A Neglected Issue in the 3D/4D Debate

In what follows, I explore a neglected issue in the disagreement between three- and four-dimensionalists—I will show that the nature of the fundamental mereological relation can decisively influence the outcome of this debate. In short, if the fundamental mereological relation is *proper parthood-at-a-time* then four-dimensionalism is false. Recognizing this does two things for us: (i) It makes room for three-dimensionalists to say at least one of the things they have tended to say all along: persisting things do not have (proper) temporal parts, and (ii) it re-focuses the debate over persistence on a narrower and perhaps more tractable question—"What is the nature of the fundamental mereological relation?"

1. Three- and Four-dimensionalism[1]

I take it to be minimally necessary for the truth of four-dimensionalism that

(4D) Every object has an instantaneous temporal part at any time it exists.[2]

For one thing to be an instantaneous temporal part of another at some time, three conditions must be satisfied:

(ITP) x is an *instantaneous temporal part* of y at t $=_{df}$ (i) x exists at but only at t, (ii) x is part of y at t, and (iii) x overlaps at t everything y overlaps at t.

Four-dimensionalists believe also in non-instantaneous temporal parts, and since these are relevant to the discussion, we may as well record a natural extension of (ITP), *viz*.:

(TP) x is a *temporal part* of y throughout interval, *I*, iff for any instant, t, (i) x exists at t iff t is in *I*, and (ii) for each t in I, x is part of y at t and x overlaps at t everything y overlaps at t.

Some believe (and I am sympathetic) that the truth of (4D) is also sufficient for four-dimensionalism,[3] although it may be worth mentioning a caveat here. (4D) has been *one* focal point in the debate about persistence—there are others. This much is clear: a

[1] This version of (4D) and (ITP) are due to Theodore Sider. See Sider (2001).
[2] What if every temporal interval has further sub-intervals? (4D), then, is false yet presumably a four-dimensionalist would amend rather than abandon his theory. Here, and throughout, I ignore this complication.
[3] See Sider (2001), chapter 3.

good deal of the attention has been focused on (4D).[4] For my present purposes, and perhaps oversimplifying somewhat, I will take four-dimensionalism to be the thesis that (4D) is true, and I will take the minimal commitment of the three-dimensionalist to be that (4D) is false. Some three-dimensionalist's have openly claimed as much, and said (by way of contrast) that persisting objects are distinguished by being 'wholly present'.[5] As I want to avoid the obscurities involved in taking the debate to turn on an unexplained notion of an object's being 'wholly present', I now stipulate that this means the object does not have any (proper) temporal parts.[6] So long as one is willing to gloss being wholly present in that way, the debate about whether or not objects are wholly present is the topic of this paper. We can record the three-dimensionalist's minimal commitment as follows:

(WP) No object has proper temporal parts at any of the times it exists.

While (4D) is necessary and sufficient for four-dimensionalism, (WP) should be regarded merely as a necessary condition for three-dimensionalism. I will mention five additional commitments that I think most three-dimensionalists would accept.

(1) The fundamental properties of the actual world are all, strictly speaking, relational. (Let's say that *a* has a relational property if for some relation, R, and some other thing, y, *a* is R to *y*.) One standard way of going, here, the one I will adopt, is to take all fundamental properties to be time-relative, and to have the form '…is F at t', for some t.[7] Four-dimensionalist's standardly think of the fundamental properties as

[4] Most recently, Sider (2001) claims that (4D) is the four-dimensionalist's minimal commitment. Among those who seem to locate the debate elsewhere, going so far as to regard (4D) as *compatible* with three-dimensionalism, may be John Hawthorne, Ernest Sosa, Kit Fine and Berit Brogaard. I don't take there to be an important disagreement here—'three-' and 'four-dimensionalism' are terms of art, and many different views have gone by those names. I intend to isolate and challenge one of them.

[5] For a representative list, see Sider (1997), p. 208. See especially Markosian (1994), who interprets wholly present much as I do.

[6] There is an intermediate position that one might take—one might say that it is enough that objects do not *always* have temporal parts—see Dao (1986). The position is available, but in my opinion too weak to be of any serious interest.

[7] There are other ways, for example, the adverbial approach—see Hawley (2001), §1.4 and §1.5. What goes for the fundamental properties also goes for fundamental relations: I am 5 feet from something (if I am) *at some time*, my hand is part-at-present of me, and so on. I except identity, and temporal relations will require a different treatment.

'intrinsics', where this means, roughly, something's having of a property is independent of the existence of anything else, including times.[8]

(2) Persistence is a matter of strict identity. When we utter sentences of the form 'x at t is y at t*' we mean to that x and y are strictly identical—that is neither contingent nor a matter of being identical relative to some time. (Of course, this is a point of agreement with many four-dimensionalists.[9])

(3) There exist, strictly speaking, many of the objects of our ordinary ontology: statues, rocks, cats, and so on—no nihilism.

(4) Many of those ordinary things just mentioned exist at more than one time and gain/lose parts over time.

