

1. First, a digression: expansion and contraction

There will be a few themes. One to get us going: expansion versus contraction. About an object, o , and the region, R , of space(time) in which o is exactly located,¹ we may ask:

- i) must there exist *expansions* of o : objects in filled *superregions*² of R ?
- ii) must there exist *contractions* of o : objects in filled *subregions* of R ?

Despite the apparent symmetry, entirely different considerations bear on each question.

The existence of expansions follows from two premises.³ First, *unrestricted composition*: for any X s, there exists a “fusion” of the X s (or, object the X s “compose”), defined as an object of which each of the X s is a part, and each

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¹Definitions: an object is exactly located in a region iff the region contains all and only the points in which the object is located (assume for simplicity that spacetime is atomic). A region is filled iff it has no empty points — no points in which no objects are located.

²= regions of which R is a subregion.

³More carefully: the two premises guarantee that some object is exactly located in some superregion of the chosen filled superregion of R . Without the principle of contraction, we cannot infer the existence of an object *exactly* located in the chosen superregion. Thanks to Hud Hudson and Tamar Gendler.

part of which overlaps at least one of the *X*s. Second, the *inheritance of location*: an object is located wherever any of its parts are located. Stick your arm out the window, and *you* thereby become located outside the window; any list of all the points in which you are located — all the points that you occupy — must include points outside the window.⁴ The second premise is uncontroversial (though significant — see below); the first is not; so the real issue is the first. Expansion is a matter of mereology.

Contractions need not exist if the strange creatures known as *extended simples* are possible.⁵ Extended simples would lack proper parts but nevertheless be located at more than one point. The possibility of extended simples follows from plausible principles about location and possibility; mereology has nothing to do with it. The principle about location is that location is a fundamental relation between objects and points of space.⁶ The principle about possibility is a combinatorial principle requiring, roughly, that any pattern of instantiation of a fundamental relation be possible. These principles imply the possibility of the location relation's holding in a one-many pattern between a mereologically simple object and points of space — an extended simple. Combinatorialism as a full-blown analysis of modality faces well-known problems;⁷ and even setting aside analysis, formulating a counterexample-free version of the principle is non-trivial. But everyone should admit *some* combinatorial element to possibility, and it seems likely that that element will be enough for the argument for extended simples. Contraction is a matter of modality.

(Notice that this argument does not imply the possibility of *heterogeneous* extended simples. Suppose, for instance, that *P* is a (monadic) natural property of an actual, nonextended, simple. Combinatorial reasoning generates a world in which an object that instantiates *P* is an extended simple, but not a world in

⁴There are senses of 'location' that do not obey this principle, for instance that of being *wholly* located. I intend 'location' in a sense that obeys the principle. This stipulation does not trivialize the principle. Suppose you wish to discuss a certain one of the men named 'Bill Clinton'. You might specify which one by saying that he is the one for whom the sentence 'Bill Clinton was president of the U.S. in 1998' is true. This would not trivialize that sentence.

⁵See Markosian 1998*b*; McDaniel 2003*a*, 2007, Forthcoming; Parsons MS; Hudson 2006, chapter 4. As Raul Saucedo pointed out, the nonexistence of contractions does not follow solely from the existence of extended simples: contractions that do not overlap the extended simple might exist.

⁶If substantivalism is false, and spatial facts emerge from spatial relations among material objects, extended simples would also follow from combinatorialism about these relations. But let's keep things simple.

⁷See Armstrong 1989; Sider 2005.

which an extended simple instantiates P “relative to” or “at” some places but not others. No scrambling of the pattern of instantiation of P and the relation of occupation will add an argument place to P (or to instantiation). This means that the possibility of extended simples — if established combinatorially — has no implications for the -adicy or nature of actual properties, contrary to what some have supposed.⁸)

Assuming the necessary truth of unrestricted composition, and enough combinatorialism to establish the possibility of extended simples, expansions must exist whereas contractions need not. But is this asymmetry defensible? Should not the liberal combinatorialism that justifies extended simples be part of a generally liberal theory of possibility? Such a liberal account (in the neighborhood of “anything consistent is possible”) might allow for possible worlds in which mereological composites — and thus expansions — go missing. The existence of an object in one region is one thing, and the existence of a numerically distinct object in a superregion is another; why should the two be necessarily connected? How can the existence of a composite object necessarily follow from the existence of its parts?⁹

It can follow if composites are, in some sense, *identical* to their parts: *composition as identity* is true.

This is the first of several roads leading to the center of this paper: composition as identity, and the unique status and special intimacy of the part-whole relation.

2. The intimacy of parthood

Composition as identity challenges our habitual thinking about identity and number. How can many things be identical to a single thing? §4 will present a

⁸Parsons (2004) and Markosian (MS) argue for actual irreducible “distributional” properties and actual “stuff”, respectively, from the possibility of heterogeneous extended simples. One complication: further combinatorial principles (I have in mind this template: ‘every consistent Ramsey sentence is possibly true’) may well generate a possible world in which there exists a relation, R, holding between extended simples and places, which plays a nomic role similar to P’s actual nomic role. This is a kind of heterogeneity, but not heterogeneity with respect to the actual property P itself, since the further combinatorial principle will not imply that R=P; R may be “alien”. Parsons and Markosian need the assumption that the properties of possible heterogeneous simples would be identical to actually instantiated properties and relations.

⁹The question is easily answered if, in a suitable sense, the meanings of quantifiers are flexible and up to us. Against this view of quantifiers see Sider 2001a, Sider 2001b, introduction, and Sider 2008.

watered-down version for the faint of heart. But first, please take a fresh look, and appreciate its appeal. *Something* is deeply right about it.

Composition as identity goes a long way toward articulating something we should all believe: that parthood has a unique status as an especially intimate relation. There is an impulse to deny that parthood is a relation at all, just as Wittgenstein (1961, 5.5301) and Hume (1739, 200–201) denied that identity is a relation. Calling parthood and identity relations understates the difference between parthood and identity, which connect a thing to *itself*, and other relations. My arms, legs, head, and torso: that's *me*. We give metaphorical expression to deep love by saying: "this person is a part of me". Deep loss: "A part of me has been cut out".

We grope toward parthood's special status with cryptic sayings: "The whole is nothing over and above the parts."¹⁰ "A part is just some of a whole." "I am nothing more than my head, arms, legs and torso. They are all there is to me. They exhaust me." Thus, Socrates, in the *Theaetetus* (204): "...when a thing has parts, the whole is necessarily all the parts".¹¹

Consider:

- I own this car
- My hitting the ball caused the window to shatter
- I am taller than my mother
- I am friends with Ned Markosian
- My fingertip is three feet from my shoulder

-
- My arm is part of me
 - I am identical to me

Each is the holding of a relation. But the last two cases go together. The connection between the relata in those cases is *closer* than in the rest. It would be wrong to draw the line between the last case — identity — and the others,

¹⁰I used to think that 'nothing over and above' should (like 'overdetermination' and 'individuate') be banished from philosophy. Now I think it gets at something right: some form of composition as identity. Note that this is *not* what, for example, Derek Parfit (1984, 209–213, 471–472) is getting at with phrases like 'nothing over and above' and 'separately existing entity'.

¹¹The translation is from Burnyeat 1990. See Harte 2002 for extensive discussion of composition as identity in Plato.

lumping parthood with owning, causing, taller-than, friendship, and distance. Parthood belongs on the other side of the line.

All this is admittedly elusive, but should not be ignored. On reflection, an important fact about parthood presents itself. Our job as philosophers is to understand it. We fail if we belittle it as being (merely) obscure.

3. Strong composition as identity¹²

One way of doing justice to the aphorisms of the previous section is to take the identification of things with their parts at face value, as the strict and literal truth:¹³

Strong composition as identity For any X s and any y , if y is composed of the X s then $y =$ the X s

We need a concrete example. I volunteer. I am composed of a head, h , a pair of arms a , a pair of legs l , and a torso, t . The defender of strong composition as identity claims that I am identical to h , a , l , and t — identical in the sense of strict numerical identity.

This can seem like nonsense.

It would not be nonsense to identify me with an object, O , that somehow wraps h , a , l , and t into one (perhaps a quantity of matter, or a set). But strong composition as identity is far more radical. Identifying me with such an O is logically conservative: it attributes identity to a pair of single entities. But that kind of identification leaves unexplained the “wrapping up into one” by which we get O from h , a , l , and t . Strong composition as identity explains this wrapping up into one. It is accomplished by identity itself, which holds directly between me and my many parts, rather than between me and a single intermediate object O .¹⁴

‘Ted = h , a , l , and t ’ does *not* mean ‘Ted= h and Ted= a and Ted= l and Ted= t ’. (That *would* be nonsense.) Compare the predicate ‘surrounded’ in ‘Tom, Dick, and Harry surrounded the escaped prisoner’. Two points. First, this use of ‘surrounded’ is *collective* rather than *distributive*: the sentence is not

¹²In writing this section, I set out intending to refute strong composition as identity, but in the end nearly became convinced, like Josh McDowell, that it just might be true. The section ends negatively, but inconclusively so.

¹³The leading defender is Donald Baxter (1988a,b).

