# CAN MEREOLOGICAL SUMS CHANGE THEIR PARTS?*

Many philosophers think not. Many philosophers, in fact, seem to suppose that anyone who raises the question whether mereological sums can change their parts displays thereby a failure to grasp an essential feature of the concept "mereological sum." It is hard to point to an indisputable example of this in print,[1] but it is a thesis I hear put forward very frequently in conversation (sometimes it is put forward in the form of an incredulous stare after

* I thank Achille Varzi for extensive comments on a draft of this paper, which have led to many revisions. I hope that he, like me, regards the revisions as improvements.

[1] One possible example is the section "Constitution and Mereology" (pp. 179–85) of Lynne Rudder Baker's *Persons and Bodies* (New York: Cambridge, 2000). I say "possible example" because much of what Baker says in this section I do not understand. But it does seem to me that what she says presupposes or implies that since a mereological sum "is identical with its parts," is "nothing over and above" its parts, it cannot change its parts: for it to change its parts would be impossible for a reason analogous to the reason for which it is impossible for Cicero to become identical with someone other than Tully. It seems, moreover, that she subscribes to the thesis that the concept of a mereological sum *is* the concept of an object that is identical with its parts or is nothing over and above its parts. I will not in this essay address the question whether a mereological sum is identical with its parts, is identical with the things it is a sum *of*. The thesis that a mereological sum is identical with its parts implies (in cases of mereological sums of more than one thing) that one thing can be identical with "two-or-more things" (not "individually," which everyone agrees is impossible—a violation of the principle of the transitivity of identity—but, as it were, collectively). In my view, this thesis is logically incoherent. For a discussion of this thesis and my reasons for thinking it logically incoherent, see my essay "Composition as Identity," in James E. Tomberlin, ed., *Philosophical Perspectives, Volume 8: Logic and Language* (Atascadero, CA: Ridgeview, 1994), pp. 207–20, reprinted in Peter van Inwagen, *Ontology, Identity, and Modality: Essays in Metaphysics* (New York: Cambridge, 2001), pp. 95–110. As to "nothing over and above its parts," as far as I can see, the phrase 'nothing over and above' is entirely meaningless.

A second possible example is chapter 6 ("Parts and Wholes") of Jonathan Lowe's *Kinds of Being: A Study of Individuation, Identity and the Logic of Sortal Terms* (Oxford, UK: Blackwell, 1989). I again say "possible example" because Lowe does not think that the objects he calls mereological sums *have* parts—at least not in the ordinary sense of 'part'. Consider the well-known case of Tibbles the cat, his tail ("Tail"), and "all of him but his tail" ("Tib"). According to Lowe, Tibbles is not only distinct from the sum of Tib and Tail (the two have different persistence conditions), but Tail is not a part of the sum of Tib and Tail—not, at least, in the sense of 'part' in which Tail is a part of *Tibbles.* If we say that Tib and Tail are *s-parts* of the sum of Tib and Tail ('s' for 'sum'; 's-part' is my term, not Lowe's), then Lowe's position is that a sum cannot change its s-parts: in *that* sense, he contends that a mereological sum "cannot change its parts." And he regards this statement as a conceptual truth: someone who said that the mereological sum of Tib and Tail could cease to have Tail as an s-part would exhibit thereby a failure to grasp the persistence conditions associated with—and part of the meaning of—the sortal term 'mereological sum'.

And there is a second reason why I have said "possible example": I do not know what Lowe means by 'mereological sum'. He does not define the term and he explicitly

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I have said something that implies that mereological sums can change their parts).

I want to inquire into the sources of this conviction, and, by so doing, show that it is groundless.

One of its sources, I think, is the apparently rather common belief that 'mereological sum' is, in its primary use, a stand-alone general term like 'unicorn' or 'material object'—a phase that picks out a *kind* of thing, a common-noun-phrase whose extension comprises objects *of a certain special sort*.[2] (Or perhaps it is saying too much to say that this is a common *belief*. I might say, more cautiously, that there seems to be common tendency to presuppose that 'mereological sum' is a stand-alone general term, or a common tendency to treat 'mereological sum' as a stand-alone general term.)

On this understanding of 'mereological sum', there can be philosophical disputes about whether there are or could be mereological sums—as there are philosophical disputes about whether there could be unicorns or are material objects. For example (on this understanding), 'mereological sum' might be defined as "object that is identical with its parts" or "object that is nothing over and above its parts" or "object that is nothing more than the sum of its parts."[3] And, once a definition of the general term 'mereological sum' has been given,

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rejects the definition used in the present essay. (He sees clearly that, if 'mereological sum' is defined as it is defined in this essay, Tibbles *is* the mereological sum of Tib and Tail; and, as Lowe sees matters, that simply will not do, since, if Tail were surgically removed from Tibbles, Tibbles would continue to exist and would no longer have Tail as a part; and—as everyone knows—mereological sums cannot change their parts.)

A final example: in *Real Names and Familiar Objects* (Cambridge: MIT, 2004), Crawford L. Elder says (p. 60), "An *aggregate* of microparticles is the mereological sum of individually specified microparticles. It continues to exist just as long as *those* individual microparticles exist, and just where those individual microparticles exist." I am fairly sure that Elder thinks that it is a conceptual truth that if something is a mereological sum of certain microparticles, it will continue to exist just as long as those individual microparticles exist.