(5) Sometimes, distinct objects coincide mereologically, as (for instance) a statue and the piece of bronze from which it is made. I leave open whether or not the statue is identical to the piece of bronze of which it is made when they exist at all the same times. It is compatible with three-dimensionalism that if the latter condition is met, the statue is the piece of bronze, but that when one is shorter lived than the other, they are distinct at any given time. Thus, the weaker claim I am endorsing here—on behalf of the three-dimensionalist—is the denial of the principle that for any time, if x and y share all their parts at that time, x is identical to y.[10] (Again, this is a point of agreement between three- and four-dimensionalists. The four-dimensionalist, however, does take a stand on the more general principle, for he endorses the following: If for any time, t, x exists at t iff y exists at t, and if x and y share all their parts at t, then x = y.)[11]

Many three-dimensionalists accept all of these, but I will not here explore the extent to which one can pick and choose. From now on, when I refer to three-dimensionalism, I mean the conjunction of (WP) and all of (1) – (5), recognizing that this does involve some regimentation of the term 'three-dimensionalism'.

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[8] What it means to say a property is intrinsic is a vexed issue, and not one worth pursuing here. I take it the notion has wide enough currency to do the work I put it to here.

[9] Theodore Sider's Stage View, which deserves the name four-dimensionalism by the criterion adopted here, is an exception. The Stage View endorses (4D), identifies a thing with its present stage, and analyzes persistence in terms of some suitable relation among stages. But given the Stage View's commitment to (4D), all of my central arguments apply to it, as well.

[10] Van Inwagen is an exception.

[11] Most three-dimensionalists will also say that there may be cases where distinct objects coincide at all times, but the issues on which this decision turns lay beyond the scope of this paper.

2. If the fundamental mereological property is *proper parthood-at-a-time*, then (4D) is false.

We can begin with this point of agreement between three- and four-dimensionalists: the fundamental mereological relation is either a relation obtaining between pairs of objects and times, or it is a relation obtaining among pairs of objects. I have noted in the previous section that four-dimensionalists think the latter is correct. However, one strength of (4D) and the definitions of temporal part that go with it is that they meet the three-dimensionalist on his own territory. Those definitions are expressed in a mereology that fits with the metaphysical picture of properties that the three-dimensionalist prefers—for short, let's call that a 'temporal mereology'. Given (4D), if we had independent reasons for thinking that the fundamental properties are as the three-dimensionalist says, four-dimensionalists could embrace a temporal mereology and say all that they want to say.

This situation suggests that, aside from the disagreement over whether the true mereology is a temporal one or not, there are no further disagreements between three- and four-dimensionalists stemming from the logic of parts and wholes. Let me clarify. There would still be the disagreement over whether axioms guaranteeing universal fusions are true (whether uniquely or not), whether (for example) there is some (unique) thing that is the fusion at some time of London and me. There would still be the disagreement over whether the correct mereology is extensional or not, that is, whether sharing of all parts is sufficient for identity. Rather, the suggestion is that there is no disagreement between three- and four-dimensionalists at the *ground floor*, so to speak, when it comes to mereology, that the three- and four-dimensionalist, given a temporal mereology, would agree up to a point, up to an axiom of some strength, and disagree thereafter. While things could be that way, I believe they are not—the disagreement goes all the way down, even in the context of a temporal mereology. If I'm right, then for some choice of mereological primitive, the four-dimensionalist should be unable to take the same starting point. I will now argue that a three-dimensionalist can and a four-dimensionalist cannot take *proper parthood-at-a-time* as his primitive.

Suppose, then, that we construct the beginnings of a mereology, call it 'T', starting with *proper-parthood-at-t* (symbolized as '$<<_t$') as our primitive notion. In addition, let's take standard definitions of overlap ('O_t') and parthood simpliciter ('$<_t$'); and assume axioms guaranteeing the transitivity, irreflexivity and asymmetry of proper parthood at a time (unbound variables, x, y, z and t are assumed to be universally quantified with widest possible scope, here and throughout).

Mereology T:

D1. $x <_t y =_{df} x <<_t y \vee x = y$

D2. $x O_t y =_{df} (\exists z) [z <_t x \wedge x <_t y]$

A1. $x <<_t y \wedge y <<_t z \supset x <<_t z$ (transitivity)

A2. $\sim (x <<_t x)$ (irreflexivity)

One further axiom should be included:

A3. $x <<_t y \supset (\exists z) [z <<_t y \wedge \sim (x O_t z)]$

A3 is a 'remainder' principle, and says that where a thing has a proper part, it must have at least one other wholly distinct proper part. There are strong motivations to accept A3, since without it, T is satisfies models on which things have only a single proper part, and this would arguably do too much violence to our concept of proper parthood.[12]

One can extend T, adding axioms of varying strengths up to those guaranteeing unrestricted fusions. One such axiom, accepted by four-dimensionalists, is this:

(PO) x exists at t $\wedge$ y exists at t $\wedge \sim (x <_t y) \supset (\exists z)[z <_t x \wedge \sim (z O_t y)]$.[13]

(PO) is an 'overhang' principle, and says that where something is not a part of another, the first has parts that are wholly distinct from the second—as it were, the first extends "beyond the boundaries" of the second. (PO) has some plausibility, as well, but it will turn out to have disastrous consequences for both theorists if added to T.