¹⁴Composition as identity must therefore be distinguished from “constitution as identity”.

equivalent to ‘Tom surrounded the escaped prisoner and Dick surrounded the escaped prisoner and Harry surrounded the escaped prisoner’. Tom, Dick, and Harry can surround a prisoner even though no one of Tom, Dick, and Harry surrounds the prisoner on his own. Second, surrounding is (arguably) not a relation between the prisoner and some extra entity that wraps Tom, Dick, and Harry into one. *People* (together) surround prisoners. Thus, ‘surrounded’ is *irreducibly plural*: it relates the three men directly to the prisoner, and it is collective. Likewise for ‘is identical to’, according to the defender of strong composition as identity — even when that predicate expresses identity in the strictest sense. The identity sign in ‘Ted = *h, a, l*, and *t*’ is collective, and it relates *h, a, l*, and *t* directly to Ted.

Irreducibly plural predicates are not nonsense. But could the identity predicate be one? You may be tempted to intuit *no* (and you may well be right); but let’s not be too hasty. Radical views can take some getting used to.

3.1 Leibniz’s Law

Whatever else one thinks about identity, Leibniz’s Law must play a central role:¹⁵

$$\frac{x=y \quad \phi(x)}{\phi(y)}$$

The defender of strong composition as identity will regard the usual schema, where ‘*x*’ and ‘*y*’ are singular schematic variables, as insufficiently general, since ‘=’ can be flanked by grammatically plural terms. In a more general formulation ‘*x*’ and ‘*y*’ may be replaced with either plural or singular terms.

But now there is a problem. Given the truth of ‘Ted = *h, a, l*, and *t*’ and ‘Ted is human’, the Law apparently implies that ‘*h, a, l*, and *t* is human’ is true. This sentence is ungrammatical; the logic/English hybrid we are now speaking at best allows ‘*h, a, l*, and *t are* human’.

The Law could be restricted to cases where the conclusion is grammatical, but that would make it overly weak. If Ted is human and Ted = *h, a, l*, and *t*, then Leibniz’s Law should have *something* to say about the humanity of *h, a, l*, and *t*. A better tactic is to introduce a new language in which ‘*h, a, l*, and *t* is human’ *is* grammatical. (In some natural languages, for example Hungarian, such sentences are already grammatical.) In this new language,

¹⁵Let the law exclude intensional and other problematic contexts.

predicate-arguments are not fixedly singular or plural; indeed, one can simply drop the singular-plural distinction altogether. This language is better suited to describe a world in which ‘Ted’ and ‘ $h, a, l,$ and t ’ pick out the same portion of reality. (Grammatical revisionism was perhaps already in place right at the start, with ‘Ted = $h, a, l,$ and t ’.¹⁶) We could flag this by replacing ‘is’, ‘are’, etc., with ‘BE’. Then, from ‘Ted = $h, a, l,$ and t ’ and ‘Ted BE human’, we may infer by Leibniz’s Law that ‘ $h, a, l,$ and t BE human’.

Defenders of strong composition as identity must accept this version of Leibniz’s Law; to deny it would arouse suspicion that their use of ‘is identical to’ does not really express identity.¹⁷ But this yields a striking implication: the apparatus of plural quantifiers, predicates, and referring expressions behaves in unexpected ways.¹⁸

First consider the predicate ‘is one of’, standard fare in the logic of plurals. If I am identical to $h, a, l,$ and t , then anything that is one of them is one of me. h is one of them¹⁹, so h is one of me — not something one would ordinarily say. Further, strong composition as identity implies the following principle:²⁰

Parts \leftrightarrow one-of y is part of the fusion of the X s iff y is one of the
 X s

(Left-to-right: let a be the fusion of the X s, let y be part of a . In addition to being composed of the X s, a is composed of y and a .²¹ Given strong composition as identity we get that $a =$ the X s, and also that $a = y$ and a ; and so the X s = y and a . Since y is one of y and a , it follows that y is one of the X s. Right-to-left follows immediately from the (p. 1) definition of ‘fusion’.) Parts \leftrightarrow one-of then implies the failure of the following principle:

Lists x is one of y_1, \dots, y_n iff ($x=y_1$ or, \dots , or $x=y_n$)

¹⁶See van Inwagen 1994.

¹⁷Compare believers in temporary identity like Myro (1986) who deny that ‘ x is identical at t_1 to y and x is F at t_2 ’ implies ‘ y is F at t_2 ’.

¹⁸See also Yi 1999, §II.

¹⁹That a_i is one of $a_1 \dots a_k$, for $i \in \{1 \dots k\}$, cannot credibly be denied.

²⁰I assume in this section that the defender of strong composition as identity accepts classical mereology; the next section defends this assumption.

²¹One doesn’t normally consider decompositions of objects that include those very objects, but they do satisfy the definition of ‘composes’. Note that the argument could instead consider a decomposition of a into y and the mereological difference $a - y$ (except when $y=a$).

For any part of the fusion of y_1, \dots, y_n , not just y_1, \dots, y_n themselves, will count as one of y_1, \dots, y_n . Thus, strong composition as identity implies that there can be no predicate that behaves the way ‘is one of’ is commonly assumed to behave.

Similarly, there can be no predicate ‘carried the casket’ such that

Tom, Dick, and Harry carried the casket

is true, but

Tick, Darry, and Hom carried the casket

is false, where Tick = Tom’s head+Dick’s “body” (Dick minus his head), Darry = Dick’s head+Harry’s body, and Hom = Harry’s head+Tom’s body. For strong composition as identity implies that Tom, Dick, and Harry are identical to Tick, Darry, and Hom.

Nor can there exist *distributive predicates* (except in certain extreme cases). A distributive predicate Π obeys the law:

Distribution $\Pi(x_1, \dots, x_n)$ iff [$\Pi(x_1)$ and \dots and $\Pi(x_n)$]

Suppose Π obeys Distribution, suppose $\Pi(x_1, \dots, x_n)$, suppose $y_1 + \dots + y_m = x_1 + \dots + x_n$ (‘+’ denotes fusion), and suppose $\sim\Pi(y_i)$ for some i . By strong composition as identity we have $x_1, \dots, x_n = x_1 + \dots + x_n$ and $y_1, \dots, y_m = y_1 + \dots + y_m$; by transitivity and symmetry of identity we have $x_1, \dots, x_n = y_1, \dots, y_m$; by Leibniz’s law we have $\Pi(y_1, \dots, y_m)$; by Distribution we then have $\Pi(y_i)$; contradiction. (The contradiction is avoided only in the extreme case of a predicate Π where parts of fusions of Π s are always themselves Π s, for in such a case we could not have chosen y_i above.)

Similarly, suppose the predicate ‘are n in number’ applies to x_1, \dots, x_n and that $y_1 + \dots + y_m = x_1 + \dots + x_n$. Then by strong composition as identity and Leibniz’s Law, ‘are n in number’ applies to y_1, \dots, y_m , even if $m \neq n$.

What underlies all these cases of unexpected behavior of plural expressions is that plural expressions are never “tied to a unique decomposition”, given strong composition as identity. What is true of the X s is also true of the Y s, where the fusion of the X s = the fusion of the Y s. Unlike a singular term for a set, the plural referring expression ‘the X s’ does not “divide reality” in a unique way: its sole function is to single out the portion of reality consisting of the fusion of the X s. For short, plural referring expressions are not “set-like”.

Though a bit disquieting, this is not so very distant from the picture of reality that the defender of strong composition as identity accepts. The consequences might simply be embraced. Since h is one of $h, a, l,$ and t , h is indeed one of Ted. If x_1, \dots, x_n are n in number, then so are y_1, \dots, y_m . Since Tom, Dick, and Harry carry the casket, so do Tick, Darry, and Hom. Metaphysical discoveries! This reaction is perhaps not as silly as it first appears. Widespread reluctance to utter such sentences might be explained by the lack of appreciation of the truth of strong composition as identity by the general public. Further, even if composition as identity is true, one could introduce a (somewhat metaphysically second-rate) language in which plural terms denote sets. In this language ‘Ted = $h, a, l,$ and t ’ would *not* be true (since $\{\text{Ted}\} \neq \{h, a, l, t\}$); in this language the odd consequences involving ‘one of’, ‘are n in number’, and so on, and even the thesis of composition as identity itself, would not hold. Perhaps ordinary English itself is such a language, which would again explain the widespread reluctance to utter the sentences.

3.2 Classical mereology

With the appropriate form of Leibniz’s Law in place, the core principles of classical mereology²², a simple and elegant theory of parthood, may be derived²³ from strong composition as identity, or at any rate from this stronger kindred principle:

Superstrong composition as identity: For any X s and any y , y is composed of the X s if and only if $y =$ the X s

Superstrong composition as identity results from replacing the ‘if’ in strong composition as identity with ‘if and only if’. Though the strong and superstrong versions of the thesis are distinct, each can be regarded as being motivated by the same idea, namely, that the composition relation and the identity relation are one and the same relation. Moreover, it is hard to imagine a defender of strong composition as identity denying superstrong composition as identity: if

²²See Simons 1987.

²³The derivations require apparently innocuous assumptions about the logical behavior of plural referring expressions (which I make explicit in footnotes). Might someone argue that these assumptions are not so innocuous after all, given composition as identity?

y is identical to many things, then what could they be other than y 's parts?²⁴ So I will henceforth take "strong composition as identity" in its superstrong form.

Superstrong composition as identity implies that parthood is reflexive. For any x , $x=x$, and so x is composed of x by superstrong composition as identity, and so x is part of x by the (page 1) definition of 'composes'.²⁵

Transitivity of parthood also follows. Suppose x is part of y , which in turn is part of z . Given reflexivity and the definition of 'composes', z is composed of y and z ; and y is composed of x and y . Given strong composition as identity, $z = y$ and z ; and $y = x$ and y . By Leibniz's Law, $z = (x \text{ and } y)$ and z . Now, a principle of associativity for plural referring expressions seems impossible to deny, so we may drop the parentheses and write: $z = x \text{ and } y \text{ and } z$. By superstrong composition as identity, z is composed of x and y and z , and so x is part of z by the definition of 'composes'.