[2] All the philosophers cited in the previous note would appear to believe that mereological sums are a special sort of object. See the paragraph complete on p. 183 of Baker's *Persons and Bodies*. Lowe certainly believes that mereological sums are a special sort of object: that that is so is a central thesis of his theory of parts and wholes. Elder evidently regards 'aggregate' (or 'mereological sum') as a name for a kind of object, a kind that can contrasted with other kinds: kinds comprising objects that do not bear the specified relation to "individually specified microparticles."

[3] I do not mean to imply that I regard these as adequate definitions. An adequate definition, at a minimum, pairs a definiendum with a meaningful definiens, and these three definientia are entirely meaningless. I have explained why I think that the first and the second of them are meaningless in note 1. As to the third—well, let us define a "dog" as an object that is nothing more than a dog. There can be no adequate definition of mereological sum but the definition I shall give in the text (in section I).

philosophers can, as is their custom, proceed to dispute about whether there are or could be mereological sums in the sense of the definition.

Philosophers who understand 'mereological sum' in this way will, however, concede that there is more to be said about the phrase, for they will be aware that 'mereological sum' has a use different from its use in sentences like 'The mereological sum sitting on that table is green' or 'All artifacts are mereological sums'. 'Mereological sum' (they will be aware) is not used only as a stand-alone general term, since the phrase also occurs in *relational* statements like 'That statue is a mereological sum *of* certain gold atoms' and 'A mereological sum *of* a railway engine and any number of cars is a *train* when those objects are fastened to one another in a certain way'. How shall those who understand 'mereological sum' as, in the first instance, a stand-alone general term define the relational phrase 'mereological sum of the so-and-sos'? Their answer to this question will have to be of the following general form: '*x* is a mereological sum of the so-and-sos if and only if *x* is a mereological sum and…the so-and-sos…*x*…'—the second conjunct of the *definiens* being some condition on the so-and-sos and their relation to *x*. This fact has a consequence that I find rather odd. Presumably, the second conjunct would have to be something along the lines of 'the so-and-sos are all parts of *x* and every part of *x* overlaps at least one of the so-and-sos' (see section I, below).[4] But (according to those who believe that mereological sums are a certain special sort of object) the following story is at least formally possible. Call the bricks that were piled in the yard last Tuesday the "Tuesday bricks." Between last Tuesday and today, the Wise Pig has built a house—the "Brick House"—out of the Tuesday bricks (using them all and using no other materials). The Brick House did not exist last Tuesday (that is, it was not then a pile of bricks, a thing that was not yet a house but would become a house). The Brick House is not, therefore, a mereological sum; for if it were, it would have been (it would have "existed as") a pile of bricks last Tuesday. Because it is not a mereological sum, it is not (by the present definition) a mereological sum of the Tuesday bricks. Nevertheless the following statement is true: The Tuesday bricks are all parts of the Brick House and every part

[4] For if an object is a mereological sum of certain things, each of those things is—presumably—a part of that object. But perhaps I should not say 'presumably' because at least one philosopher, Lowe, has denied this very thesis (see note 1). My excuse is that, as I have said, I do not know what Lowe means by 'mereological sum'. Is not the purpose of applying the adjective 'mereological' to the noun 'sum' to distinguish one application of the word 'sum' from others ("arithmetical sum," "vector sum," "logical sum,"…)?; and does this application not have to do with 'parts' in the most literal sense of the word? Does '*merós*' not mean 'part'?

of the Brick House overlaps at least one of the Tuesday bricks. This seems to me to be a very odd result, since (it seems to me) 'a mereological sum of the Tuesday Bricks' is the obvious thing to call something of which the Tuesday Bricks are all parts and each of whose parts overlaps at least one of the Tuesday Bricks. Is this odd result—or is the apparent oddness of this result—perhaps a consequence of an illegitimate employment of tenses and temporal indices? In section III, we shall address the issues this question raises.

In my view, it is the philosophers who understand 'mereological sum' as a stand-alone general term who have failed to grasp an essential feature of the concept "mereological sum"—or, better, of the concept "mereological summation." The order of definition implicit in the correct understanding of mereological summation is this: one *first* defines '*x* is a mereological sum of the so-and-sos'. That is to say, the basic or fundamental or primary occurrence of 'mereological sum' is as a part of this longer phrase, a phrase that asserts that a certain relation holds between one object and a plurality of objects. Having given a definition of '*x* is a mereological sum of the so-and-sos' one can, if one wishes, proceed to define the stand-alone general term 'mereological sum' in terms of the relational phrase 'mereological sum of …'. And the definition that one will give (if one wishes) is obvious: "*x* is a mereological sum if and only if there are certain objects such that *x* is a mereological sum of those objects."

I will defend the following thesis: for every object *x* (or at least for every object *x* that has parts) there are objects such that *x* is a mereological sum of those objects. I will in fact defend the thesis that this statement is true by definition, a consequence of a correct understanding of mereological summation. And (if 'a mereological sum' is indeed no more than an abbreviation of 'an object that is, for certain objects, a mereological sum of those objects') it follows immediately that every object (that has parts) is a mereological sum. The phrase 'mereological sum' does not, therefore, mark out a special kind of object—or, at any rate, it marks out no kind more special than "object that has parts." (And, of course, if we so use 'part' that everything is by definition a part of *itself*, 'object' and 'object that has parts' coincide.) An immediate consequence of the correct conception of mereological summation is that 'mereological sum' is not a *useful* stand-alone general term. In this respect, 'mereological sum' is like 'part'. If everything is a part of itself, then the word 'part' does not mark out a special kind of object and 'part' is not a useful stand-alone general term—for 'a part' can be defined only as "an object that is a part of something," and every object is thus a "part." The case of arithmetical summation teaches the same lesson: It is *possible* to lift the word 'sum' out of the relational sentence '$x$ is the sum of $y$ and $z$' and to use the word as a stand-alone general term—for example, 'The number 17 is a sum'—but no purpose is served by doing so.