[12] For a discussion of an atemporal version of A3, see Simons (1987), pp 26-28. The principle is not uncontroversial in this context and I will discuss it in a later section.
[13] See Sider (1997 & 2001).

Let's consider the three-dimensionalist's situation first. It is clear that (PO) is unacceptable to anyone who endorses T, (WP) and the possibility of coinciding objects, for T plus (PO) entails that any objects are identical if they share all their proper parts at any time. To see why, consider a statue and lump that share all their microphysical parts at some time that both exist. By (PO), the statue is part of the lump at the relevant time, since there is no part of the statue at that time that does not overlap the lump at that time. But if so, then the statue is either a proper part of the lump or identical to it (by definition). By A3, it is not a proper part of the lump, since there is no proper part at that time of the lump that is not overlapped by the statue. Therefore, if the statue is part of the lump at the time they both exist, the statue and lump are identical at that time. But that result is incompatible with the three-dimensionalist's commitment to distinct coinciding objects, and therefore a three-dimensionalist cannot accept the addition of (PO) to T.

However, and this point is crucial, the four-dimensionalist cannot accept the addition of (PO) to T, either. Let's add that the statue is an instantaneous object and that the lump is longer-lived. The statue, then, is a candidate for the sort of thing that the four-dimensionalist would call an instantaneous temporal part of the lump. However, by the argument in the previous paragraph, we can demonstrate that the four-dimensionalist cannot claim that the statue is a temporal part, for temporal parts are parts, and—given (PO)—that would entail that statue is identical to the lump. In general, adding (PO) to T entails (by the same reasoning) that any four-dimensional space-time worm is identical to any of its proper temporal parts. And that is to say, given T and (PO), four-dimensionalism is incoherent.

Of course, excluding (PO) would solve the problem for both theorists, for then it could not be argued that the statue is identical to the lump at the time both exist, for it would not follow that the statue is a part of the lump at that time. But accepting T has serious consequences for four-dimensionalists, for within that mereology they cannot articulate the claim that objects have temporal parts, if temporal parts are understood in accordance with (ITP) and (TP) above. However, the gravity of this consequence depends on whether or not there is some other definition of temporal parthood that the four-dimensionalist can supply. I think the answer is no, but I will discuss this strategy in the next section. There are two other consequences for the four-dimensionalist that we

should bring out.

First, typical four-dimensionalists endorse unrestricted mereological composition, according to which any things, howsoever scattered in space and time, compose something. However, adding an axiom guaranteeing universal composition to T entails (PO). This can be seen as follows, for which I assume a fusion axiom that is weaker than unrestricted mereological composition, though it should be obvious that A4 (below) follows from the unrestricted principle.[14]

Proof of (PO) from MT and A4

D3. x is a *fusion at t* of a set S $=_{df}$ (i) every member of S is part of x at t, and (ii) every part of x at t overlaps at t some member of S.

A4. For any set, S, of material objects, and any time, t, such that every member of S exists at t, there exists a fusion of S at t.

Conditional proof, on the assumption of MT, D3, A4 and $(\exists x)(\exists y)(\exists t)[\sim (x <_t y)]$.

1. $\sim a <_t b$	(EI, and assumption)
2. $(\exists x)$ [x = fusion at t of S = {a, b}	(A4)
3. c = fusion at t of S = {a, b}	(2, EI)
4. $a <_t c \ \wedge \ b <_t c$	(3, D3)
5. $(a <<_t c \ \vee a = c) \ \wedge \ (b <<_t c \ \vee \ b = c)$	(4, D1)

There are, therefore, four cases to test:

Case 1: $(a = c) \ \wedge \ (b = c)$

Case 2: $(a = c) \ \wedge \ (b <<_t c)$

Case 3: $(a <<_t c) \ \wedge \ (b = c)$

Case 4: $(a <<_t c) \ \wedge \ (b <<_t c)$

[14] If every set S has a fusion at any time some member of that set exists, then those sets whose members exist at once have a fusion (which is what A4 says).

(Cases 1 and 3 contradict line 1, and from Case 2 the desired result follows immediately by A3 and D1.)

