existential vagueness. In order to establish that mereological vagueness leads to existential vagueness, the opponent of mereological vagueness needs to move beyond abstract models and make substantial assumptions about what sorts of objects are in the world and how these objects are identified and distinguished from one another. But it is in such ontological assumptions that proponents and opponents of mereological vagueness differ most sharply. Obviously, to start from the assumption that objects are identified through their parts (as sets are identified through their members) is to load the dice against mereological vagueness.

But, aside from the difficulties attending any form of vagueness, the crucial issue for mereological vagueness is whether it can give a systematic account of objects that preserves the sorts of common-sense intuitions that motivate it. For example, [van Inwagen, 1981] offers a systematic account of objects, but one which denies that the world includes tables, chairs, tails, legs, and so on. One is justified in wondering in what sense van Inwagen's account is preferable to the (perhaps) slightly less intuitive, but simpler accounts of Lewis and Sider. If mereological vagueness has any support, it is in our strong intuitions that the world includes objects like tables, chairs, cats, dogs, tails, and legs, that these sorts of objects are no more determinate than they appear to be, and that we can distinguish a particular object without having to list all of its parts. But it is not at all obvious how these intuitions can be convincingly filled out so as to account for the many problem cases, like that of Walter's unfinished table, in which common sense leaves us without clear guidance as to what objects there are.³⁰

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¹ I take *mereological vagueness* to be the thesis that the truth-value of claims of the form ‘*x* is part of *y* (at time *t*)’ may be indeterminate even when all singular terms in the claim denote unique individuals. Implicit in this formulation is an assumption that the sort of vagueness we are concerned about here is not merely epistemological—it is not just that we cannot know whether the parthood claims are true or false. Notice that if the vagueness of parthood claims *were* merely epistemological, there would certainly be no reason for taking mereological vagueness as a sign of real indeterminacy in which objects are in the world.

² I take *existential vagueness* to be the thesis that it is indeterminate which objects there are. Since I take an Eternalist approach throughout this paper, I understand existential vagueness *not* as a claim that it is indeterminate which objects are present in the world now or at another particular time, but, rather, as the claim that it is indeterminate which objects are present in the world any time. This approach to the issue follows that of, e.g., [Sider, 2001] and [Hawley, 2002]. Note, however, that some authors (e.g., [Smith, 2004]) treat existential vagueness more broadly as including also indeterminacy in which objects are present at a given time.

³ A formal analysis of composition is given in Section 3 of this paper in terms of the fusion predicate, *FUS*. Roughly, the objects in collection *C* compose *x* at time *t* (i.e. *x* is the *fusion* of *C* at *t*) if and only if i) every member of *C* is part of *x* at *t* and ii) every part of *x* at *t* overlaps at *t* a member of *C*. This analysis of composition corresponds to that of [Sider, 2001] and, with minor alterations, to that of [van Inwagen, 1981].

⁴ I find both Sider’s and (especially) Lewis’ arguments against compositional vagueness obscure. I may be misreading them, but if they do not accept (*), then I do not see how their arguments are supposed to work. I take the following claims as evidence that both philosophers accept (*).

Suppose...that it can be vague whether a given class has a fusion. In such a case, imagine counting all the concrete objects in the world. One would need to include all the objects in the class in question, but it would be indeterminate whether to include another entity: the fusion of the class.
[Sider, 2001]

There is such a thing as the sum [of a given class of objects], or there isn’t. It cannot be said that because the *desiderata* for composition are satisfied to a borderline degree, there sort of is and sort of isn’t. What is this thing such that it sort of is so and sort of isn’t, that there is any such thing.
[Lewis, 1986].

And I take it that (*) is what Smith has in mind in the claim “Whenever there is a case of vague composition, there is a case of vague existence”, which he takes as a premise in Lewis’ and Sider’s arguments against compositional vagueness [2005, 381]. Though Smith rejects another premise of the Lewis/Sider argument (the denial of existential vagueness), he endorses (*). For some suggestion that van Inwagen also accepts (*), see [1981, 271-273].

⁵ Nonetheless, [Hawley, 2004] provisionally grants that a proponent of compositional vagueness must also accept existential vagueness, but she does not explain what might be the basis of this commitment to existential vagueness—how exactly might compositional vagueness lead to existential vagueness if (*) does not hold? After calling (*) into question, Hawley mentions one rather implausible strategy for

endorsing compositional vagueness while avoiding existential vagueness and then lets the matter drop, accepting “for the sake of argument that all plausible, moderate, informative accounts of composition permit the type of vagueness in composition which entails vagueness in existence”. After voicing his misgivings over (*), [Merricks, 2005] also lets the matter drop and focuses instead on arguing that not every moderate restriction on composition leads inevitably to compositional vagueness.