Now if every object (every object that has parts, that has even itself as a part) is a mereological sum, every object that can change its parts is a mereological sum that can change its parts.[5] And, since the statement "Some objects can change their parts" involves no conceptual confusion, neither does the statement "Some mereological sums can change their parts." I grant that if every object is a mereological sum, it may nevertheless be that no mereological sum can change its parts—because no *object* can change its parts. But what is *not* true (I shall contend) is this: to speak of a mereological sum changing its parts is to misapply the concept "mereological sum."[6] And, of course, if every object is a mereological sum, it is not true that although some objects can change their parts, no mereological sum can change its parts.

## I. EVERYTHING IS A MEREOLOGICAL SUM

Let us set out formally the definitions of 'mereological sum of' and 'mereological sum' (*tout court, simpliciter*) that were anticipated in the above introductory remarks. Our primitive mereological term will be 'is a proper part of'. We begin with two preliminary definitions.

$x$ is a part of $y =_{\mathrm{df}}$ $x$ is a proper part of $y$ or $x = y$
$x$ overlaps $y =_{\mathrm{df}}$ For some $z$, $z$ is a part of $x$ and $z$ is a part of $y$.

Our definitions of 'mereological sum of' and 'mereological sum' will make use of the following logical apparatus: plural variables, the

[5] An object can change its parts only if it persists through time. In this paper, I will presuppose an "endurantist" or "three-dimensionalist," as opposed to a "perdurantist" or "four-dimensionalist," view of persistence through time. For my views on the endurantist-perdurantist controversy, see my essays "The Doctrine of Arbitrary Undetached Parts," *Pacific Philosophical Quarterly*, LXII (1981) 123–37, "Four-dimensional Objects," *Noûs*, XXIV (1990): 245–55, and "Temporal Parts and Identity across Time," *The Monist*, LXXXIII (2000): 437–59. All three essays are reprinted in *Ontology, Identity, and Modality*.

[6] Suppose that the very idea of a thing's changing its parts is conceptually incoherent, that "mereological essentialism" is an analytic or conceptual truth. Would that not entail that "to speak of a mereological sum's changing its parts is to misapply the concept 'mereological sum'"? Well, no doubt—but only in a very strict and pedantic sense of "misapplying the concept…." It would also be true, in this strict and pedantic sense, that to speak of a cat's losing its tail was to misapply the concept "cat." The person who said, "That cat has lost its tail" or "That cat is composed of different atoms from the atoms that composed it last week," would not, in the case imagined, be making a conceptual mistake *peculiar to* the concept "cat." That person's conceptual mistake is better located in his or her application of the concepts "part" and "change." And so for the person who said, "That object is this week a mereological sum of different atoms from the atoms of which it, that very object, was a mereological sum last week." We shall consider this question—the question whether it is conceptually coherent to suppose that any object can change its parts—in section IV.

relational phrase 'is one of', and (in the second definition) a plural quantifier.[7] (An alternative would have been to use only ordinary "singular" variables and to quantify over sets.)

> $x$ is a mereological sum of the $y$s $=_{\mathrm{df}}$ For all $z$ (if $z$ is one of the $y$s, $z$ is a part of $x$) and for all $z$ (if $z$ is a part of $x$, then for some $w$, ($w$ is one of the $y$s and $z$ overlaps $w$)).[8]

Informally: the $y$s are all parts of $x$, and every part of $x$ overlaps at least one of the $y$s. The first clause of the definiens tells us (speaking very loosely) that the $y$s are not too inclusive to compose $x$, and the second that they are not insufficiently inclusive to compose $x$.[9] Finally,

> $x$ is a mereological sum $=_{\mathrm{df}}$ For some $y$s, $x$ is a mereological sum of those $y$s.

We now show that for any $x$, there are $y$s such that $x$ is a mereological sum of those $y$s. It will suffice to show that any object $x$ is a mereological sum of its parts. The proof is trivial: we simply substitute 'the parts of $x$' for 'the $y$s' in the definition of 'mereological sum of'. (Or substitute 'the $y$s such that $\forall z$ ($z$ is one of those $y$s $\leftrightarrow$ $z$ is a part of $x$)'[10].) Inspection of the result of making this substitution will make

[7] For an exposition of this apparatus, see van Inwagen, *Material Beings* (Ithaca: Cornell, 1990), pp. 23–28.

[8] This definition presupposes that if $x$ is a proper part of $y$, $y$ has at least one part that does not overlap $x$. Thus, it is not possible, for example, for an object to have exactly two parts, itself and one proper part. If this were possible, the definition would imply that such an object was a mereological sum of the things identical with its proper part.