6. $a <<_t c \ \wedge \ b <<_t c$	(Case 4)
7. $b <<_t c \supset (\exists x) [x <<_t c \ \wedge \ \sim (x \ O_t \ b)]$	(6, A3)
8. $d <<_t c \ \wedge \ \sim (d \ O_t \ b)$	(6, 7, EI)
9. $d <_t a \ \vee \sim (d <_t a)$	
10. $d < a \supset (\exists x) [x <_t a \ \wedge \ \sim (x \ O_t \ b)]$	(8, 9)
11. $\sim d < a \supset \sim (d << a) \ \wedge \ \sim (d = a)$	(D1)
12. $d \ O \ a \ \vee \ \sim (d \ O \ a)$	
13. $\sim (d \ O \ a) \supset (\exists x) [(x << c) \ \wedge \ \sim (x \ O \ a) \ \wedge \ \sim (x \ O \ b)]$	(contra D3)
14. $(d \ O \ a)$	(12, 13)
15. $(d \ O \ a) \ \wedge \ (\sim d \ O \ b)$	(8, 14)
16. $(d \ O \ a) \supset (\exists x) [x <_t d \ \wedge \ x <_t a]$	(D2)
17. $e <_t d \ \wedge \ e <_t a$	(14, 16, EI)
18. $e <_t a \ \wedge \ \sim (e \ O_t \ b)$	(15, 17)
19. $(\exists x) [x <_t a \ \wedge \ \sim (x \ O_t \ b)]$	(EG)

20. (PO): $\sim (a <_t b) \ \supset \ (\exists x) [x <_t a \ \wedge \ \sim (x \ O_t \ b)]$	(1 – 19, CP)

That completes the proof—adding A4 to Mereology T entails (PO). Therefore, no four-dimensionalist who would endorse unrestricted mereological composition can accept T. But let's suppose the four-dimensionalist were willing to give up unrestricted composition.[15] Still, there is a second cost—the loss of an argument against (WP), and

[15] The situation is actually worse than I portray it, for there are a number of far weaker mereological principles that will also get the same result. For example, if it were true that whenever two things overlap-at-a-time, they have a greatest common part-at-that-time, then the same result is provable given Merelogy T. (The fusion of the statue and lump in my argument is one such object.) See Simons (1987), pp. 25-37 for a survey of mereological principles stronger than (PO) and weaker than universal composition.

therefore against three-dimensionalism as I have been representing that view.[16]

Consider, again, the possibility of a lump of clay that is formed into a statue for one instant of its career (how it occurs is irrelevant).[17] The statue, by hypothesis, exists at but only at a single instant (call it 't'), and on standard assumptions about the relationship between statues and the lumps of clay of which they are made (such as that they at least have all the same micro-physical parts when they both exist), the lump overlaps at t everything that the statue overlaps at t.[18] The statue, then, satisfies two out of the three conditions for temporal parthood, as given by (ITP). That it satisfies the third would follow from (PO), as we have seen, since from the assumption that the statue and lump share all their micro-physical parts it follows that every part of the statue overlaps some part of the lump at the relevant time. Thus, given (PO), a three-dimensionalist must either deny the possibility of instantaneous objects such as the statue we have been discussing, or give up what he claims it means for persisting objects to be wholly present whenever they exist, that is, give up (WP).[19]

This argument depends on (PO), and as we have seen the four-dimensionalist cannot appeal to it in T. It is worth emphasizing at this point: it is not merely true that the four-dimensionalist is not entitled to conclude that the statue is an instantaneous temporal part of the lump—he cannot say it on pain of incoherence.[20] Four-dimensionalism is not true if the fundamental mereological relation is *proper parthood-at-a-time*.

On the other side, three-dimensionalists usually do *not* endorse universal composition, and so three-dimensionalists have a freer hand in this matter. A three-dimensionalist can (and, of course, must) stop short of (PO). Moreover, T should be

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[16] This argument is first made in Sider (1997), and also appears in Sider (2001). It should be obvious by now that the argument in the next paragraph cannot presuppose Mereology T, and it does not. The background mereology Sider presupposes is probably Mereology F, below.

[17] A lump of clay with a single statue-shaped temporal part would not, of course, amount to four-dimensionalism; however, if the lump had even one instantaneous temporal part, then (WP) would be false, and that is the issue at the moment.

[18] Perhaps someone might say that the lump doesn't overlap, say, the head of the statue. However, there are atoms (in the non-mereological sense) that are parts of the head and also parts of the lump, and as I am using 'overlap', any part-sharing amounts to overlap.

[19] Instantaneous objects are perhaps not worth worrying about, but the problem will generalize to longer lived (proper) temporal parts, for there is are natural extensions of (ITP) and (PO) to cover intervals of time, and thus similar arguments will entail that any ordinary statue that is shorter-lived than the lump of which it is made is an extended (but nonetheless proper) temporal part of the lump over an interval. Even if it were innocuous to deny the possibility of instantaneous objects, almost no one would deny the possibility of their longer-lived cousins (nihilism, remember, has been set aside).

[20] Once again, he cannot say it given (ITP) and (TP)—alternatives will be considered in the next section.

attractive to a three-dimensionalist because it allows him to say one of the things he has tended to say all along—that persisting things do not have proper temporal parts. That said, there is a deeper reason that three-dimensionalists should sign on with T, but this issue can become clear only after we have considered what responses a four-dimensionalist might make to this argument.

