Supersubstantival composition as identity

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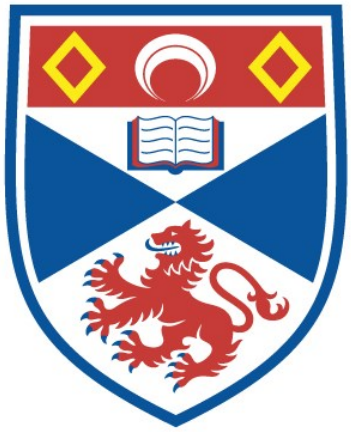

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ABSTRACT

The most popular form of supersubstantivalism claims that each material object is identical to its location. Composition as Identity (CAI) claims that each material object is identical to its parts taken together. These two theories are crying out for unification: they share many commitments, they can solve problems for each other, and the theory that results from their combination is elegant and powerful. Elegant because it unifies three phenomena (composition, location, and identity) and two different theories (supersubstantivalism and CAI). Powerful because it puts one relation (identity) to a great deal of work, using it to offer answers to the general and special composition questions as well as solutions to various mysteries about the relationship between material objects and spacetime. The work of this thesis is to combine supersubstantivalism and CAI into a new theory. I call this new theory *supersubstantival composition as identity*. Or, *super-CAI*, for short.

In the course of advocating for super-CAI, I offer some new advances for related literature. I show how to make a restricted view of composition consistent with CAI and with supersubstantivalism. I show that supersubstantivalism is consistent with failures of harmony. I develop a method of relativising *is one of* predications to ways of counting. And I explain why colocation of physically discernible material objects is (at least physically) impossible. All while offering a systematic defence of a novel theory of composition and location.

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CONTENTS

INTRODUCTION

Suppose I have assembled a house out of bricks. I might ask "what is the relationship between the bricks and the house?" Perhaps there are multiple relationships between them, but one answer is simple and obvious: the bricks compose the house, so they stand together in the *composition* relation to the house. But enquiry does not end there. Next, I might wonder what the composition relation is. Can it be further analysed? Peter van Inwagen called this the *general composition question*.[1] In this thesis, I advocate the following answer to that question: composition is the identity relation. The bricks together compose the house, and composition is identity, so the bricks together are identical with the house. This means that my view is a version of *composition as identity* (hereafter, CAI), which is discussed in Chapter 1.

Unlike my fellow CAI advocates, however, I also claim that *exact location* is identity. A material object's exact location is the region of spacetime it occupies. Therefore, when I claim that the exact location relation is the identity relation, I can be understood as saying that objects are identical with regions of spacetime. This is a version of a view called *supersubstantivalism*, which is discussed in Chapter 2. The result of combining supersubstantivalism and CAI is a new view I call *supersubstantival composition as identity*. Or *super-CAI*, for short. I establish this view in Chapter 3.[2] Objections are considered in Chapter 5, and alternative views are considered in Chapters 6 and 7.

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[1] Van Inwagen (1990).

[2] When I started this project, and at the time it occurred to me to combine CAI with supersubstantivalism, nothing like this view had been articulated. However, several years into this project, a paper by Duncan and Miller (forthcoming), advocating a combination of CAI and supersubstantivalism, was accepted for publication in *Inquiry* and became available online. This means that, despite developing the idea independently for years prior to that publication, I am not the first to publish this theory. Nevertheless, many significant differences between that work and this are worth noting. Obviously, the greater length of this work permits greater detail; I offer a formal semantics for the view and there are a great many arguments I consider that are absent from their discussion. There are also points of disagreement. For instance, I claim that supersubstantivalism does not entail mereological harmony (see Chapter 2). They disagree (ibid. p.13). But there is one great

Super-CAI is an elegant theory; it unifies three different phenomena (composition, location, and identity) and two different theories (CAI and supersubstantivalism). The two theories share commitments, and there are natural arguments leading from one to the other, making them ripe for combination. Super-CAI is also a powerful theory; it enables us to solve some problems for CAI and offer solutions to mysteries about what it is for an object to be located. Further, by combining the views that composition is identity and location is identity, we can offer novel answers to the *special composition question*,[3] which asks "under what circumstances does composition occur?". I discuss this in Chapter 4.

The result of this thesis, then, is a view that offers traction on several different, difficult problems, including the nature of location and the two composition questions.