⁶ A disclaimer: I am definitely not attempting to defend mereological vagueness against all attacks in this paper. In fact, I am not so much defending mereological vagueness as attempting to clear up one popular basis for criticism of it. There are apparent difficulties in making sense of any case of vagueness—for example, difficulties concerning higher-order vagueness and the logic of indeterminate propositions. I will assume that these are also difficulties for mereological vagueness. My primary concern in this paper is with whether mereological vagueness carries the *extra* liability of committing its proponents to indeterminately existing objects.

⁷ [van Inwagen, 1981, 217-218] uses a nearly identical example in making his case for mereological vagueness. Similar examples are discussed, but used to support alternatives to mereological vagueness, in [Unger, 1980], [Geach, 1980], and [Lewis, 1993]. See also [Schulz et al., 2005] for a discussion of this sort of example from a biological perspective.

⁸ [Williamson, 1994] rightly points out that it does not follow automatically from the fact that we cannot conceive of how to determine whether a claim is true or false that the claim is indeed neither true nor false. But the inconceivability of any method for establishing whether ‘CARB is now part of Tibbles’ is true or false is at least a very good *prima facie* reason for thinking that CARB’s current mereological relation to Tibbles is indeterminate. In the absence of comparable reasons for thinking that it is determinate, we should conclude that it is not. But I admit that if mereological indeterminacy were to entail to existential vagueness or if any more general problems for a non-epistemological account of vagueness prove insurmountable, then we *might* have an overriding reason for thinking that apparent mereological vagueness is merely a form of ignorance.

⁹ I am assuming, for the sake of simplicity, that ‘CARB’ has a determinate referent. But if ‘Tibbles’ lacks a determinate referent, then perhaps ‘CARB’ does as well. In this case, we should say: ‘CARB is part of Tibbles now’ is neither true nor false because some, but not all, candidate referents of ‘Tibbles’ have candidate referents of ‘CARB’ as parts.

¹⁰ I leave open the question of whether the VST Solution is compatible with there being any ordinary objects (cats, mats, tables, etc) at all. [Lewis, 1993] assumes that cats are the sorts of things that might significantly overlap one another, while [Heller, 1988] thinks that at least his version of the VST Solution implies that there are no ordinary objects. Of course, if the VST Solution implies that there are no ordinary objects, then it turns out to be not so different from the Nihilistic Solution and all the more unintuitive for that.

¹¹ Compare the situation here to that of obviously vague singular terms like ‘the nicest person in America’. In contexts where this sort of term is used but fails to distinguish a unique individual, we normally presume that we can clarify who the intended referent is by substituting a precise designation, such as the person’s name. But if terms like ‘Tibbles’ or ‘the cat on the mat’ turn out to be vague in the way the VST solution claims they are, there is no precise terminology available to take their place.

¹² Notice that for philosophers who think that there are nonexistent objects, existential vagueness may not seem quite so incoherent as I assume it is. But even these philosophers may find the thesis that there is no determinant set of actually existing objects unappealing. See [Sider, 2003] for a more detailed exposition of problems facing existential vagueness.

¹³ Philosophers such as van Inwagen, who treat composition as a relation between an object *x* and a plurality of *pairwise discrete* objects making up *x*, can consider instead of CARB and Tibbles, the plurality consisting of CARB plus all of the atoms definitely in Tibbles. This plurality of pairwise discrete objects sums to Tibbles (or a part of Tibbles) if and only if CARB is part of Tibbles and, according to common sense, composes nothing when CARB is not part of Tibbles.

¹⁴ As his support for (*), [Smith, 2005] presents an example of three teacups. According to Smith, it is indeterminate whether the cups compose an object only if there is an indeterminately existing object, Cup, which the cups (indeterminately?) compose. In so far as I understand it, the crucial difference between Smith’s example and the CARB/Tibbles example is that in the former there is supposedly no determinately

existing object which might consist of just those three teacups. But I find Smith's example odd and unhelpful, because I cannot imagine who might think that it is indeterminate whether the three cups compose something. Most normal people would, I assume, hold that the cups definitely fail to compose anything. The sorts of philosophers who endorse universalism (or, at least, a restricted form of universalism applying to teacups) would hold that the teacups definitely compose something. I cannot see why anyone would hold that there are arbitrary sums of teacups, but that these sorts of things exist only to an intermediate degree. (Compare: Some think that God exists. Others deny that God exists. But no one thinks that God exists to an intermediate degree.)

¹⁵ The intended constraints on admissible interpretations are supposed to correspond to the admissibility constraints on the precisifications of predicates in supervaluationist treatments of vagueness with the mereological principles playing the role of what [Fine, 1975] calls 'penumbral truths'.

¹⁶ See, for example, the mereologies of [Whitehead, 1929], [Leonard and Goodman, 1940], and [Tarski, 1956].

¹⁷ A time-independent mereology may also be appropriate for a presentist ontology. I do not consider presentism in this paper.