3. Responses

I have argued that a three-dimensionalist can, and a four-dimensionalist cannot, accept T. But there a number of responses a four-dimensionalist could give at this point in the argument. I will now argue that none of them undermines my main thesis: that if the fundamental mereological relation is *proper parthood-at-t*, then four-dimensionalism is false.

Response 1: The argument that generated the difficulty from the case of the instantaneous statue and the longer-lived lump depended on A3, the remainder principle. It might be suggested that A3 be rejected in favor of (PO). Setting A3 aside, then, it follows from (PO) and D1 that the statue is a proper part-at-t of the lump; and since proper parts-at-t are parts-at-t, it also follows that the statue is an instantaneous temporal part of the lump at t.

The problem with this strategy, however, is that it also requires giving up A1 or A2. For the same argument showing that the statue is a proper part-at-t of the lump also shows that the lump is a proper part-at-t of the statue. It must be allowed, then, either that things may sometimes be proper parts of themselves (for $S <<_t L \wedge L <<_t S$; then by transitivity, $S <<_t S$), or that proper parthood-at-t is intransitive and symmetric. So, the difference between the mereologies in question is not simply a matter of opting for (PO) rather than A3—it also involves a radical reconstrual of proper parthood-at-t. While the three-dimensionalist I am imagining takes that concept to be primitive, A1 – A2 are (by his lights) essential constraints governing its behavior. Moreover, any relation that is not transitive is not the relation of proper parthood that my three-dimensionalist says is the fundamental mereological relation. Therefore, to adopt this response is to concede my thesis.

Another related strategy[21] is to offer a substitute for A3:

[21] This was suggested to me by Bruce Glymour.

> (A3*) If $x <<_t y$ then there exists a z such that at some time, t*, z is part of y at t* and z does not overlap x at t*.

Let's refer to the mereology that includes A1 – A2, and A3* as T*. (PO) may be introduced into T*, and it will not follow in T* that the statue is the lump. Moreover, this avoids the need to reject transitivity or irreflexivity, for while the four-dimensionalist can now say that the statue is a proper part of the lump when they both exist, nothing compels him to say also that the lump is a proper part of the statue at that time.

While this is better than the wholesale rejection of any remainder principle, it should be pointed out that proper parthood-at-t as governed by A3* is not proper parthood-at-t as governed by A3, since in T* one is free to say that the statue is a proper part of the lump when both exist and in T one is not free to say the corresponding thing.

Response 2: A four-dimensionalist has at least one strategy available to him here that is not available to the three-dimensionalist. The four-dimensionalist could define parthood-at-t using (provisionally) a temporally relativized predicate, '$=_t$'. Thus, he might say that $x <_t y =_{df} x <<_t y \vee x =_t y$.[22] The four-dimensionalist may then define '$=_t$' in terms of identity and temporal parts: $x =_t y$ iff x's temporal part at t = y's temporal part at t. This would allow a four-dimensionalist to agree that the fundamental mereological relation is proper parthood-at-t, to accept all of A1 – A3 and (PO), and to avoid the conclusion that the four-dimensional worm is identical to the stage.

The three-dimensionalist I am imagining, however, cannot accept a primitive '$=_t$' relation. What could that be, from his point of view, except some relative identity thesis? If the three-dimensionalist is to maintain his second commitment (as listed in section 1), then he must maintain that $x =_t y$ if and only if x = y and x and y exist at t. But perhaps it would be jumping to conclusions to say that '$=_t$' is relative identity, or some other deviant

[22] This is intended to be a temporally relativized parthood relation, not an atemporal one.

identity relation. What must be true, here, is that $=_t$ is a new primitive, and as such a mereology that has two fundamental relations is not mereology T, a fact which vindicates my conclusion.

Response 3: The four-dimensionalist can give an alternative temporal mereology, and this is not hard to do. He can take '$<_t$' as primitive, defining proper parthood-at-t and overlap-at-t, and adding comparable axioms:[23]

Mereology F

4D1. $x <<_t y =_{df} x <_t y \ \wedge \ \sim (y <_t x)$ (proper part)

4D2. $x \ O_t \ y =_{df} (\exists z) [z <_t x \ \wedge \ z <_t y]$ (overlap)

4A1. (transitivity of $<_t$)

4A2. If $x <<_t y$ then $(\exists z) [z <<_t y \ \wedge \ \sim (x \ O \ z)]$ (remainder)

Adding (PO) to this axiom set does not yield the difficulties of the previous system, for it is left open whether any x and y are identical. Moreover, it follows from 4A1 – 4A2 and (PO) that the statue of the previous section's example is a part of the lump at the time they both exist. Therefore, against the background of this provisional mereology, the statue is an instantaneous temporal part of the lump.

However, this is not the mereology my three-dimensionalist accepts, for this mereology rejects the assumption that proper parthood-at-a-time is the fundamental relation. A retreat of this kind vindicates my thesis.