[9] We define '*a* mereological sum of the $y$s' rather than '*the* mereological sum of the $y$s' because we wish to leave it an open question how many mereological sums two or more objects may have. At least some advocates of the popular thesis that "the gold statue is distinct from the lump of gold" might wish to express their thesis this way: certain gold atoms have two mereological sums, one of which is a gold statue and the other of which is a lump of gold. The two axioms of Leśniewski's "mereology" are: Parthood is transitive; For any $y$s, those $y$s have *exactly one* mereological sum. We should *not* think of mereological summation in the following way: mereological summation is, by definition, the relation having the properties ascribed to the relation called "mereological summation" by the theory of parts and wholes called "mereology." Rather, we should think of "mereology" as a theory that ascribes certain properties to the relation of mereological summation, a relation of which we have a definition that is independent of the axioms of mereology. Other, competing, theories of parts and wholes (for example, "nihilism," the theory whose sole axiom is "Nothing has any proper parts"; one "theorem" of nihilism is that the only mereological sums are metaphysical simples, each of which is a mereological sum of the objects identical with itself) ascribe different properties to mereological summation from those ascribed to this relation by "mereology"—in the very same sense of "mereological summation."

[10] The expressions 'the parts of $x$' and 'the $y$s such that $\forall z$ ($z$ is one of those $y$s $\leftrightarrow$ $z$ is a part of $x$)' are (open) *plural definite descriptions*. Cf. the closed plural definite descriptions 'the presidents of the U.S.' and 'the $x$s such that $\forall y$ ($y$ is one of those $x$s $\leftrightarrow$ $y$ is a president of the U.S.)'.

it plain that $x$ is a mereological sum of the parts of $x$—provided that $x$ *has* parts. (Presumably, $x$ is a mereological sum of the parts of $x$ only if $x$ has parts, as a woman is a daughter of her mother only if she has a mother.) But everything has parts: itself if no others. Therefore, $x$ is (without qualification) a mereological sum of the parts of $x$. (It is also easy to show—by a trivial variation on this argument—that if a thing has proper parts, it is a sum of its proper parts.)

Here is a second argument for the conclusion that for any $x$, there are $y$s such that $x$ is a mereological sum of those $y$s. A straightforward "substitution" argument similar to the argument of the preceding paragraph shows that any object $x$ is a mereological sum of the things identical with $x$ (of the $y$s such that $\forall z$ ($z$ is one of those $y$s $\leftrightarrow z = x$)).[11]

Everything, therefore, has this feature: there are objects (its parts; the things identical with it) such that it is a mereological sum of those things.[12] And this is just our definition of 'is a mereological sum'. Everything is therefore a mereological sum.

## II. WHERE DOES THE MODALITY COME FROM?

If "A mereological sum cannot change its parts" is a conceptual truth, it must be that "mereological sum" is a modal concept, or at least a concept that has some sort of modal component. But (one might want to ask) how could that be? As we have seen, 'mereological sum' can be defined in terms of 'part of', and parthood does not seem to be a modal concept—or even a concept that "has some sort of modal component." On what basis, then, can someone who holds that mereological sums can change their parts be accused of some sort of conceptual mistake?

[11] Is mereological summation unique in these two cases at least? Can we say that everything is *the* mereological sum of its parts and *the* mereological sum of the things identical with it? That depends. Developments of mereology often define identity as mutual parthood. But suppose that one did not assume that a plurality of objects had at most one mereological sum, that one also regarded '=' as a primitive—a purely logical symbol—and, finally, that one did not adopt as a mereological axiom the thesis 'If $x$ is a part of $y$ and $y$ is a part of $x$, then $x = y$'. In that case it would be formally possible to say that, for example, the gold statue and the lump of gold are each parts of the other and yet numerically diverse. If these *two* objects, the statue and the lump, are indeed parts of each other, the statue is a mereological sum of the parts of the lump, and the lump is a mereological sum of the things identical with the statue.

[12] Typically, of course, objects will also be mereological sums of "other things" than their parts and the things with which they are identical. The gold statue, for example, is a mereological sum of certain gold atoms—just those gold atoms that are parts of it (let us suppose that there are more than two of them). If two among those gold atoms have a mereological sum X, then the statue is a mereological sum of X and the atoms that are not parts of X. And X and the atoms that are not parts of X are not identical with the parts of the statue—owing to the fact that the two atoms that make up X are both parts of the statue, but neither of those two atoms is one of X and the atoms that are not parts of X. (We say that the $x$s *are identical with* the $y$s just in the case that everything that is one of the $x$s is one of the $y$s and everything that is one of the $y$s is one of the $x$s.)

A question is not an argument, however, and it would be possible to reply to this question by pointing out that an exactly parallel question could be addressed to someone who maintained that it was impossible for sets to change their members and who contended that anyone who thought that sets could change their members was a victim of conceptual confusion. And (the reply might continue) the parallel question would have no power to undermine the conviction—certainly a conviction that many philosophers have—that it is impossible, conceptually impossible, for sets to gain or lose members. Let us explore this parallel.

Many philosophers have convictions about the modal properties of sets, and the conviction that a set can neither gain nor lose members is one of the most prominent of them. I myself share this popular conviction. Consider, for example, my two dachshunds, Jack and Sonia. I have my doubts about the existence of sets (I incline toward something like a "no-class theory" elimination of sets from my ontology), but I am certainly convinced that if there is such an object as {Jack, Sonia}, it must have exactly the two members it does—at any time, and, what is more, in any possible world. (Perhaps it somehow exists outside time. In that case, it certainly can not gain or lose members. And, even in that case, I am convinced that it does not have other members in other possible worlds. If it exists "in time," then, I am convinced, it exists when and only when both Jack and Sonia exist. Thus, if Sonia, say, ceases to exist, then {Jack, Sonia} also ceases to exist—and at very moment Sonia ceases to exist.)