¹⁸ See [Thomson 1983] for other another example of a temporal mereology that allows distinct objects to share all of their parts at a time.

¹⁹ This corresponds to the treatment of composition in [Sider, 2001]. Somewhat different conventions are adopted in [van Inwagen, 1981]. Here, the objects in collection A are taken to compose x at t if and only if i) x is a fusion of A at t AND ii) no two members of A overlap. But this difference does not affect the points made in this paper.

²⁰ In fact, [Smith, 2005] uses two different parthood relations, only one of which (*concrete parthood*) comes in degrees. The other parthood relation (*notional parthood*) is a crisp relation. Also, Smith's concrete parthood is interpreted as a mapping that assigns a real number in $[0, 1]$ to each pair of objects at a given time in a given *possible world*. I do not consider variation across possible worlds in this paper.

²¹ More precisely, [van Inwagen, 1981] explicitly endorses the following i) every object is either a simple or an organism and ii) it is indeterminate which organisms there are. Existential vagueness follows immediately from i) and ii) together with: iii) it is determinate which simples there are. While I do not know that van Inwagen ever explicitly endorses iii), it is clear enough that the problem cases that force him to accept existential vagueness (e.g., cases involving viruses) have to do with indeterminacy, not in which simples there are, but rather in which composite organisms there are. Here, the vaguely existing object is a borderline organism and definitely not a simple.

²² See also [Akiba, 2004] for the suggestion that objects extend over 'precisified worlds' just as they might extend over possible worlds or temporal worlds. On Akiba's treatment of vagueness, sharp objects occupy exactly the same spatial location (at a given time, in a given possible world) in all precisified worlds, while vague objects occupy different spatial locations (at a time, in a possible world) in different precisified worlds. Given this sort of analysis of vague objects, different interpretations of the parthood predicate could correlate to the different mereological configurations of objects in different precisified worlds.

²³ In fact, there could be reasons for allowing indeterminacy in which times there are. But I do not see that this issue is relevant to our concerns about mereological vagueness and existential vagueness, so I think we can fairly ignore it in the interest of simplicity.

²⁴ For a treatment of higher-order vagueness that involves much more complicated mathematical machinery than we use here, see [Smith, 2004]. Alternatively, we could introduce higher-order vagueness into the models by allowing the sets of interpretations to be *vague sets* in the sense of [Tye, 1990].

²⁵ In all of the example OI models presented in this section, every member of the object domain is a fusion of simples. I have chosen to present only these sorts of OI models here because they are much simpler than, e.g., models in which every object has (at every time) a proper part. Since these later models have infinite object domains, their interpretations cannot be specified through lists of parts as I have done in my examples. But I cannot see that the issue of whether there are any simples at all (and, if so, whether every object is, throughout its life, a fusion of simples) has much bearing on our concerns over mereological vagueness. It is easy enough to come up with (but time-consuming to present) mereologically vague OI models in which there are no simples. As one sketch of how this might be done: let Δ be the set consisting

of the number 0 and, in addition, all non-empty open regular subsets of the set of real numbers. In assigning parts to the sets of reals in Δ , interpretations i and j both treat the set's subsets as its parts (at all times). But whereas i assigns to 0 the exact same parts as it does to (0, 1), j assigns to 0 the exact same parts as it does to (1, 2). This OI model is mereologically vague, but the predicate **SIM** has an empty extension on both interpretations.

Also, whereas all of the example models presented in this section include only two alternative interpretations, I assume that there are generally indefinitely many plausible assignments of parts to ordinary objects (in particular, indefinitely many alternative time intervals throughout which CARB might plausibly count as a part of Tibbles). Again, the limitation on the example OI models is adopted here only in order to simplify their presentation.

²⁶ Other varieties of mereological vagueness are independent of both compositional vagueness and durational vagueness. **PP**-vagueness, **SIM**-vagueness, and **CMP**-vagueness are all independent of both compositional and durational vagueness.

²⁷ However, both Sider and Lewis use the assumption that mereological vagueness is false to support their claims that strong universalist principles hold. It is not clear exactly what case they would make for universalism if mereological vagueness were not ruled out.

²⁸ On this point, see my comments in endnote 8.

²⁹ In fact, though, if there are both mereologically vague common-sense objects and objects which are determinate (and permanent) aggregates of fixed collections of simples, then even the 'precise' aggregates of simples may have indeterminate parts. In Example 2, because it is indeterminate whether F is a fusion of $\{a, b\}$ between 0.5 and 0.75, it is indeterminate whether F is part of \underline{G} (the aggregate of a and b) between 0.5 and 0.75. But we can at least assume that mere aggregates of simples, unlike tables, have determinate simple parts. And it would seem that anything with determinate simple parts and a determinate duration should be too different from a typical table to count as a borderline instance of a table.

³⁰ I am grateful to Nicholas Asher and two anonymous reviewers for helpful comments on this paper.