Perhaps the four-dimensionalist will deny that this strategy rejects the fundamentality of proper parthood, for he defines parthood-at-t, in terms of atemporal proper parthood.[24] I can grant this. Still, the move rejects mereology T, for atemporal proper parthood is not logically equivalent to proper parthood-at-t. For consider the instantaneous statue in the history of a longer-lived lump of clay: that statue is an atemporal proper part of the lump, but it obviously is not a proper part of the lump at the time they both exist. Thus, again, I find that my conclusion is vindicated. A four-dimensionalist who adopts a temporal mereology that takes parthood-at-t as its primitive

[23] He can take any of the other mereological predicates as his primitive, if he prefers, the result will be the same.

[24] As follows: $x <_t y$ iff x and y exist at t and $x << y$.

makes a claim about the fundamental mereological property that my three-dimensionalist rejects.[25]

Response 4: The problem for four-dimensionalist derives from the definition, D1, of parthood-at-t, which contains identity in its second disjunct. However, if there were some way to define parthood-at-t and overlap-at-t without appealing to identity, my argument would collapse. Suppose, then, that the four-dimensionalist were to take D1 not as a definition of parthood-at-t, but as the definition of an intermediate parthood relation, call it 'parthood-at-t*' ('$<_t$*'):

D1*. $x <_t^* y =_{df} x <<_t y \vee x = y$

Adding to this an intermediate overlap relation:

D2*. $x O_t^* y =_{df} (\exists z) [z <_t^* x \wedge z <_t^* y]$

From D1* and D2*, we can define the following relation, which we suppose is the four-dimensionalist's proposal for parthood-at-t simpliciter.

D3*. $x <_t y =_{df} \sim (\exists z) [z <_t^* x \wedge \sim(z O_t^* y)]$[26]

This strategy looks promising, for it does take proper parthood-at-t as its primitive and gets the result that the statue is a part-at-t of the lump, since nothing that's a part*-at-t of the statue fails to overlap*-at-t the lump.

However, this strategy will have difficulty with another case of the same sort. Among the things that have temporal parts whenever they exist, according to four-dimensionalists, are mereological atoms. Suppose, then, that the statue and lump are atoms. Since atoms have no proper parts at any time, it would follow that the statue is identical to the lump. For the statue is a part*-at-t of the lump and so must overlap* the lump at t. But if so, the statue is either a proper part of the lump at t or is identical to the lump. Therefore, this strategy also requires the rejection of A3 and some of A1 – A2, since unless the statue is a proper part-at-t of the lump, it is, by these definitions, either no part-at-t of the lump or identical to it. Developed along these lines, therefore, Response 4 reduces to Response 1.

Though I cannot defend the claim here, it is hard to see how any strategy that takes proper parthood-at-t as primitive and allows identity into the definitions of

[25] The same points apply, *mutatis mutandis*, to a provisional mereology that takes *overlap-at-t* or *disjointness-at-t* as their primitives.
[26] This suggestion is due to Theodore Sider, in correspondence.

mereological predicates can avoid this problem. Moreover, I cannot see any way to define adequate notions of parthood-at-t and overlap-at-t in terms of proper parthood-at-t without using identity. If this is right, there is serious pressure on the four-dimensionalist to deny that the fundamental mereological relation is proper parthood-at-t.

An alternative would be to define $<_t$ as follows: x part-at-t of y iff x and y are proper parts at t of all the same things.[27] This avoids the introduction of identity into the definitional axioms of the mereology, but has a serious cost. For imagine a world populated by only two mereological atoms that are contemporaries at some time, t. However these atoms are situated in space at that time, it would follow that the atoms are parts of one another at t. This shows that this definition of $<_t$ is hopeless, I think, for whatever parthood-at-t is, it could not be true that atoms at far ends of the universe are parts of one another when they both exist.

Response 5: Another sort of strategy that a four-dimensionalist might employ at this stage of the argument is to stick with A1 – A3, stopping short of (PO) along with the three-dimensionalist, and then redefine temporal part.[28] This is somewhat artificial, since the four-dimensionalist will want to endorse (PO) and the definitions of temporal parthood above. However, we can imagine that in this context, he suspends his full view, hoping to argue that even without (PO), a statue is an instantaneous temporal part of the lump at the time both exist. Since the three-dimensionalist denies that the statue is a part-at-t of its coinciding lump, perhaps the four-dimensionalist should drop that condition from ITP.

> (ITP2) x is an *instantaneous temporal part* of y at t $=_{df}$ (i) x exists at but only at t, and (ii) $(\forall z)$ [x O_t z iff y O_t z]

This, however, will be no help. For if we spell out condition (ii) in accordance with our definition of overlap, we get:

$$(\forall z)(\exists w)\ [(w <_t x \ \wedge \ w <_t z) \text{ iff } (w <_t y \ \wedge \ w <_t z)]$$

However, everything overlaps itself at any time it exists. Thus, the three-dimensionalist I am imagining will claim that one instance of (ii) is false; for if we name the statue ‘S’ and name the lump ‘L’ we get:

[27] This was suggested to me my Kit Fine in conversation.
[28] Again, these suggestions are due to Theodore Sider in correspondence.