The principle of uniqueness of composition, which says that no X s compose distinct things, follows immediately from strong composition as identity: if some X s compose y and also compose z , then by strong composition as identity, the X s = y and also the X s = z , from which $y=z$ follows by Leibniz's Law.

Given uniqueness, we can derive:

Weak supplementation: If x is part of y and $x \neq y$, then y has a part that does not overlap x

Suppose for reductio that x is part of but numerically distinct from y , and that every part of y overlaps x . Then given the definition of 'composes', y is composed of x ; but x is also composed of x , violating the uniqueness of composition.

The relation between unrestricted composition and (super)strong composition as identity is a bit more complicated. Strictly speaking, superstrong composition as identity allows some X s to not compose anything at all. If the X s compose something then it must be identical to them; and if the X s are identical to something then that thing must be composed of them. But for all this says, there may simply be nothing that is either identical to or composed

²⁴Note also that superstrong composition as identity is derivable from strong composition as identity and the reflexivity of parthood. Given reflexivity, any y is composed of y , and so if $y =$ the X s then, by Leibniz's Law, y is composed of the X s.

²⁵I assume that ' x ' is an allowable substitution for 'the X s' (if not, just substitute ' x, x ', and then infer by the principle of absorption (§3.3) that $x, x = x$), and that x is one of x , which follows from the principle in note 19.

of the X s. However, the intuitive idea behind strong composition as identity underwrites the dodgy move in the following otherwise solid argument for unrestricted composition. Consider any X s. By the reflexivity of identity and existential generalization (plural forms), we get: (*) there are some Y s identical to the X s (namely, the X s themselves). Dodgy move: we may replace ‘some Y s’ in (*) with ‘some y ’, resulting in (**): there is some y that is identical to the X s. The thought behind this replacement is inspired by composition as identity: if the Y s are many, then speaking of them as one is just as good as speaking of them as many (and if the Y s are one then of course we may speak of them as one). To speak of some Y s as one thing containing each of the Y s as a part is just a redescription of the same fact. Given (**), superstrong composition as identity then implies that there is some y that is composed of the X s. Conclusion: for every X s, some y is composed of the X s.

An alternate argument from strong composition as identity to unrestricted composition will appeal to Kripkeans about modality. Consider any X s:

1. $\diamond \exists y Xs \text{ compose } y$
2. $\Box \forall y \forall Xs (Xs \text{ compose } y \rightarrow y = Xs)$
3. $\Box \forall y \forall Xs (y = Xs \rightarrow \Box (Xs \text{ exist} \rightarrow (y \text{ exists} \ \& \ y = Xs)))$
4. $\forall y \forall Xs (y = Xs \rightarrow Xs \text{ compose } y)$
5. $Xs \text{ exist}$
6. Therefore, $\exists y Xs \text{ compose } y$

Comments: The argument is valid assuming a “B” modal logic. Premise 1 is harder than one might think for the defender of strong composition as identity to deny. Counterpart theory aside, the defender cannot say that, for example, two people could not possibly have composed something, while allowing that their subatomic particles *could* have composed something; for the defender identifies the people with the particles.²⁶ Premise 2 is just the necessitation of strong composition as identity. Premise 3 follows from the necessitation of Leibniz’s Law and the following logical truth: $\Box \forall y \Box (y \text{ exists} \rightarrow (y \text{ exists} \ \& \ y = y))$. (Counterpart theorists will deny this premise.) Premise 4 follows from superstrong composition as identity. Premise 5 is true by supposition.²⁷

²⁶Jason Turner pointed out, however, that 1 is less plausible when the X s are drawn from different ontological categories.

²⁷Thanks to John Hawthorne, Nick Stang, and Jason Turner for helpful discussion.

Further, defenders of composition as identity will be unmoved by one common source of resistance to unrestricted composition. Unrestricted composition implies the existence of objects undreamt of by most: fusions of trout with turkeys, and the like. For some reason that I do not understand, this is sometimes taken as a reason not to believe in the fusions. But if the fusion of a trout and a turkey is just the trout and the turkey, then the alleged reason is undercut, for who has not dreamt of trout and turkeys? The fusions that unrestricted composition delivers — if they exist — are identical to things (“thingses”, I should say²⁸) in which we already believe.²⁹

It is therefore natural, if not inevitable, for a defender of strong composition as identity to accept unrestricted composition. Once unrestricted composition has been established, by means fair or foul, the remaining core principle of classical mereology will have likewise been established:

Strong supplementation: If y is not part of x then y has a part that does not overlap x

For suppose the consequent is false: every part of y overlaps x . By unrestricted composition, there exists a fusion of x and y ; call it a . But a also qualifies as a fusion of x : x is part of a ; and every part z of a overlaps either x or y (since a is a fusion of x and y), and so, given the initial supposition, z overlaps x in each case. It is an immediate consequence of reflexivity and the definition of ‘fusion’ that x is a fusion of x . Hence $a=x$, by uniqueness. Since y is part of a , y is part of x — the antecedent is false.³⁰

3.3 Against strong composition as identity

Strong composition as identity has a lot going for it. It takes powerful intuitions about the intimate nature of parthood at face value. It implies the core principles of classical mereology. Some will take its counterintuitive implications about ‘one of’ and counting as decisive reason to reject it, but I prefer a more open-minded approach. Strong composition as identity is a radical thesis about the nature of plurality, identity, and number. As such, it challenges us to reorient our thinking about a wide domain of related concepts. Its proponents are saying: “Try this on for size. Thinking in our way leads to a better theoretical

²⁸See Hazen 1997.

²⁹Thanks to Trenton Merricks.

³⁰This proof is due to Paul Hovda.

position.” Flatfooted insistence on the status quo is not a fruitful response to this sort of challenge.

A better approach is to consider whether the proposed reorientation really would lead to a better theoretical position. In fact, strong composition as identity leads to a theoretically stagnant position; this is my reason for rejecting it. Since the groundbreaking work of George Boolos (1984, 1985), irreducibly plural quantification has become entrenched as a valuable theoretical tool in the philosophy of language, logic, and mathematics. Strong composition as identity would undermine the utility of this tool.

According to Boolos, in addition to the familiar singular quantifiers which bind variables taking the place of singular terms such as ‘Jones’, we can introduce “plural quantifiers” that bind variables taking the place of plural terms such as ‘Tom, Dick, and Harry’. These are the quantifiers ‘for some X s’ and ‘for all X s’ that I have been using. For Boolos, plural quantification over a domain is not disguised singular quantification over subsets of that domain (as it would be in the metaphysically second-rate language introduced at the end of §3.1). Plural quantification is quantification over the domain itself, in an irreducibly plural way. In addition to the plural quantifiers and variables, Boolos also invokes a logical predicate ‘is one of’, as in ‘ y is one of the X s’. And it is here where the conflict arises. We saw in §3.1 how strong composition as identity distorts the behavior of ‘is one of’. This, as we will see, undercuts the benefits of plural quantification.

One theoretical benefit of plural quantification is the interpretation of English sentences containing plural expressions, for example the Geach-Kaplan sentence:³¹

(GK) Some critics admire only one another

This sentence is not representable in first-order logic with quantifiers that range only over individuals. One could take ‘some critics’ to quantify existentially over sets of critics, but this commits ordinary speakers who utter (GK) to an ontology of sets. Intuitively, (GK) is about critics, not sets. It is therefore attractive to follow Boolos in interpreting (GK) using plural quantification:

There are some X s such that for each y , if y is one of the X s then
i) y is a critic, and ii) anything that y admires is not y itself but is
one of the X s

³¹See Boolos 1984; Rayo 2002.

In general, Boolos interprets the English plural quantifier ‘Some Fs’ as meaning ‘for some X s, for each y , if y is one of the X s then y is an F, and ...’; he interprets anaphoric expressions such as ‘one another’ in (GK) using ‘is one of’ and plural variables; and so on. Call this the *plurals strategy*.

The plurals strategy interprets English plurals using ‘is one of’. But as we saw, strong composition as identity distorts this predicate’s behavior. This induces a corresponding distortion of English plurals. Consider the sentence ‘There are some critics’. The plurals strategy represents this sentence thus:

Critics There are some X s, such that each x that is one of the X s
is a critic

But given strong composition as identity, Critics is false: there can be no X s, each of which is a critic. For suppose that each of the X s is a critic. Some x is one of the X s — there are no “empty pluralities”. So x is a critic. But x has parts that are not critics, which are parts of the fusion of the X s, contradicting $\text{Parts} \leftrightarrow \text{one-of}$.

If Critics is false, then the plurals strategy is untenable. According to the plurals strategy, Critics gives the truth condition of ‘There are some critics’. So ‘There are some critics’ would be false. Indeed, *every* sentence of the form ‘Some critics are ϕ ’ would be false. Moreover, since there exists at least one critic, the following clearly valid argument form would turn out invalid:³²

There is at least one F
Therefore, There are some Fs

More metaphysical discoveries? Might the defender of strong composition as identity accept even these consequences? That would be going too far. The distortion in the predicate ‘is one of’ has now spread, via the plurals strategy, to make hash of the semantics of all English plural expressions of the form ‘some Fs’. The defender of strong composition as identity must renounce Boolos’s plurals strategy, and construe English plural quantification as singular quantification over sets after all. English is the metaphysically second-rate language described in §3.1.