Before getting stuck in, some preliminaries are in order. First, a note on the scope of this thesis. In what follows, I focus only on regions of spacetime and material objects that are wholly and entirely located at them. I will not be considering mereological relations between abstract or otherwise-non-located objects. It is common practice to restrict one's attention in this way.[4] Sometimes, this restriction is put in place for merely pragmatic reasons (things get more complicated when we look to include non-material objects) but the door is left open to a univocal notion of composition that is generalised from the composition of material objects. Other times, this restriction is put in place because the theory being offered cannot *in principle* apply to non-located entities. Super-CAI plausibly involves the latter kind of restriction.[5] That is a cost, but I hope to convince you that it is one worth paying.

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similarity: their paper and this thesis both independently conclude that shared commitments and shared tools for problem solving make a strong case for combining CAI and supersubstantivalism. At time of submission, I have had no correspondence with Duncan or Miller, but would welcome the opportunity to talk with them about this compelling idea.

[3] Van Inwagen (1990).

[4] See Baxter (1988b), van Inwagen (1990), Fine (1999), Merricks (2001), Schaffer (2010b), Cotnoir (2013b), Markosian (2014), and many others.

[5] That super-CAI should be restricted in this way seems to follow from its use of location. But not all theories of location require location in space, time, or spacetime. I return to this briefly in Chapter 8. Until then, I treat 'location' as equivalent to 'location in spacetime'.

The scope of the theory I advocate is restricted in another way, too. I do not claim that super-CAI is necessarily true. Some of the arguments I give (in Chapters 2, 4, and 5) rely on actual laws of physics, which I presume could be otherwise. A brief defence of this is offered in Chapter 4 and picked up again in Chapter 8.

Second, a note on the logical tools I will be using. I will be using standard classical, first order logic and plural logic. I use an *identity* predicate ('=') and an *is one of* predicate ('≺'), and I make regular use of plural predication and plural quantification. Precisely how I understand these things is outlined in Chapter 3 but, until then, they can be understood in the standard ways, with one exception: I use an identity operator that can express many-one identities (e.g. $xx = y$), which is non-standard. This is because my identity operator is generalised from the one-one identity of classical logic and the many-many identity of plural logic. The details of this generalised identity are found in Chapter 3. Readers will have to grant me this operator until then.

Finally, I understand parthood in the usual way. It is the mereological relation that obeys the three ordering axioms (so called because together they characterise parthood as a partial order). Using '≤' to express parthood, we can state those axioms as follows.

Reflexivity $\forall x(x \leq x)$

Everything is part of itself.

Antisymmetry $\forall x \forall y((x \leq y \,\&\, y \leq x) \rightarrow x = y)$

If two objects are parts of each other, then they are identical.

Transitivity $\forall x \forall y \forall z((x \leq y \,\&\, y \leq z) \rightarrow x \leq z)$

Whenever an entity is part of something, it is part of everything that thing is part of.

There are controversies here. It has been alleged that there are counterexamples to each of these axioms,[6] but I do not join in those debates. Dissent from the standard conception of parthood is still uncommon, and I have plenty to say that does not stand or fall with these axioms, so I am confident that what follows will not be made any less interesting by those controversies.

Now, let's get started.

[6] See Cotnoir and Varzi (forthcoming, Chapter 3) for a rundown of the relevant arguments.

CHAPTER 1:

COMPOSITION AS IDENTITY

I advocate a version of the theory known as *composition as identity* (CAI). This means I claim that the relation which holds between a material object and its parts (taken together) is identity. The purpose of this chapter is to outline that view, as well as to introduce its motivations and its principal objections. I proceed as follows. I begin (in 1.1) by pinning down its core claim. Then (in 1.2), I examine the ontologically flat model of the world it commits us to. Finally (in 1.3) I go over some of the standard reasons for accepting it and (in 1.4) the standard reasons for rejecting it. By the end of this chapter, readers should have a good sense of the view under examination.

1.1 The Core Claim of Composition as Identity

There is no universally agreed-upon definition of CAI and different proponents have added different bells and whistles to the theory. Nevertheless, there is a minimal commitment that all versions share.[7] It is this: for any plurality xx and any individual y, if xx compose y, then xx are (collectively) identical to y. The word 'collectively' is important. Pluralities can have properties collectively or distributively. If a property is possessed distributively, then it is possessed by each individual in the plurality. For example, a plurality of bricks might have the property of *being red all over* and, if it does, then each individual brick in that plurality must

[7] When I say that composition is identity, I am speaking literally. I do not mean that composition is merely analogous to identity. This means I am not considering so-called *weak* versions of CAI. In fact, I think nobody who claims to endorse CAI has ever held that view. Lewis (1991, Chapter 3.6) is the standard example, but Bohn (2011) has convincingly argued against that interpretation of Lewis (see also Bricker (2016, p.282 n.35)). It seems that Lewis did not think composition was analogous to identity; he thought that many-one identity (which composition is) is analogous to one-one identity, and that both are instances of a more general identity relation. That is a common view among advocates of CAI (for example, Cotnoir (2013a), Bricker (2016), Bohn (forthcoming)). As will be revealed in Chapter 3, I agree.