$(S <_t S \wedge S <_t S)$ iff $(S <_t L \wedge S <_t S)$

Since it is precisely the first conjunct of the right hand side that we are now supposing the three-dimensionalist denies, and since the left hand side is trivially true, any argument to the conclusion that the statue is a temporal part of the lump in the sense of (ITP2) also requires (PO).

It might be thought that the four-dimensionalist can appeal to a weaker notion of overlap, *viz*.:

(D2*) $x\ O^*_t\ y =_{df} (\exists z)\ [z <<_t x \wedge z <<_t y]$.

This amounts to:

(ITP3) x is an *instantaneous temporal part* of y at t $=_{df}$ (i) x exists at but only at t, and (ii) x and y share all their proper parts at t.

This would get the four-dimensionalist the conclusion he wants, for the statue is (by hypothesis) is an instantaneous temporal part in *this* sense. However, this definition suffers from a serious defect—by ITP3, any mereological atom is an instantaneous temporal part (when it exists) of any of its contemporaries. Thus, even if a three-dimensionalist is compelled to admit that the statue is an ITP3 of the lump, this should not bother him, for this will not yield a thesis sufficiently general to be regarded as four-dimensionalism.

One last strategy of this sort:

(ITP4) x is a temporal part of y at t iff x exists only at t, and for some set, S, x is a fusion-at-t of S and y is a fusion-at-t of S.

This strategy for defining a temporal part gives up the idea that a temporal part is a part in any sense, and that is to say it concedes to the three-dimensionalist his claim that the instantaneous statue is no part of the lump when they both exist. Therefore, there is no conflict between ITP4 and D1—and perhaps it would be bad enough if things had instantaneous temporal parts, even in this sense, whenever they exist.

However, ITP4 also suffers from a serious defect. No mereological atom could be a temporal part of another in this sense, since any mereological atom fuses-at-a-time only the set of which itself is a member. So, for any pair of mereological atoms of any duration whatever, there is no set that they both fuse at *any* time. Once again, even if the statue is an instantaneous temporal part of the lump according to ITP4, it should not

worry the three-dimensionalist, since ITP4 will not yield a thesis sufficiently general to be regarded as four-dimensionalism.[29]

Response 6: (4D) contains mereological conditions, and the point of the foregoing has been to show that there are fundamental mereological disagreements standing between the three- and four-dimensionalist. Perhaps the four-dimensionalist can avoid the issue entirely by giving a non-mereological version of his thesis (note that this would be a severe concession, even if the strategy worked). The picture that the four-dimensionalist has is that persisting objects are "stacks" of instantaneous things distributed through and filling regions of space-time, and perhaps that is all he should insist on with the three-dimensionalist. Suppose, then, that the four-dimensionalist were to cash out that picture as follows. Let's represent regions of space-time as sets of ordered pairs of times and spatial points, and say that a region, R, is 'filled' just in case for each pair, <t, p> in R, something or other exists at p at t. Then the four-dimensionalist could say this:

> (4D*) For any filled region of space-time, R, and any time, t, in R, there is an object, x, that exists at but only at t, and for any p, such that <t, p> is in R, x exists at <t, p>.

(4D*) is weak indeed, and I don't think a three-dimensionalist should worry about it. Take a simple case—a world populated by an atom, A, that exists at only two times, t1 and t2. At this small world, something persists, since A exists at more than one time. If (4D*) is also true at this world, there are also two instantaneous things: B, which exists at but only at t1, and C, which exists at but only at t2 (in the same place as A at each respective time). However, without any additional claim about the relation standing between A and B at t1, and between A and C at t2, I can't see why a three-dimensionalist should feel threatened. Notice, in particular, that without some further claims about the relations between A, B, and C at the times they exist, it might also be true at this world that any part of A at any time is part of A at every time it exists—that is to say, these three things are consistent: something persists, (4D*), and mereological eternalism.

[29] However, ITP4 could be used to articulate four-dimensionalism if it were true that everything had proper parts whenever it existed—i.e., if it were true that there are no mereological atoms. But four-dimensionalism in this sense is stronger than the view against which I have been defending (WP), since it requires a strong contingent assumption about our world.

Therefore, (4D*) cannot capture what four-dimensionalists believe any better than the other proposals considered above.

4. Is there a reason to embrace Mereology T if you're a three-dimensionalist

I have said little about the relationship between temporal mereologies and atemporal ones. The four-dimensionalist's (4D), (ITP) and (TP) can be translated into atemporal languages by the following schema (let 't-temporal part' abbreviate 'x's temporal part that exists at t'). We have to be particularly careful at this stage about which parthood relation is in play, and so when I am either mentioning or using 'part-at-t' as it appears in Mereology F, I will write '4-part-at-t'. Otherwise, when I writer 'part-at-t' it should be understood to be the relation that appears in Mereology T.