Strong composition as identity would mean renouncing the theoretical benefits of plural quantification, not only in the philosophy of language, but

³²If you think ‘There are some Fs’ requires that there be at least two Fs, modify the premise to read ‘There is an F, and there is an F distinct from the first F.’

in the philosophy of logic and mathematics as well. Plural quantification can sometimes act as a surrogate for quantification over sets. Consider a simple example: defining ancestrals. The usual definition of the ancestral of a relation quantifies over sets:

$R^*xy =_{df}$ for any set S, IF i) everything that x bears R to is a member of S, and ii) anything that a member of S bears R to is itself a member of S, THEN y is a member of S.

Friends of plural quantification generally assume that plural quantification can be used instead:

$R^*xy =_{df}$ for any X s, IF i) everything that x bears R to is one of the X s, and ii) anything that one of the X s bears R to is itself one of the X s, THEN y is one of the X s.

But not if strong composition as identity is true. Suppose for reductio that the definition correctly defines ‘ancestor of’ as the ancestral of ‘parent of’. Then, since my father is my ancestor, my father is one of any X s as specified in the definition. Suppose for reductio that one of his molecules, b , is *not* my ancestor. Then for some X s as specified in the definition, b is not one of the X s. So my father, but not his part b , is one of these X s, which violates Parts \leftrightarrow one-of. So b — a molecule — counts as one of my ancestors. The definition fails to correctly define ‘ancestor’.

Another benefit of plural quantification is that it can be used to interpret (monadic) second-order logic. The following is a valid sentence of second-order logic.

$$\exists X \forall x (x=x \rightarrow Xx)$$

The more common (non-plural) interpretation of second order logic has the second-order variables ranging over sets. But if the second-order variables range over sets, and if the second-order predication Xx means that x is a member of the set X , then the quantifiers could not range over absolutely all sets (otherwise the sentence would assert the existence of a universal set.) Yet we need second-order quantifiers over all the sets. We need them when, instead of the infinitely many replacement axioms of first-order Zermelo-Frankel set theory, we formulate a single second-order axiom of replacement (Boolos, 1998, 71). And we need them when we say the intuitively correct “there are some

things that are all and only the sets” (Lewis, 1991, §3.2). Plural quantification gives us everything we want: the second-order variables can be taken as wholly unrestricted plural variables, and ‘ Xx ’ can be taken as ‘ x is one of the X s’, without paradox.³³

Strong composition as identity ruins this interpretation of second-order logic. For example, the following is a valid schema of second-order logic:

$$\exists x \phi \rightarrow \exists X \forall x (Xx \leftrightarrow \phi)$$

(where ϕ may be any formula containing only x free.) But not under the plurals interpretation, given strong composition as identity. For let ϕ be ‘ x is a critic’. The antecedent is true; but the consequent is false, since it implies the sentence Critics discussed above.

There are many other areas in which plural quantification has proved invaluable: ontological commitment (Boolos, 1984; Rayo, 2002), the mereological interpretation of set theory (Lewis, 1991), cardinality comparisons between “pluralities” that are “too big” to form sets (Uzquiano, 2006). The list of applications for plural quantification grows by the year. All the applications require plural variables to be set-like; all would be undermined by strong composition as identity.

So: strong composition as identity deprives us of a valuable philosophical tool. How might its defenders respond?

Instead of identifying a whole with each and every collection of parts that composes it, they might identify a whole with only one collection of parts: that collection that comprises *all* of its proper parts. More carefully:

for any y and any X s, $y =$ the X s iff for every z , z is one of the X s
iff: z is a proper part of y (or the X s are just one in number, and y
is one of the X s).

I doubt this weakened view does justice to the motivation behind composition as identity. More importantly, it does not succeed in rescuing ‘is one of’. Let a , b , and c be mereological simples; suppose for reductio that ‘is one of’ behaves as it’s supposed to — so that in particular, the principle “Lists” from §3.1 is true. Then the weakened form of strong composition as identity implies each of the following:

³³See Boolos 1985 and Rayo and Uzquiano 1999 for extensions of the semantic conception of validity and consequence to second-order logic thus interpreted.

$$a+b+c = a, b, c, a+b, b+c, a+c$$

$$a+b = a, b$$

$$b+c = b, c$$

$$a+c = a, c$$

By Leibniz's Law, it follows that $a+b+c = a, b, c, a, b, b, c, a, c$. Given plausible principles of associativity and commutativity for plural terms, plus a plausible principle of absorption ($\alpha, \beta, \beta = \alpha, \beta$), it follows that $a+b+c = a, b, c$. But this is inconsistent with the weakened form of strong composition as identity (given Lists).³⁴

Alternatively, the defender of strong composition as identity might distinguish two types of plural referring expressions: those that are set-like and those that are not. Set-like plural referring expressions could be indicated with boldface — '**Tom, Dick, Harry**' — to distinguish them from the plural referring expressions that occur in ' $Ted = b, a, l, \text{ and } t$ '. Set-like plural variables will be needed too: '**the Xs**'. The intent is for set-like plurals to be tied to unique divisions. '**Tom, Dick, Harry** carried the casket' is to be true whereas '**Tick, Darry, Hom** carried the casket' is false; ' b is one of b, a, l, t ' is to be true whereas ' b is one of **Ted**' is to be false; and so on. Of course, if strong composition as identity plus the corresponding version of Leibniz's Law were admitted for set-like plurals, then the position would collapse:

- i) where α and β are set-like plurals, if $\ulcorner \alpha$ is composed of $\beta \urcorner$ is true, then so is $\ulcorner \alpha = \beta \urcorner$
- ii) where α and β are set-like plurals, if $\ulcorner \alpha = \beta \urcorner$ and $\phi(\alpha)$ are true, so is $\phi(\beta)$

Denying ii) would again raise suspicion that '=' is not really being used to express identity. So i) must be denied.

But then how should these new set-like plural expressions be regarded? As denoting sets? That would undermine all the uses of plural quantification surveyed. As *sui generis*? That is not an appealing position. For how would the set-like plurals be distinguished from the other sort? Yes, they interact differently with '=', but there ought to be an intuitive source for this difference. And why hold strong composition as identity for only one sort and not the other?

³⁴Thanks to Gabriel Uzquiano for discussion here.

A quite different response would be to claim that predicates like ‘is one of’, ‘carried’, and so on, create opaque contexts. This would block the damaging applications of Leibniz’s Law. According to one version of this response, the semantic values of these predicates are sensitive to the meanings of the plural referring expressions they attach to. According to another, these expressions are context-sensitive in some way.³⁵

Here is one model of the second version. (The first version faces parallel problems.) The predicate ‘is one of’ has a hidden “slot” for a property. Call the properties that go in the slot *divisional* properties, since they single out divisions of objects. The divisional property is given by the context of use, perhaps informed by the meanings or other linguistic features of the flanking terms, perhaps not. Where β is a plural referring expression, the sentence $\ulcorner \alpha \text{ is one of}_P \beta \urcorner$, where P is the operative divisional property, is true iff the referent of α instantiates P and is part of the fusion of the referents of β . The divisional property for a typical use of ‘ h is one of $h, a, l,$ and t ’ would be *being a body part*, and so the sentence would be true (since h is part of me and h is a body part). The divisional property for a typical use of ‘ h is one of Ted’ would be *being a person*, and so the sentence would be false (since h is not a person.)

This model works best when ‘is one of’ is flanked by constant terms. But it seems inapplicable when ‘is one of’ is flanked by variables bound to quantifiers, for lack of a mechanism to select an appropriate divisional property. And yet, such uses of ‘is one of’ lie at the heart of the most interesting applications of plural quantification. Boolos quantifies plurally over sets when giving his second-order formulation of set theory, without regard to which properties those sets instantiate; he expects ‘is one of’ to continue to behave like the predicate of set-membership. No single property selected by his context of utterance will serve as a divisional property. Might he quantify over divisional properties, replacing his plural quantifiers with pairs of plural quantifiers and quantifiers over divisional properties P ? For instance, $\exists X(Xa \& Xb)$ could be replaced by $\exists X \exists P (X_P a \& X_P b)$. For this to deliver the right results, the properties quantified over could not be restricted to qualitative properties or properties expressible in the language of set theory (recall the second-order axiom of replacement). The properties quantified over must include a property for every set. But the whole point of using irreducibly plural quantification was to avoid taking the second-order variables as singular quantifiers over sets, and

³⁵Thanks to Karen Bennett and Adèle Mercier. Compare the account of counting in Wallace MS.

now we are using singular quantifiers over properties. For Boolos's purposes, differences between sets and properties that are at least as numerous as the sets are irrelevant. For Boolos to quantify over properties in this way would be to give up his project.

Such is my case against strong composition as identity. It is perhaps a bit underwhelming. The argument is indirect: strong composition as identity deprives us of a valuable philosophical tool. Still, this tool has proved so useful that we should be loath to relinquish it. And do not forget the nonargument that strong composition as identity is just too weird to be believed. Conservatism *can* be the right reaction to logically deviant views (think of dialethism or the denial of the transitivity of identity). Whether because of argument or prejudice, most of us will, in the end, shy away from strong composition as identity.