be red all over. In general, colour properties such as *being red all over* are distributive. Alternatively, if a property is possessed collectively, then it is possessed by the plurality taken together but need not be possessed by each individual in the plurality. For example, a plurality of bricks might have the property of having a mass of one tonne, but it does not follow that each individual brick has a mass of one tonne. If the plurality of bricks contains more than one brick, then it cannot be the case that they each have a mass of one tonne. Yet the plurality taken together does. In general, mass properties such as *having a mass of one tonne* are collective.

CAI makes the claim that, for any composite object y, the property of being identical to y is possessed collectively (not distributively!) by the plurality of its parts xx. No single one of the bricks is identical to the house, but all the bricks, taken together, are identical to the house. Using 'C' as a predicate that expresses composition, it is standard to formalise the minimal commitment in the following way:

CAI (minimal commitment): $\forall xx \forall y(xxCy \rightarrow xx = y)$

where the semantics of many-one identity will have to guarantee that the identity relates y to xx collectively. Some authors use this formalisation of the minimal commitment as their definition of CAI.[8] Others state the view in stronger terms, by turning the conditional into a biconditional:[9]

CAI (biconditional formulation): $\forall xx \forall y(xxCy \leftrightarrow xx = y)$

[8] See Sider (2007), Calosi (2018), and Loss (forthcoming).
[9] See Sider (2007 and 2014).

The biconditional formulation says not only that every instance of many things composing one thing is an instance of many-one identity, but also that every instance of many-one identity is an instance of composition. This is more controversial when the variables can range over abstract objects. Do letters *compose* the alphabet? Do subclasses *compose* classes? Affirmative answers to these questions are defensible, but so are negative.[10] Since my attention in this work is restricted to material objects, located in space and time, those controversies can be avoided. In this restricted context, the biconditional formulation is about as controversial as the minimal commitment. Still, I think it is not strong enough.

Like Bohn, I worry that the biconditional formulation leaves open the possibility that composition and many-one identity are different but actually coextensive relations.[11] Hence, Bohn and I claim something stronger: composition is *defined* as many-one identity.

CAI: $xxCy =_{df} xx = y$

I read this definition as an analysis: composition can be analysed in terms of many-one identity.

The differences between the minimal commitment, the biconditional formulation, and CAI (as stated above) will rarely be front and centre of the discussion in this work. This is because all the standard objections are objections to the minimal commitment (and thereby objections to the others, which entail it). This is even true of most of the non-standard objections I consider below.[12] Nevertheless, it matters that I have in mind an analysis of composition. It matters because it represents an answer to van Inwagen's general composition question. I return to this in the final chapter.

[10] For instance, take the case of mereological relations between classes. Lewis (1991) argues that subclasses compose classes. Oliver (1994) argues against Lewis.

[11] Bohn (2014, p.145).

[12] The exception is the argument that identity is symmetric but composition is not, so CAI is false. That argument does not threaten the minimal commitment. I address it in Chapter 3.1.3.

Lurking behind all the formalisations above is a dramatic departure from the way much of modern ontology is conceptualised.

1.2 Leaving the Layered World

Ontological orthodoxy states that the world is structured in a hierarchy of layers or levels. More fundamental entities are on lower layers, and less fundamental ones are above them. Less fundamental entities are built out of more fundamental entities, and maybe there is a bottom layer (perhaps containing the most fundamental particles described by physics) but maybe there is not. Kim calls this conception of metaphysical structure the "layered world",[13] about which he says:

> The Cartesian model […] has been replaced by that of a layered world, a hierarchically stratified structure of 'levels' or 'orders' of entities and their characteristic properties.

The thought goes like this. Elementary particles sit at one level of the structure, and the atoms they come together to build are on the level above them. Above that we find molecules, then cellular life, then complex multicellular beings, then social groups. Each time we move from one level up to the next, we do so by virtue of some entities coming together to build something less fundamental.[14] That particular list of levels was picked out by Putnam and Oppenheim, who saw it as

[13] Kim (1993, p.190).

[14] Unless you are Schaffer (2010b) who reverses the order of the layers but still endorses a layered view.