(C) x is a 4-part of y at t *iff* (i) x and y exist at t, and (ii) x is part of y.[30]

The schema instructs how to recover the four-dimensionalist's preferred mereology from the temporal guise of (4D) and (ITP).[31] (C) takes us from 4-parthood-at-t to parthood, and (let's suppose) the four-dimensionalist defines atemporal parthood in terms of atemporal proper-parthood in a way superficially like the three-dimensionalist's definition in T, *viz*., $x < y =_{df} x << y \vee x = y$. Thus, there is an indirect relationship between *parthood-at-t* and atemporal proper parthood.

What is an atemporal proper part? Let's think for a moment like a four-dimensionalist. Imagine taking a God's eye view of objects in time—the four-dimensionalist's picture is that they are temporal 'stacks' of instantaneous things extending from the past to the future. Persisting things, according to four-dimensionalism are fusions of those instantaneous things.[32] An atemporal *proper* part of a persisting thing is any part of it that is not coextensive with its total material content. Among such things are what the three-dimensionalist calls proper parts of me *at times—e.g.*, my toes, my eyes, and so on. But also, the whole of my material content *now* is an atemporal proper part of my temporally extended self, by a four-

[30] Compare Sider (1996), p. 200.
[31] There are other options ways for the four-dimensionalist to go, of course, but there is no reason he couldn't go this way.
[32] Again, I am setting aside Sider's Stage View.

dimensionalist's lights. And that is to say that among a persisting thing's atemporal proper parts are its (alleged) temporal parts.

Now, accepting *4-parthood-at-t* as the starting point for a mereology does not thereby commit one to the existence of temporal parts, much less to (4D). If the four-dimensionalist is playing fair, he ought to leave room for the three-dimensionalist to deny that there are any such things, and Mereology F does that. However, if we suppose for a moment that Mereology F includes (PO), things look differently. Given F plus (PO), there still is room for one to deny that things have temporal parts. One is free to deny the existence of statues that are shorter lived than the lumps of clay from which they are made. One is free to deny that there are trees once he recognizes that the collection of molecules coincident with anything he would call a tree would very likely outlast the tree if it existed. In short, one can embrace a kind of nihilism if one likes. The lesson for my three-dimensionalist: Mereology F plus (PO) forces a decision: either admit that there are at least some temporal parts (and deny (WP)), or embrace nihilism. On the other hand, this is leaving *my* three-dimensionalist no option at all, for he *does* think there are statues and trees and he does *not* think that there are temporal parts. Neither denying (WP) nor embracing nihilism will tempt him. Therefore, he will deny (PO) if he must accept Mereology F.

So, no matter how things turn out with respect to the fundamental mereological relation, whether it is *proper-parthood-at-t* or *4-parthood-at-t*, my three-dimensionalist must deny (PO). The situation is this: Mereology T plus the three-dimensionalist's background commitment to mid-sized persisting things entails that (PO) is false, and Mereology F plus the commitment to (WP) entails that (PO) is false. Absent any argument for (PO) and a choice between Mereology T and Mereology F, my three-dimensionalist should accept T, for T plus his belief in mid-sized persisting things provides an explanation what he believes anyway, that (PO) is false.[33]

5. Conclusions

[33] Strictly, one can deny (PO) only if the fundamental mereological relation is *proper parthood-at-t* and unrestricted mereological composition is not true. If there are also unrestricted mereological fusions then everyone must accept (PO). But then everything would be a mereological fusion. That would be grim, indeed.

I argued that if the fundamental mereological relation is proper parthood-at-a-time then four-dimensionalism is false. That argument is strengthened by the apparent fact that, given *proper parthood-at-a-time* as the starting point of our mereology, the only adequate notions of *parthood-at-a-time* and *overlap-at-a-time* include identity. If that is right, and if the fundamental mereological relation is *proper parthood-at-t*, then there is no notion temporal part general enough to articulate four-dimensionalism that does not also imply that the alleged temporal part is identical to the longer-lived persisting thing. But then, of course, no persisting thing has an instantaneous temporal part (or larger proper temporal part) at any of the times it exists. That is to say, (4D) is false, and the minimal commitment of three-dimensionalists is true: persisting things do not have proper temporal parts.

If that much right, it brings to light a neglected issue in the debate over persistence. While three- and four-dimensionalists do, in fact, disagree about the existence of temporal parts, there is a more basic disagreement between them—whether or not the fundamental mereological relation is *proper parthood-at-t*. Moreover, a cogent argument to the effect that the fundamental mereological relation is *proper parthood-at-t* would settle the debate in the three-dimensionalist's favor. The four-dimensionailst *can* articulate his thesis using *4-parthood-at-t* as his primitive notion; but despite the superficial resemblance between that relation and *parthood-at-t* as defined by the three-dimensionalist (D1 in section 2), the three- and four-dimensionalist are talking about different relations. Except for the limiting case where x is identical to y, every x that is an improper 4-part-at-t of y is also an atemporal proper part of y. Moreover, every such thing is a temporal part of y in the context of (PO). Therefore, the four-dimensionalist would seem to need two arguments, one that would compel the three-dimensionalist to concede that the basic mereological relation is *4-parthood-at-t* and another convincing him that (PO) is true.