4. The intimacy of parthood made precise

4.1 A cluster of theses

What, then, should we make of the intimacy of parthood? Without strong composition as identity, it seems impossible to express what is special about parthood in a single, precise thesis. But we need not rest content with the aphorisms of §2. A cluster of precise theses can jointly elucidate the intimacy of parthood. The theses are not logical consequences of any single unifying claim, but neither are they miscellaneous. They flow from and help to articulate a *picture* of parthood: of parts as specially characterizing a thing, of the whole being nothing more than the parts, of a part being just some of a whole, and so on:

Inheritance of intrinsicity: if property P is intrinsic, then the property <i>having a part that has P</i> is also intrinsic	
Inheritance of location: if x is part of y , then y is located wherever x is located	
Unrestricted composition: any X s have a mereological sum	} Classical mereology
Uniqueness of composition: no X s have more than one mereological sum	
Reflexivity: parthood is reflexive	
Transitivity: parthood is transitive	
Weak supplementation: if x is part of y and $x \neq y$, then y has a part that does not overlap x	
Strong supplementation: If y is not part of x then y has a part that does not overlap x	
Absoluteness: parthood is a two-place relation; it does not hold relative to times, places, sortals, or anything else	
Mereological monism: there is a single (fundamental) relation of parthood, which applies to all objects, regardless of ontological category	
Precision: ‘is a part of’ is not a source of vagueness	

4.2 The theses unified

Each thesis can be seen as flowing from the aphoristic conception of parts as intimate with their wholes.

The inheritance principles: these say that the part — its intrinsic nature and location — is reflected in the whole. The part shines through.

Uniqueness of composition: if some X s compose two things, then wholes could not be “nothing over and above their parts”. How could distinct things each be nothing over and above the same parts?³⁶

³⁶We might speak of distinct logical constructions as each being nothing over and above a certain common basis. But this is a different sense of ‘nothing over and above’. Logical constructions do not really exist; the construction allows one to talk as if they exist while really only talking about the basis. Clearly one can develop distinct constructions (distinct ways of

Reflexivity and transitivity: these flow directly from the idea that a part is “some of” a whole, since the intuitive notion of being some-of is itself transitive, and also seems reflexive. Moreover, reflexivity and transitivity were shown to follow from strong composition as identity, and so help render composition as similar as possible to identity, which is demanded by the aphorism that “the whole is just its parts”.

Weak supplementation: this similarly follows from strong composition as identity. Moreover, consider the aphorism that “a part is some of a whole”. Just as the aphorism that the parts are the whole asks us to think of composition as being like identity, this aphorism asks us to think of parthood as being like the notion of some-of used in claims like ‘the even numbers are some of the numbers’. This notion obeys the analog of weak supplementation: if the evens are some of, but not all of, the numbers, then there must be some numbers that are *separate* from the evens (in that no numbers are both some of them and also some of the evens). This notion also obeys the analog of strong supplementation: if the Joneses are not some of the Smiths, then there must be some of the Joneses that are separate from the Smiths. The aphorism points to strong supplementation.

Absoluteness: if parthood held relative to times (say), then so would composition. But then composition would not be much like identity, which does not hold relative to times (or anything else).³⁷ Moreover, if two things were composed of the same *X*s at different times, then how could each be “nothing over and above” the *X*s? (See §5.2.) Moreover, consider the intuitive notion of some-of in “a part is some of a whole”. If this notion holds relative to times, then so does the corresponding notion all-of. But just as ‘the *X*s are all of the *Y*s’ implies ‘the *X*s = the *Y*s’, so too ‘*x* is all of *y*’ implies ‘*x*=*y*’. If all-of and identity are to remain thus connected, then since identity does not hold relative to times, neither does all-of. Hence neither does some-of, and so neither does parthood.

Mereological monism: a single notion of identity applies to objects of diverse ontological categories (to both concrete and abstract objects, for instance). Nails and numbers are self-identical in the same sense. Likewise, a single

talking about fictitious entities) grounded in the same basis. Wholes, in contrast, really exist; and my use of ‘nothing over and above’ is intended to signify a relation that these real entities bear to their parts (a relation that, I claim, cannot hold between two wholes and the same parts).

³⁷ *Pace* Geach (1972, 1980), Myro (1986), and Gallois (1998); see Hawthorne 2003; Sider 2001*b*, chapter 5, §5.

notion of some-of applies across ontological categories. So if we are trying to cleave as much as possible to the intuitive ideas that a part is just some of a whole and that the whole just is the parts, a single notion of parthood should also apply to diverse ontological categories.³⁸ (Some deniers of monism wish to distinguish different parthood relations, call them A-parthood and B-parthood, over a common domain of objects. But the options for this position are limited if every such parthood relation must satisfy the intuitive picture of parthood. For one, the antimonomist must accept “quasi-uniqueness”: no X s have an A-fusion and a distinct B-fusion. Otherwise, either A-wholes are not “nothing over and above” their A-parts, or B-wholes are not “nothing over and above” their B-parts. For another, the antimonomist must accept that an object is A-composed of some objects iff it is B-composed of those objects. If y is A-composed of the X s, then, assuming unrestricted composition for B-parthood, the X s have a B-fusion, which by quasi-uniqueness must be y .³⁹)

Precision: since identity is not vague, neither is composition; since some-of is not vague, neither is parthood. (The evident vagueness in certain sentences of the form $\ulcorner \alpha$ is part of $\beta \urcorner$ must therefore be attributed to referential indeterminacy in the singular terms α and β .)

What about unrestricted composition? Could one claim that the whole is nothing over and above the parts when the whole exists, but nevertheless claim that sometimes the whole does not exist? I am inclined to say *no*, though the arguments that come to mind are regrettably shaky. First, the intuitive picture of the intimacy of parthood demands that we adhere as closely as possible to strong composition as identity, and so requires acceptance of unrestricted composition (though as we saw in §3.2, the relation between strong composition as identity and unrestricted composition is not straightforward.) Second, consider the following line of thought⁴⁰, which is compelling though hard to evaluate. Unless composition is unrestricted, it is in general an *open question* whether some X s compose something. But then in cases where some X s *do* compose something, the composed object seems to be something “over and above” the X s. For it is an open question whether the object exists given that the X s do, whereas it is *not* an open question whether the X s exist given that the X s do. Finally, opposition to unrestricted composition — distrust of scattered objects and the like — is undermined by the idea that the whole is “nothing over and

³⁸*Pace* McDaniel (2003*b*) and van Inwagen (1990, pp. 19–20).

³⁹Thanks to Jason Turner.

⁴⁰Thanks to Karen Bennett.

above the parts”.

Other claims might be added to the list of theses that flow from the intimacy of parthood.

First, since identity and “some-of” do not come in degrees, we might add that parthood does not come in degrees either.

Further, suppose that — against Lewis (1986, §4.5) — you accept the “constancy” of *de re* modal judgments. You think that, roughly, objects have *de re* modal properties absolutely rather than relative to sortals. Naturally, you accept the necessity of identity. And so, you might add to the list the thesis that if the *X*s compose *y* then it is necessary that the *X*s compose *y*.⁴¹ (You might not have begun life as a mereological essentialist. Should you hold fast to your modal convictions and water down — or even give up — the intimacy of parthood? Or should you revise your modal beliefs? Or should you question the constancy of *de re* modal judgments, without which there is no conflict? I prefer each of the latter two choices to the first — since I view the metaphysical modalities as not particularly cutting at the world’s joints and as being in a sense conventional (Sider, MS), it seems to me misguided to accord them much influence in the realm of the actual — but I cannot make your decisions for you. I grant that there is a choice to be made.)

Further, one might construe “the whole is nothing over and above the parts” as implying that the *features* of the whole are in some sense nothing over and above the features of the parts. This should not be taken to rule out the possibility of irreducibly macroscopic features (for instance quantum states of entangled systems, or, more mundanely, shapes of composite objects, which do not supervene on the properties of the parts).⁴² Any irreducibly macroscopic features can be pinned on relations between the parts, and therefore do not essentially involve the whole to the exclusion of the parts. Here is one way of making this precise:

For every property, *P*, of a composite object, *x*, there are some proper parts of *x*, the *Y*s, and some relation *R*, such that the *Y*s compose *x*, the *Y*s stand in *R*, *R* is at least as natural⁴³ as *P*, and necessarily, anything composed of some things standing in *R* itself has *P*

⁴¹ See Merricks 1999 on the relationship between *strong* composition as identity and the necessity of part-whole relations.

⁴² Thanks to Cody Gilmore, John Hawthorne and Trenton Merricks for discussion.

⁴³ See Lewis 1986, 59–69.

Various theses have been argued to “flow from” an intuitive conception of parthood. I would have liked a little more mathematical rigor. On the other hand, it is hard to see how to do better. Mathematical rigor directs transitions between precise theses, not the flow of rivers; and a single precise thesis articulating what is special about parthood has proved elusive.

4.3 An argument

If the theses do indeed issue from a unified attractive picture, then that picture can be seen as *explaining* the theses. For one way to explain is to exhibit diverse phenomena as issuing from a single source. And if the picture of the intimacy of parthood is explanatory in this way, there is then the possibility of *arguing* from some of its component theses to the others. This would be an inference to the best explanation.

As *everyone* agrees, the inheritance principles are true. This points to a special feature of parthood that needs to be explained.

Consider, first, the inheritance of intrinsicity: if P is an intrinsic property, then so is the property *having a part that is P*. For instance, if *being red* is intrinsic, then so is *having a red part*. Relatedly, if a part of a thing changes, then the thing itself typically changes.⁴⁴ My nature reflects that of my parts: this speaks to an especially intimate connection between me and my parts.⁴⁵ We have here a distinctive feature of the part-whole relation. For other relations R (other than identity), *bearing R to a red thing* is not an intrinsic property; things do not automatically change when something to which they bear R changes.