What is the source of these convictions? It is hard to see how they could have their source in "official set theory"—that is, in the theory of sets as it is presented in a book like Paul Halmos's *Naïve Set Theory* (or as it is presented in a book like W.V. Quine's *Set Theory and Its Logic*, which is particularly sensitive to philosophical questions raised by set theory). Let us separate cases: these convictions are either without basis in reality, or they have some basis in reality. In the former case, the analogy with sets is of no interest to us. In the latter case, we may ask what kind of basis in reality they have. I cannot see what basis they could have but some sort of "intuition" of the objects that set theory is about. Gödel has famously, or infamously, said that the axioms of set theory "force themselves upon the mind as true." If that is so, perhaps there are other propositions about sets that force themselves upon the mind as true—other propositions than those that would be of interest to a mathematician whose only interest in set theory is as a tool to be used in "real" mathematics (Halmos) or to a philosopher who regards all questions about the necessary or essential features of things as misplaced (Quine). If the power-set axiom can force itself upon the mind as true, perhaps the proposition that sets cannot change their members can also force itself upon the mind as true.[13] Perhaps it *must* force itself upon the mind of anyone who grasps the concept "set" and who so much as considers the question whether sets can change their members. I will not try to develop this suggestion. I will only point out that if it is correct, this must be because human beings somehow have an intuition of (some sort of immediate intellectual access to) sets, to objects of a certain *sort*, to those *special* objects of which set theory treats. And, if that is so, the statement "Mereological sums cannot change their parts" and the statement "Sets cannot change their members" are in no way analogous. They are in no way analogous for the simple reason that, as we have seen, mereological sums are not a special sort of object. Although not everything is a set, everything is a mereological sum. 'Set' is a useful stand-alone general term. 'Mereological sum' is not a useful stand-alone general term. Perhaps human beings have "intuitions" about sets; perhaps our intuitive knowledge of sets somehow reveals to us that sets cannot change their members. Perhaps. What is certainly not the case is that human beings have intuitions about mereological sums—because there is no such thing as having intuitions about mereological sums. At any rate, there is no such thing unless it is having intuitions about parthood or about objects with parts.[14] Some among us may claim to have the following "intuition" about objects with parts: an object with parts cannot change its parts. (In section IV, I will consider an argument that might be thought of as an attempt to make explicit the considerations on which this intuition rests.) This intuition may even be right. I think it is wrong, but perhaps *I* am wrong. What I am certain I am not wrong about is this: whether objects can

[13] Could the conviction that sets cannot change their members be due to nothing more than the axiom of set theory that provides the principle of identity for sets: $x$ is identical with $y$ if and only if $x$ and $y$ have the same members? I do not think so. Suppose there were actually someone thought that sets could change their members. Such a person, surely, would contend that, owing to the fact that set membership can vary with time, the phrase 'have the same members' was ambiguous—that this phrase could mean 'now have the same members', 'sometimes have the same members', or 'always have the same members'. The following statement (he would further contend) is the proper principle of identity for sets: $x$ is identical with $y$ if and only if $x$ and $y$ *always* have the same members. We shall return to the topic of temporal qualification of set membership in the next section.

[14] Professor Varzi has pointed out to me that in note 8 I have appealed to an intuition about mereological summation: that an object cannot be a mereological sum of the things identical with its sole proper part. But this case nicely illustrates my point. The "intuition" I appeal to there can be described as an intuition about mereological sums, but it can also be described as an intuition about parthood: that if $x$ is a proper part of $y$, then $y$ has at least one part that does not overlap $x$.

change their parts or not, the intuition that objects cannot change their parts is not an intuition about mereological sums; it is, rather, an intuition about objects-in-general.

Granted: a question is not an argument. But neither has our question—Where does the modality come from?—been answered.

## III. TEMPORAL QUALIFICATION

"The fact that sets cannot change their parts (or at least the fact that that is the way everyone who uses set theory looks at sets) is reflected in the fact that set membership cannot be temporally qualified. It is a plausible thesis that expressions like '$\in$ on December 11th, 2005' are meaningless. It is certainly true that the official language of set theory affords no syntactical opportunity to attach temporal adverbs (or adverbs of any sort) to '$\in$'. And even if temporal qualification of set membership is meaningful (even if sentences like 'Sonia $\in$ on December 11th, 2005 {Jack, Sonia}' have truth values), it would *have a point* only if at least some sets could (in at least some circumstances) change their members. The fact that '$\in$' cannot be temporally qualified—the fact that no one has so much as proposed a version of set theory that permits temporal qualification of set membership—shows that everyone who makes use of set theory simply *takes it for granted* that sets cannot change their members.

"And the same point, *mutatis mutandis*, holds for mereology. The syntax of a formal mereological theory affords no opportunity to attach adverbs (temporal or otherwise) to 'is a part of' or 'overlaps' or to whatever its primitive mereological term may be. If a formal mereological theory takes parthood as primitive, this relation will be represented by an expression like '$\mathrm{P}x,y$'—and not '$\mathrm{P}x,y,t$' or '$\mathrm{P}x,y$ at $t$' or '$\mathrm{P}_t\ x,y$'. Does this fact not show that everyone who makes any use of mereological reasoning simply takes it for granted that parthood requires no temporal qualification—takes it for granted that temporal qualification of parthood is either meaningless, or is, if not meaningless, pointless, since, in every case, if $x$ is a part of $y$ at any time, $x$ is a part of $y$ at every time (at which $y$ exists)? And if the temporal qualification of parthood is meaningless or pointless, must the temporal qualification of mereological summation, which—as you have pointed out—is definable in terms of parthood, not also be meaningless or pointless?"

Whatever may be the case with set theory, I should say that the alleged fact about formal mereological theories is a fact only about *certain* formal mereological theories. It is indeed true that the inventor of "mereology" (the formal theory of that name) and the inventors of "the calculus of individuals" took it for granted that temporal qualification of parthood was either meaningless or pointless. But, as we have seen, there are other mereological theories, theories inconsistent with and in competition with mereology and the calculus of individuals. The proponents of at least one of these theories—nihilism—will agree with Stanisław Leśniewski and with Henry Leonard and Nelson Goodman on this point. (If the only part a thing can have is itself, temporal qualification of parthood is at best pointless.) But what of those philosophers who do think that at least some things *can* change their parts? What of Judith Jarvis Thomson, for example, who has said, "It is really the most obvious common sense that a physical object can acquire and lose parts. Parthood surely is a three-place relation, among a pair of objects and a time."[15] And what of *me*?—for I think that lots of the atoms that were parts of Sonia at noon yesterday are not parts of her today. We shall maintain that *of course* one cannot say what one needs to say to describe the relations of things to their parts without making use of some expression along the lines of '*x* is at *t* a part of *y*'. We shall contend that the verbs in the above definition (in section I) of 'mereological sum of' must be understood as being in the present tense. We shall say that this definition is, in effect, a definition of what it is for *x now* to be a sum of the *ys*. We shall say that this definition should be subsumed under the more general definition

> *x* is at *t* a mereological sum of the *y*s $=_{\mathrm{df}}$ For all *z* (if *z* is one of the *y*s, *z* is at *t* a part of *x*) and for all *z* (if *z* is at *t* a part of *x*, then for some *w*, (*w* is one of the *y*s and at *t z* overlaps *w*)).[16]

Having given this definition, we shall affirm the following general thesis:

> For all *t*, if *x* exists at *t*, there are *y*s such that, *x* is at *t* a mereological sum of those *y*s.

[15] Thomson, "Parthood and Identity across Time," this JOURNAL, LXXX, 4 (April 1983): 201–20; reprinted in Michael Rea, ed., *Material Constitution: A Reader* (Lanham, MD: Roman and Littlefield, 1997), pp. 25–43. The quoted sentences are on p. 36 of the reprint.

[16] Do expressions of the form '*x* is one of the *y*s' also require temporal qualification? Is, for example, Jane one of Tom and Jane at a time at which (Jane exists and) Tom does not exist? A similar question can be asked about the quantifiers, both singular and plural: Should quantification over things that can begin to exist and cease to exist be temporally restricted?—Should we perhaps be using quantifier phrases like 'for some *x* that exists at *t*' and 'for all *x*s that there are at *t*'? I shall assume that such qualifications are not necessary—for no better reason than the fact this assumption reduces the complexity of the expressions I have to write out and the reader has to parse. If the qualifications are indeed needed, they can be inserted at the appropriate places and doing so will have no consequences for the arguments I shall present.

(Since, if *x* exists at *t*, *x* is at *t* a mereological sum of the things that are at *t* parts of *x*, and of the things with which *x* is identical.[17])

We shall say that the strictly correct form of the (more or less useless) definition of 'mereological sum' (as a stand-alone general term) would be

> *x* is at *t* a mereological sum $=_{\text{df}}$ For some *y*s, *x* is at *t* a mereological sum of those *y*s.

Having given this (more or less useless) definition, we shall affirm the following thesis

> For all *t*, if *x* exists at *t*, *x* is at *t* a mereological sum.

(Since, if *x* exists at *t*, there are things of which it is at *t* a mereological sum.) Because we affirm this thesis—and affirm that if *x* is a mereological sum at *t*, *x* exists at *t*—, we may offer an equivalent but simpler definition of '*x* is at *t* a mereological sum': "*x* exists at *t*." And, if we like, we can drop the qualification 'at *t*' by defining 'a mereological sum' as a thing that is a mereological sum whenever it exists.

Let us see how these definitions and these theses apply in a particular case, the case of the Wise Pig, the Tuesday Bricks, and the Brick House. When this case was introduced, we assumed that the Brick House did not exist on Tuesday. (That is, we assumed that the thing that is today a house composed of bricks was *not anything* on Tuesday—not a pile of bricks, not an "aggregate" of bricks, not anything.) We now make one further assumption: Earlier today, the Brick House lost a part (a brick, in fact), owing perhaps to some truly extraordinary pneumatic exertion of the Wolf's. That is, there is a moment *t* such that the Brick House existed both before and after *t* and a certain brick (we will call it the Lost Brick, although, of course it was not lost before *t*) was a part of the Brick House before *t* and was not a part of the Brick House after *t*. (In all these "set-up assumptions," the concepts of number and identity are to be understood in their "strict and philosophical sense": the Brick House is not to be thought of as an *ens successivum*,[18] some of whose earlier "momentary

[17] I shall assume that identity requires no temporal qualification (cf. note 16.). That is, I shall assume that the formal, logical relation that goes by the name 'identity' requires no temporal qualification. If one (unwisely, in my view) decided to call some other, nonlogical relation "identity"—the relation "having the same parts," perhaps—one might well find it necessary to attach temporal qualifications to identity (so called): "the statue and the lump were identical on Monday, but not on Tuesday."