It may be objected that the inheritance of intrinsic properties is a mere analytic truth, a trivial consequence of what we mean by ‘intrinsic’. Cleansed

⁴⁴Typically but not always. A change to a part of a symmetric object might be counterbalanced by a corresponding change to another part of the object. Or consider the fusion of infinitely many spatially unlocated Fs and infinitely many spatially unlocated Gs (F and G being intrinsic properties), and imagine one of the Fs changing to become a G. Thanks to Timothy Williamson.

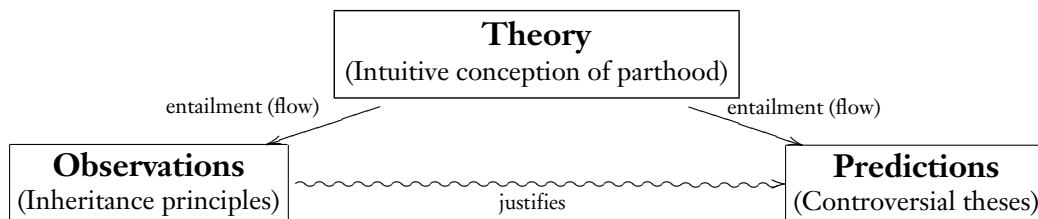
⁴⁵To explain this connection, it is not enough to say merely that parthood is a natural or fundamental relation. Although that would explain why there is some asymmetry or other between properties involving parthood and properties involving other (unnatural) relations, it would leave unexplained the particular asymmetry under consideration: that, for instance, my property of having a part that is hand-shaped is part of *my* nature. Further, suppose that spatiotemporal relations hold, fundamentally, between composites rather than simple things (perhaps because all objects are composite, that is, “gunky”), and are therefore natural relations over composites. Still, whether a thing has the property *being five feet from something hand-shaped* is not a matter of *its* intrinsic nature.

of pre-Quinean confusion about analyticity and truth by convention,⁴⁶ what exactly is the objection? Perhaps that the linguistic decision to link ‘intrinsic’ with parthood is *arbitrary*, and so the truth of the inheritance of intrinsicity principle does not mark anything special about parthood. We could just as easily have linked ‘intrinsic’ with another relation R.

Thus interpreted, the objection is just wrong. Imagine a linguistic community that counts properties like *having a long-haired brother* as “intrinsic”, so that people “change” when their brothers get haircuts. These linguistic choices are intuitively bizarre; these concepts do not carve conceptual reality at its natural joints. We latch onto something important with *our* notions of change and intrinsicity. Part-intrinsicity carves nature at its joints in a way that “sibling-intrinsicity” does not.

Consider, next, the inheritance of location. The locations of a thing’s parts are automatically reflected in the thing’s location — more evidence of the intimate nature of the part-whole connection. Parthood is alone in this respect; my location is not tied to the locations of my relatives, things I own, things I am near, and so on. As before, this should not be written off to analyticity. Our choice of meaning for ‘located’ is not arbitrary. It would be bizarre to choose a meaning under which people would be “located” wherever their brothers were located. Our actual usage of ‘located’ reflects the peculiar intimacy of parthood; we choose a meaning that matches my boundaries with my parts’ locations.

Everyone accepts the inheritance principles. If they are true, then the part-whole connection is a uniquely intimate one. The intimacy of this connection must be explained. The best explanation is a conception of parthood that renders the connection between parts and wholes as intimate and identity-like as possible. And since the other, more controversial, theses also flow from that intuitive conception, everyone has a reason to accept those more controversial theses as well. Compare the justification of an empirical theory’s predictions by observations that confirm the theory:



⁴⁶See Quine 1936; Sider MS.

Making the observations increases one's degrees of belief in the predictions entailed by the theory. The "observations" in the present case are the inheritance principles, the "theory" is the unifying intuitive conception of the intimacy of parthood, and the predictions are the further, more controversial theses: unrestricted composition, uniqueness of composition, and so on. (The relation between theory, on the one hand, and observation and prediction, on the other, is not entailment in this case; it is the more elusive relation of flowing from.)

Must anyone who accepts the inheritance principles also accept the more controversial theses? Of course not; inference to the best explanation is defeasible. More modestly, the argument should lead those who accept the inheritance principles to raise their degrees of belief in the controversial theses.

Of course, the argument has this effect only to the extent that the theses of the intimacy of parthood really are unified by a single attractive picture, and to the extent that there is no similarly attractive rival conception of parthood from which the inheritance principles flow but the controversial theses do not. Note that one initially attractive alternate style of explanation is in fact not explanatory at all: the claim that the intrinsic properties of wholes *supervene* on the intrinsic properties of the parts. The supervenience claim merely states that propositions about the intrinsic properties of the parts (modally) entail propositions about the intrinsic properties of the whole; it does not address *why* the entailments hold. Another rival explanation of inheritance fares better: wholes are logical constructions from parts. I take this view to be that there really are no wholes at all: mereological nihilism is true. Statements that appear to be about wholes are really about mereologically simple entities. On this view, it is natural to say that there really is no such relation as parthood (Dorr, 2005, §17). If the inheritance principles are taken at face value (as attempted claims about a genuine relation of parthood), then they are vacuous and therefore not in need of explanation.⁴⁷ If they are not taken at face value, but are rather interpreted in the terms of the logical construction, then the principles really concern mereologically simple entities, not composites. Either way, there is no pressure to accept the remaining theses of the intimacy of parthood. Those willing to accept mereological nihilism (including its preclusion of the possibility of "gunk" (Sider, 1993)) evade my arguments; they have no need for composition as identity, or anything like it.

⁴⁷Thanks to Karen Bennett.

4.4 Moderate composition as identity

Some of the theses articulating the intimacy of parthood concern the relationship between a thing and any one of its parts taken individually, for instance the inheritance of intrinsicity and the inheritance of location. Others concern the relationship between a thing and all of its parts taken together — composition. Unrestricted composition and uniqueness of composition explicitly concern composition. Other theses implicitly bear on composition, via the definition of ‘composition’ in terms of parthood. Absoluteness, for instance, implies that composition does not hold relative to times, places, or sortals; mereological monism implies that one and the same relation of composition applies to objects of different ontological categories; and so on.

If all of these implications about composition are true, then composition and identity are similar in many respects:

- Just as everything is identical to something, so too any *X*s compose something (unrestricted composition)
- Just as nothing is identical to distinct things, so too no *X*s compose distinct things (uniqueness of composition)
- Just as identity does not hold relative to place, location, or sortal, so too composition does not hold relative to place, location, or sortal (absoluteness of composition)
- Just as a single identity relation applies to all objects regardless of ontological category, so too a single composition relation applies to all objects regardless of ontological category (compositional monism)
- Just as identity is never vague, composition is never vague (precision of composition)⁴⁸

Call this collection of theses about composition *moderate composition as identity*. These theses draw composition as close to identity as possible, without going so far as to identify composition with identity.

David Lewis (1991, §3.6) holds a weakened version of composition as identity, according to which composition is *analogous* to identity. The analogy

⁴⁸The precision of composition does not follow merely from the precision of parthood; one must assume in addition that the other notions used in the definition of composition are not sources of vagueness: identity, quantification and the truth-functions.

consists of some of the theses I have articulated, plus others. If Lewis’s theses are true, then composition and identity are indeed analogous. But more needs to be said. The analogy is not “accidental”. The theses flow from a single source: a conception of parthood as an especially intimate relation. A composite is just its parts. The whole is nothing over and above the parts. A part is just some of a whole. And so on.⁴⁹

4.5 Strong composition as identity again

Does strong composition as identity entail the theses that we have been discussing? If it did, it would be a great unifier.

Let us first explore the relationship between strong composition as identity and moderate composition as identity. Several of the theses of moderate composition as identity follow, more or less immediately, from strong composition as identity. We saw arguments from strong composition as identity to both uniqueness of composition and unrestricted composition in §3.2. And assuming that identity does not hold relative to times, places or sortals, absoluteness follows also from strong composition as identity. Further, the other theses of moderate composition as identity are at least quite natural to pair with strong composition as identity: monism about composition (since identity applies across ontological categories) and precision of composition (assuming that identity is not vague).

If true, therefore, strong composition as identity would unify that part of the intimacy of parthood that concerns composition — namely, moderate composition as identity. Moreover, strong composition as identity implies

⁴⁹Lewis (1991, §3.6), following Armstrong (1978, pp. 37–39), speaks also of overlap as “partial identity”, and of identity as the limiting case of overlap. These statements are intuitively compelling but what do they mean? Vacuity threatens the former: when objects overlap, a part of the one is identical to a part of the other. The latter suggests a continuous fade from overlap to identity, but in what does the continuity consist? There is a discontinuity in the sharing of properties at (complete) identity, when Leibniz’s Law kicks in. Might we say that similarity increases with increased overlap? No — consider an infinite row of alternating red and green spheres: $R_1, G_1, R_2, G_2, R_3, G_3, \dots$, where every R_i is exactly like every other, and likewise for the G_i s. There is more overlap in the second of the following ordered pairs than in the first:

$$\begin{aligned} &\langle R_1+G_1+R_2+G_2+R_3+G_3\cdots, R_2+G_2+R_3+G_3\cdots \rangle \\ &\langle R_1+G_1+R_2+G_2+R_3+G_3\cdots, G_1+R_2+G_2+R_3+G_3\cdots \rangle \end{aligned}$$

but the members of the first pair resemble each other perfectly whereas the members of the second do not.

reflexivity, transitivity, weak supplementation, and (modulo queasiness about the argument for unrestricted composition) strong supplementation (§3.2).