[18] I have borrowed this medieval term (and some related terminology) from Roderick M. Chisholm's voluminous writings on parthood and identity across time. See, for example, chapter 3 of *Person and Object* (La Salle, IL: Open Court, 1976).

stand-ins" had the Lost Brick as a part and some of whose later momentary stand-ins did not.)[19]

If the set-up assumptions are granted, the Brick House is a mereological sum that loses a part: In the story, there is an object $x$ such that for a certain interval before $t$, $x$ was a mereological sum of the Tuesday Bricks and, for a certain interval after $t$, $x$ was a mereological sum of "the Tuesday Bricks minus the Lost Brick."[20]

"But the Brick House was not the *same* mereological sum before and after the Lost Brick ceased to be a part of it."

Well, it was not a mereological sum of the *same things*. But that does not mean that it "wasn't the same mereological sum." What, in fact, *does* that phrase mean? It certainly does not wear its sense on its sleeve. Suppose it means this:

> $x$ is the same mereological sum as $y =_{\text{df}} x$ is a mereological sum and $y$ is a mereological sum and $x = y$.[21]

If we so define 'same mereological sum'—and how *else* could we understand this phrase?—then the thing that was before $t$ a mereological sum of the Tuesday bricks *is* the same mereological sum as the thing that was after $t$ a mereological sum of the Tuesday Bricks minus the Lost Brick. (Given that the two definite descriptions in this sentence are proper. If we wish to leave open the possibility that either the Tuesday Bricks had more than one mereological sum before $t$ or the Tuesday Bricks minus the Lost Brick had more than one mereological sum after $t$, we shall have to say this:

> *Something* that was before $t$ a mereological sum of the Tuesday bricks *is* the same mereological sum as something that was after $t$ a mereological sum of the Tuesday Bricks minus the Lost Brick.

And this will certainly be true, for the Brick House was before $t$ a mereological sum of the Tuesday bricks and was after $t$ a mereological sum of the Tuesday Bricks minus the Lost Brick. And the Brick House is the same mereological sum as the Brick House—since it is a mereological sum and identical with the Brick House.)

[19] Readers of *Material Beings* will know that the story of the Brick House and the Lost Brick is not a story that *I* regard as a possible case of the loss of a part. But at least some philosophers think (they think this even when they are in the philosophy room) that there are brick houses and that it is possible for a brick to be a part of one of them at one time and not at another. The only function of the story is to provide a particular, visualizable case that illustrates the consequences of certain definitions and theses.

[20] That is, a mereological sum of the $x$s such that $\forall y$ ($y$ is one of those $x$s $\leftrightarrow$ $y$ is one of the Tuesday Bricks and $y$ is not the Lost Brick).

[21] Either the first or the second conjunct of the *definiens* is of course redundant, being a logical consequence of the other two conjuncts.

This case illustrates what it is for a mereological sum to change its parts: for something to be, for some *x*s, a mereological sum of those *x*s at one time and (to exist and) not be a mereological sum of *those x*s at another time. And this is a necessary feature of anything that gains or loses a part (and continues to exist).

"But the Brick House before *t* is not identical with the Brick House after *t*, since they have different parts." You might as well say that yourself before dinner is not identical with yourself after dinner, since they have different *properties* (the former is hungry and the latter is not, for example).[22]

Are we—we who say these things—conceptually confused? Only if our conviction that that there are things that can change their parts is evidence of conceptual confusion, for everything we have affirmed follows from this conviction.

## IV. CAN *OBJECTS* CHANGE THEIR PARTS?

"A mereological sum cannot change its parts because nothing can change its parts. (I concede that we *talk* as if objects could change their parts. But such talk is misleading. Insofar as there is anything right in what we say when we say that, for example, a table can change its parts, it can be perspicuously expressed in terms of the table's being an *ens successivum* that is constituted by a succession of 'temporary table-stand-ins' whose parts differ.)

"Some people who hold the mistaken view that objects can change their parts compound their error with a further error: they believe that some objects—mereological sums—cannot change their parts, and that other objects (some or all objects that are not mereological sums) *can* change their parts. You have shown that this 'further error' is indeed an error—because (if one insists on treating 'mereological sum' as a stand-alone general term) everything is necessarily a mereological sum. But you are guilty of the same fundamental metaphysical error as they, namely the error of supposing that it is possible for any object to change its parts. And your error is a product of conceptual confusion: the confusion that arises from treating *entia successiva* as real, persisting things and not as what they are: useful fictions, logical constructs on their temporary stand-ins. It is the temporary table-stand-ins, not the tables, that are the real, persisting things (although—physics teaches us—they generally persist only for minute fractions of a second)."

[22] The Interlocutor's protest turns on a fallacy I have called "adverb pasting." See "Temporal Parts and Identity across Time" (cited in note 5) for an account of this fallacy.

But why is it supposed to be impossible for objects to change their parts? I know of only one argument for this conclusion.[23] I shall present it in the form of an argument for the impossibility of an object that has a small number of parts losing one of these parts, but the argument could easily be generalized to apply to an object with any number of parts, and to cases in which an object supposedly gains a part, both loses and gains a part, loses many parts and gains many parts, loses all its parts and acquires a wholly new complement of parts ("undergoes a complete change of parts")….