However, strong composition as identity does not entail either of the inheritance theses. The reason is that the inheritance theses concern the relation between a thing and *each* of its parts, whereas strong composition as identity concerns only the relation between a thing and all of its parts taken together.

This failure to entail the entirety of the intimacy of parthood actually weakens the case for strong composition as identity. If strong composition as identity managed to logically imply everything that is distinctive about parthood all on its own, that would be a point in its favor. But it does not, so we are stuck with articulating what is special about parthood piecemeal, by a plurality of principles, unified only by a picture. Since we need to take this piecemeal approach *anyway*, the logically conservative route of avoiding strong composition as identity looks more attractive.

Objection: given certain auxiliary principles, the inheritance theses follow from strong composition as identity after all. For example, strong composition as identity plus the following principle entails the inheritance of location:⁵⁰

Plural inheritance of location If the *X*s are among⁵¹ the *Y*s, then the *Y*s are located wherever the *X*s are located

Reply: Given strong composition as identity, the *X*s are among the *Y*s iff the *X*s are part of the *Y*s.⁵² Indeed, it would be in the spirit of strong composition as identity to identify the relation *being among* with the relation *being part of*. Thus, the needed auxiliary principle, the plural inheritance of location, amounts to what we are trying to prove: the inheritance of location. The conclusion stands: strong composition as identity does not on its own capture all of what is special about parthood.⁵³

⁵⁰This is so because strong composition as identity implies that the *X*s are among the *Y*s iff the *X*s are part of the *Y*s. See note 52.

⁵¹That is, for every *z*, if *z* is one of the *X*s then *z* is one of the *Y*s.

⁵²The *X*s are among the *Y*s iff everything that is part of the fusion of the *X*s is part of the fusion of the *Y*s (Parts \leftrightarrow one-of) iff the fusion of the *X*s is part of the fusion of the *Y*s (mereology) iff the *X*s are part of the *Y*s (strong composition as identity).

⁵³Thanks to Greg Fowler and John Hawthorne.

5. Last, an application: persistence

A proper understanding of parthood's nature can answer longstanding questions about persistence over time. First, it is the intimacy of parthood, rather than the supervenience of *de re* temporal properties, that stands in the way of coinciding objects. Second, the intimacy of parthood is inconsistent with most versions of the theory that objects endure.

5.1 The supervenience argument

Coincidentalists reject temporal parts while accepting what the puzzles of material constitution seem to show, namely that numerically distinct entities regularly *coincide*, that is, are each composed of some one set of parts.⁵⁴ A clay statue, *S*, is flattened, destroying it but not the lump, *L*, of clay from which it is made. According to the coincidentalists, *L* postdates, and so is numerically distinct from, *S*. Yet before the flattening, *S* and *L* are composed of precisely the same microscopic parts.

It is often urged against coincidentalism that the future trajectory of a macro-object supervenes on a certain basis, a basis with respect to which the statue and lump are indiscernible.⁵⁵ The alleged supervenience basis I will consider consists of properties involving the future trajectories of the object's micro-parts. Since *S* and *L* have, before the flattening, exactly the same micro-parts, they are indiscernible with respect to this basis. By claiming that *S* and *L* nevertheless have different future trajectories, coincidentalists violate the alleged supervenience principle.

Evaluation of this argument turns on issues in the philosophy of time. Suppose first that the *B-theory* of time is true.⁵⁶ The B-theory has two components:

⁵⁴Coincidence is sometimes defined as sharing the same spatial location at a time. But location-sharing is not metaphysically problematic in the way that part-sharing is. Combinatorial reasoning like that of §1 establishes the possibility of location-sharing; location-sharing is prohibited in actuality (if it is prohibited at all) only by the contingent existence of repulsive forces varying inversely with distance (Sider, 2000).

⁵⁵See Burke 1992, Sosa 1987, §G, and Zimmerman 1995, pp. 87–88. It is interesting that an analogous argument concerning the supervenience of past trajectory is rarely advanced. The argument comes in a modal variety as well, on which see Sider 1999; Bennett 2004; Shagrir 2002; Sider Forthcoming.

⁵⁶On a growing block theory of time, the temporal supervenience argument fares as it does given presentism; on a moving spotlight picture the argument fares as it does given the B-theory. See Sider 2001*b*, chapter 2, on theories of time.

i) eternalism, according to which past, present, and future objects are equally real, and ii) reductionism about tense, according to which a tenseless perspective on reality is fundamental, and tensed statements have tenseless truth conditions (for instance, an utterance at t of ‘there once existed dinosaurs’ is true iff there tenselessly exist dinosaurs, located before t .) B-theorists who reject temporal parts account for change by *indexing*. Temporary properties and relations always hold *at*, or *relative to*, times. Thus, a certain poker is hot *at* time t , but cold at time t' . Hotness and coldness are relations between persisting things and times.⁵⁷ Mereological change is no different: the fundamental mereological relation is three-place, holding between two things and a time: x is part of y at t . These relations hold eternally when they hold at all, for their temporality is exhausted by their inclusion of times as relata.

If parthood holds relative to times, then ‘part’ in the temporal supervenience argument’s premise — “the future trajectory of a macro-object supervenes on the future trajectories of its micro-parts” — requires temporal qualification. To rule out coincidentalism, the premise must mean this:

- (1) At any time, t , the future trajectory of a macro-object, M , supervenes on the future trajectories of the micro-objects that, at t , are part of M

The intuitive idea behind the premise is a good one: macro-facts do not float free of micro-facts. But given the B-theory, the intuitive idea does not justify (1). The tenseless perspective includes facts about macro-object M ’s micro-parts at every time at which M exists, not just t . If M ’s trajectory is secured by the totality of these facts, then, tenselessly speaking, macro-facts do not float free of micro-facts; there is no need for M ’s trajectory to be secured by trajectories of those objects that are its micro-parts at just *one* time, t , as (1) requires. Thus, given the B-theory, the intuitive idea only justifies (2):

- (2) The trajectory of a macro-object, M , supervenes on the totality of facts concerning trajectories of micro-objects that at *any* time are part of M

⁵⁷I am simplifying. Given special relativity, one should index to spacetime, not time (Sider, 2001*b*, chapter 4, §4). Also, the picture of relations to times assumes substantivalism. Coincidentalism gets complicated when combined with relationalism. See Sider 2001*b*, chapter 4, §8 and Hawthorne and Sider 2002, §III. Also, there are the adverbialists (Haslanger, 1989; Johnston, 1987).

But now, as Ryan Wasserman (2002) points out, (2) is consistent with coincidentalism, for *S* and *L* have different micro-parts after *L* is flattened. In short: from the tenseless perspective — the fundamental perspective, for a B-theorist — there are micro-differences between *S* and *L*. Hence, distinguishing *S* from *L* does not require macro-facts to float free of micro-facts.

Suppose on the other hand that *presentism* is true. According to presentism, i) only currently existing objects are real, and ii) the present, tensed, perspective on reality is fundamental. Given presentism, the whole of reality is *reality now*. Nevertheless, reality now includes temporal facts, for instance the fact that there once existed dinosaurs. Presentists regiment sentences expressing such facts using tense operators: ‘it once was the case that: there exist dinosaurs’. Since they do not believe that there exist dinosaurs, presentists deny the B-theoretic reduction of such tensed sentences; for them, tense operators like ‘it once was the case that’ are primitive.

Facts can be divided into the categories of *manifest* or *categorical*, on the one hand, and *hypothetical*, on the other. Categorical facts concern reality as it *is*. The hypothetical goes beyond the categorical, and concerns reality as it was, will be, might be, must be, and so on. For B-theorists, facts about the instantiation of categorical properties and relations throughout time are themselves categorical. But for the presentist, only facts about the present are categorical. The rest are irreducibly tensed, and so hypothetical, for instance the fact that *it was the case that the world contained dinosaurs*, and the fact that *it will be the case that the sun goes nova*.

Suppose *S* and *L* are about to be flattened. The presentist coincidentalists says that *L*, but not *S*, has the tensed property *existing four days hence*. Now, if we restrict our attention to the categorical, there are no micro-differences between *S* and *L*, since *S* and *L* currently have the same micro-parts. So if the objector can insist that the future trajectories of macro-objects are determined by the *categorical* facts about their micro-parts, the temporal supervenience argument will have force. But this insistence is likely to be dialectically ineffective. Presentists are already saddled with denying that the hypothetical supervenes on the categorical, since what happened in the past and what will happen in the future (whether at the micro- or macro- level) is not a function merely of what is happening in the present.⁵⁸ In my view, this is already a strike against presentism; but presentists who have remained faithful must have learned to live with it. And once grounding the difference between *S*

⁵⁸See Sider 2001b, chapter 2, §3.

and *L* in the categorical is off the table, the presentist will feel free to appeal to hypothetical mereological differences between *S* and *L*: *S* and *L* *will* have different parts in the future.⁵⁹

5.2 Coincidentalism and the intimacy of parthood

The temporal supervenience argument is the argument usually advanced against coincidentalism. As we have seen, it is not particularly strong. Foes of coincidentalism need a new argument. The new argument is simply that coincidentalism offends against the nature of parthood.

The combination of coincidentalism and presentism directly violates the uniqueness of composition. To see this, consider what presentists say generally about change. Since only the present is real, the only properties and relations a thing instantiates are those it instantiates now; and these properties and relations are instantiated simpliciter, rather than relative to a time.⁶⁰ If an object is now straight then it is straight simpliciter, even if a tensed claim such as *it was the case that it is bent* is true of it. Likewise, if *x* is part of *y* now then *x* is part of *y* simpliciter, even if a tensed claim such as *it was the case that x is not part of y* is true of it. So presentists will accept Absoluteness — parts are parts simpliciter, not relative to times. That means that for the presentist coincidentalists, the statue and lump are composed (simpliciter, not relative to a time) of the same subatomic particles. This strikes at the core of the intimacy of parthood; it destroys the picture of composites being “nothing over and above their parts”.

The combination of coincidentalism and the B-theory does not so directly violate the uniqueness of composition, since it relativizes parthood and composition to times, whereas uniqueness of composition only prohibits *X*s from standing in the relation of composition *simpliciter* to distinct things. Still, B-theoretic coincidentalism is inconsistent with what motivates the uniqueness principle, namely, the idea that composites are “nothing over and above their

⁵⁹Since nearly everyone accepts modal actualism, the modal version of the supervenience argument is in a similar state to the temporal supervenience argument given presentism, but with one big advantage. A coincidentalists who thinks that Allan Gibbard’s (1975) permanently coinciding statue and lump differ modally must reject a kind of supervenience of (*de re*) modal properties, which are paradigmatically hypothetical, on categorical properties; and if such a coincidentalists is not a presentist, this rejection is not buffered by an antecedent commitment to denying the supervenience of the hypothetical on the categorical. But see Sider Forthcoming for more moves available to modal coincidentalists.

⁶⁰See Hinchliff 1996; Merricks 1994.

parts”. For if B-theoretic coincidentalism is true, there simply is no set of things one could identify such that the statue is “nothing over and above” them. Given any reasonable set of things we might choose (for example, the set of parts of the statue at the time of coincidence), the lump would equally deserve to count as nothing over and above those things; but two things cannot each be nothing over and above the same things.

Moreover, relativization itself — whether or not combined with coincidentalism — violates absoluteness. Relativizing composition to times makes composition less like identity.⁶¹

Relativization leads to another violation of the “nothing over and above” slogan. Suppose some particles are first arranged in bicycle form, and are then, much later, arranged into chair form. Most relativizers will say that the chair and the bicycle are distinct entities composed by the same particles at different times. But then, given the existence of the chair, we cannot identify a set of things over and above which the bicycle is nothing.

Objection:

The bicycle is nothing over and above the particles at the first moment, and the chair is nothing over and above the particles at the second moment. Granted, composition of distinct things at a single time would violate the “nothing over and above” slogan, but the serial composition of distinct things at different times would not.

Reply: what is important is whether the whole is nothing over and above some parts *simpliciter*. Don’t be fooled by the misleading phrase ‘at *t*’. When attached to a sentence, say ‘*y* is nothing over and above the *X*s’, it misleadingly suggests the following picture. To decide whether ‘*y* is nothing over and above the *X*s at *t*’ is true, inspect the whole of reality as it is at *t*, and see whether ‘*y* is nothing over and above the *X*s’ is true of that reality. The ‘at *t*’ is detachable from the rest of the sentence, and that rest of the sentence expresses a complete proposition, which may be compared with reality. All ‘at *t*’ tells us is when we need to look at the whole of reality. So, the picture suggests, multiple composites at *one time* would mean that the whole of reality would at some point violate nothing-over-and-above-ness. But serial multiple composites would never require reality to violate that requirement.

⁶¹Relativizing parthood to places, as in Hudson 2001, chapter 2, would have the same effect.

This picture is correct given presentism. There is no tenseless perspective on reality; reality is always (then-) present reality. ‘ y is nothing over and above the X s’ expresses a complete proposition (insofar as we attach sense to it at all), which can be compared to reality as a whole (that is, reality now). But given the B-theory, the picture is all wrong. The passage of time, for the B-theorist, does not consist of “serial, heterogeneous realities”, as it does for the presentist. Rather, reality as a whole is the single, unchanging, four-dimensional block universe. ‘ y is nothing over and above the X s’ does *not* express a complete proposition on its own, and cannot be detached from ‘at t ’. ‘At t ’ is integrated into the proposition; ‘ y is nothing over and above the X s at t ’ attributes a three-place relation to y , the X s, and the time, t . Now, it is hard to see what that three-place relation would be. But setting that aside, what is important is what we say from the fundamental tenseless perspective about the two place relation *being nothing over and above* (simpliciter). Concerning that, we can reason as follows: from the fundamental, tenseless perspective, we have simply two distinct objects — the bicycle and the chair — and the particles. From this fundamental perspective, how can the chair and the bicycle *both* be “nothing over and above” the particles?

I have been arguing that the intimacy of parthood prohibits relativizing parthood to times. Does this mean that the intimacy of parthood prohibits what we ordinarily think of as change in parts? No: mereological change can be understood by means of temporal parts. Defenders of temporal parts say that the fundamental relation of parthood is temporally unrelativized.⁶² However, a defined notion of parthood at a time may be introduced:

x is part of y at t iff x ’s temporal part at t is part (simpliciter) of y ’s temporal part at t

Under this definition, one may speak of objects having different parts at different times, of parts composing different wholes at different times, and so on, despite the fact that the *fundamental* relation of parthood is temporally unrelativized. Of course, the theses of uniqueness of composition and absoluteness turn out false when ‘part’ is understood according to this definition. But the intuitive appeal of the intimacy of parthood concerns the fundamental notion of parthood, not defined-up notions.

Likewise, distinguishing statues from lumps does not on its own violate the intimacy of parthood. On a temporal parts picture, a statue and a lump may be

⁶²See Sider 2001b, chapter 3..

regarded as overlapping but numerically distinct space-time worms composed — atemporally — of different temporal parts. We may speak of them as being composed of the same microscopic parts *at certain times* (namely, the times at which they share a common temporal part), but ‘part’ here signifies the defined notion of parthood at a time, whereas the intimacy of parthood concerns the fundamental relation of parthood simpliciter.

5.3 Endurance

As we have seen, the intimacy of parthood settles questions about coinciding objects and mereological change. As a corollary, it also settles questions about whether objects perdure or endure — whether they do or do not persist by means of temporal parts. We saw that the intimacy of parthood is incompatible with:

- E₁: The coincidental form of endurantism, whether B-theoretic or presentist
- E₂: Any endurance theory implying that the part-whole relation is fundamentally relative to times
- E₃: Any B-theoretic endurance theory allowing some *X*s to compose different entities at different times (as with the chair and the bicycle)

Indeed, if the theses expressing the intimacy of parthood are necessarily true, these forms of endurance are not merely false, they are impossible. And the theses are excellent candidates for being necessary truths, flowing as they do from the very nature of parthood.

Once E₁-E₃ have been dispatched, which of the usual forms of endurance remain? On the B-theoretic side, only mereological essentialism and mereological nihilism.⁶³ Other forms allow coincidence or mereological relativity or serial composition of distinct entities.

Presentists have a little more latitude. While they must reject coincidence, they can accept mereological change without relativizing parthood to times, and they can allow some *X*s to serially compose distinct entities over time without

⁶³On mereological essentialism see Chisholm 1973, 1975, 1976, Appendix B; Zimmerman 1995. The verdict of the present paper thus meshes with that of my 2001*b*, chapter 5: mereological essentialism and mereological nihilism are the most viable forms of endurance.

violating “nothing-over-and-above-ness”, since at any one time, then-present reality will contain only one entity composed of the *X*s.⁶⁴

It is a good thing that some forms of endurance remain consistent with composition as identity, given §1’s argument that a modicum of combinatorialism implies the possibility of spatially extended simples. Assume that the B-theory is true. Then enduring simples are just the temporal analog of spatially extended simples: an enduring simple is a partless entity occupying more than one point of (space-) time. Combinatorialism therefore implies their possibility as well (though not the possibility of *changing* enduring simples! — combinatorial reasoning does not add argument places for times to properties.) Temporally extended simples *per se* do not offend against the nature of parthood, for this combinatorial argument does *not* imply the possibility of relativity of parthood to times, or of serial composition of multiple things, or of coincident entities.

6. Conclusion

Composition as identity is intuitively appealing. It is a little wild in its strong form, though not as indefensible as it first seems. Still, it should be rejected, since it undermines the theoretical utility of irreducibly plural quantification. A tamer moderate form stays as faithful as possible to the motivating idea: that a composite is nothing over and above its parts, that things just *are* their parts. And it flows from a more general conception of parthood as a uniquely intimate relation. That conception explains why intrinsic properties of parts give rise to intrinsic properties of wholes, and why things are located where their parts are. It supplies a powerful argument for classical mereology, and an argument against coincident entities and most forms of endurance. Finally, by yielding unrestricted composition, it justifies the plausible asymmetry noted at the outset between expansions and contractions.

A final word on methodology. This paper has taken an “analytic” approach. Highly abstract principles about parthood were formulated, and allowed to drive conclusions about particular cases. A “synthetic” approach reverses the procedure. It begins instead with ordinary judgments about particular cases of parthood, and erects a metaphysical edifice on this foundation.⁶⁵ In defense of

⁶⁴Of course, the intimacy of parthood includes unrestricted composition, anathema to many presentist endurantists (Merricks, 2001; Markosian, 1998*a*).

⁶⁵I have in mind Kit Fine (1994, 1999, 2003), Mark Johnston (2005), Ned Markosian (1998*a*), and Peter van Inwagen (1990), whose work is rich and illuminating, if fundamentally opposed

the analytic approach: judgments about cases are often infused with irrelevant linguistic intuitions. A more secure foundation comes from unabashedly metaphysical insight.

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