Let us use '+' to express unique mereological summation (that is, use '$x + y$' to mean "the mereological sum of $x$ and $y$"). (The argument, as I shall present it, treats expressions formed by the use of '+' as definite descriptions. Although I have been careful not to assume that mereological summation is necessarily unique, I am in fact willing to grant that, for any *x*s, those *x*s have at most one mereological sum. It would be possible to construct a rather more elaborate version of the argument that did not presuppose that mereological summation was unique, an argument whose presuppositions were consistent with, for example, the thesis that the gold statue and the lump of gold are, at a certain moment, two distinct mereological sums of certain gold atoms. What I should have to say about the more elaborate argument would not differ in any important respect from what I shall have to say about the argument that follows.) Here is the argument:

> Consider an object α that is the mereological sum of A, B, and C (that is, $\alpha = A + B + C$). We suppose that A, B, and C are simples (that they have no proper parts), and that none of them overlaps either of the others. And let us suppose that nothing *else* exists—that nothing exists besides A, B, C, A + B, B + C, A + C, and A + B + C. Now suppose that a little time has passed since we supposed this, and that, during this brief interval, C has been annihilated (and that nothing has been created *ex nihilo*). Can it be that α still exists? Well, here is a complete inventory of the things that now exist: A, B, and A + B. And α is none of these three things, for, before the annihilation of C, they existed and α existed and α was not identical with any of them (all three of them were then proper parts of α). And nothing can become identical with something else: $x \neq y \rightarrow \Box\, x \neq y$; a thing and another thing cannot become a thing and itself. We do not, in fact, have to appeal to any modal principle to establish this conclusion, for if α were (now) identical with, say, A + B, that identity would constitute a violation of Leibniz's Law, since the object that is both α and A + B would both have and lack the property "once having had C as a part."

[23] See, for example, Chisholm, *Person and Object*, Appendix B, "Mereological Essentialism."

This argument is not without persuasive power. As I have pointed out elsewhere, however, whether it is sound or not, it has two presuppositions or implicit premises that the friends of mereological change will question:

> Before the annihilation of C, A and B had a mereological sum.

> If A and B had a unique mereological sum before the annihilation of C, and if A and B had a unique mereological sum after the annihilation of C, the object that was their sum before the annihilation of C and the object that was their sum after the annihilation of C are identical.

I will consider only the first of these questionable premises. If this premise is not true, there is no reason one should not say—no reason provided by the argument, at any rate—both that before the annihilation of C, $\alpha$ was the mereological sum of A and B and C, and that after the annihilation of C, $\alpha$ was the mereological sum of A and B.

Why should the friends of mereological change (or anyone) accept this premise? Presumably, one is supposed to accept the thesis that A and B had a mereological sum before the annihilation of C because this thesis is a consequence of a general principle concerning the existence of mereological sums:

> For any *x*s, if those *x*s exist at *t*, those *x*s have at *t* at least one mereological sum.

Or, since we are supposing that any *x*s have at any time at most one mereological sum, we may state the principle in this form

> For any *x*s, if those *x*s exist at *t*, those *x*s have at *t* a unique mereological sum.

In "The Doctrine of Arbitrary Undetached Parts,"[24] I explained why I reject this principle: if certain cells or simples have a living organism as their mereological sum at a certain moment, there will be some among them that do not, at that moment, have a mereological sum. (For example, those among them that, if they composed anything, would compose "all of the organism but one of its appendages.")[25]

To say this much is not to have shown that any of the premises or presuppositions of the argument I am considering is false. It is to show that the argument rests on the above principle concerning the

[24] Cited in note 5.

[25] I also explained why I regard it as evident that there are things that can change their parts: Descartes—whom I take to have been a living organism—could have persisted through the loss of a leg (that is, he could have persisted through an episode in which a great many cells or simples that had been parts of him ceased to be parts of him).

existence of mereological sums.[26] (At any rate, I do not see why someone who did not accept this general principle would be certain that, in the very abstractly described case that the argument considers, A and B had a mereological sum before the annihilation of C.[27]) I see no reason to suppose that this principle is a conceptual truth. (It is, after all, a thesis that asserts—conditionally, to be sure—the *existence* of something. It entails that if two objects exist at a certain time, then a third object also exists at that time.) I therefore see no reason to suppose that "An object cannot change its parts" is a conceptual truth. And since, as I have pointed out, everything is a mereological sum, I see no reason to regard "A mereological sum cannot change its parts" as a conceptual truth.

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[26] It will also rest on some principle that supports the second implicit premise. What might this principle be? The most obvious candidate is this:

> If the *x*s have a mereological sum at both $t_1$ and $t_2$, the object that is their mereological sum at $t_1$ is identical with the object that is their mereological sum at $t_2$.

In my view, the following case shows that this principle is false, or, at best, accidentally true: it is possible that certain atoms had a fish as their sum four million years ago and have a cat (not identical with the fish, not the fish "in another form") as their sum today. But there may be other, weaker, principles that support the second implicit premise.

[27] Suppose that, with respect to some less abstractly described case, someone had a *special* reason for thinking that A and B had a sum before the annihilation of C—a reason that depended on the properties and the mutual relations the case ascribed to A and B. That person *would* have to suppose that (in that case) A + B + C did not survive, and could not have survived, the annihilation of C—*unless* he or she was willing to say that the sum of A and B after the annihilation of C was a different object from the sum of A and B before the annihilation of C (that is, that, for some *x*, *x* was the sum of A, B, and C before the annihilation of C, and *x* was the sum of A and B after the annihilation of C—the object that was the sum of A and B before the annihilation of C having ceased to exist).