> a system of reductive *levels* so chosen that a branch with the things of a given level as its universe of discourse will always be a potential micro-reducer of any branch with things of the next higher level (if there is one) as its universe of discourse.[15]

Kim, Putnam, and Oppenheim all suggest that the only way to move from one layer to another is by mereological composition or decomposition, which generates less or more fundamental entities (respectively). Kim writes:

> What gives this array structure is the mereological relation of *being part of*: entities belonging to a given layer are mereologically composed of entities belonging to the lower levels, and this relation generates a hierarchical ordering of levels.[16]

It is more popular, today, to suppose that composition is only one out of a family of relations that generate this layered structure. Bennett identifies composition, constitution, set formation, realization, microbase determination, grounding, and (more controversially) causation as structure-imposing relations that take us from more-fundamental layers to less-fundamental ones.[17] She groups these together in a family she calls "building relations".[18]

It would be hard to overstate how ubiquitous this layered conception of the world is, in contemporary metaphysics. Perhaps the most radical feature of CAI is that it tells a different story, at least with respect to composition. CAI is consistent with there being layers generated by some other building relations, but CAI rejects layering as a result of composition or decomposition.

[15] Oppenheim and Putnam (1958, p.9).
[16] Kim (1993, pp.190-191).
[17] Bennett (2017).
[18] Ibid (p.1).

In fact, since CAI claims that composition is identity, CAI is inconsistent with the layered world conception for composition. This can be seen from the following argument:[19]

(1) Your parts are (collectively) identical to you. (CAI)

(2) Your parts are (collectively) more fundamental than you. (Layered world)

(3) Therefore, you are more fundamental than you. (by substitution of identicals)

The argument is valid but, since nothing can be more fundamental than itself, (3) is false.[20] This means the premises cannot be true together. But this is not a concern for CAI advocates, since many of us are motivated by a different conception of metaphysical structure. We argue that composition does not produce layers in the world. Instead of the layering metaphor, we opt for a counting or carving metaphor. Frege offers some helpful comments:

> While looking at one and the same external phenomenon, I can say with equal truth both 'It is a copse' and 'It is five trees,' or both 'Here are four companies' and 'Here are 500 men.'[21]

And:

> [I]f I place a pile of playing cards in [someone's] hands with the words: Find the Number of these, this does not tell him whether I wish to know the number of cards, or of complete packs

[19] This argument is modified from Bailey (2011).

[20] Although, we could read Loss (forthcoming) and Sider (2014) as attempting to make CAI and the layered world consistent by blocking the substitution in this argument (rendering it invalid). I worry that their responses to this argument, such as restricting plural comprehension, throw the baby out with the bathwater because they appear to make it impossible to express the sentiments expressed in the Frege quotations below, which express some of the most common motivations for CAI. See Chapter 6 for more discussion.

[21] Frege (1884, p.46).

> of cards, or even say of honour cards at skat. To have given him the pile in his hands is not yet to have given him completely the object he is to investigate; I must add some further word – cards, or packs, or honours.[22]

Frege noticed that any single portion of reality can be carved up according to different concepts and that carving according to different concepts will result in different things being counted there.[23, 24] I can look at a portion of reality and carve according to the concept *copse*. If I do so, I will find that there is one thing there. Alternatively, I can carve that same portion of reality according to the concept *tree* and I will find many things. CAI takes this observation and runs with it.

According to CAI's carving conception, reality is flat (at least with respect to composition – as said above, other building relations might generate layers) and portions of that flat reality can be carved up according to different concepts. Composition occurs when one portion of reality is one object under one concept and many objects under another. For example, since the *copse* concept carves a portion of reality into one object, and the *trees* concept carves into several, we can determine that the trees compose the copse. Neither is more or less fundamental than the other; they are just different ways of carving up the world. This difference in the basic conception of the world makes a world of difference, and it is important to keep it in mind in the following chapters.

Furthermore, we are free to be as realist or anti-realist about all of this as we like. We could think that reality has joints that good concepts will carve along, and that bad concepts will carve across. Or we could think that the concepts, and the structure they correspond to, are

[22] Ibid (pp.28-29).

[23] I have used the verb 'carve' because it coheres nicely with the metaphor of carving reality at its joints. Other verbs, such as 'count' or 'cut', have been used in the literature. I consider them all synonymous.

[24] In Chapter 3, I will use properties to play the role of Fregean concepts.

all ultimately mind dependent. I leave that choice to the reader, though I will speak in realist terms.

Of course, this picture opens CAI up to new objections. One could argue that it is surprising and unlikely that one building relation (composition) should turn out to be flat, while the others generate layers. Perhaps that is true, but it cuts both ways: I take it as evidence that other building relations are flat. I think there are good independent reasons to think that constitution, for example, is identity, and this objection adds to my conviction that it should be so. Unfortunately, concerns such as these are beyond the scope of this thesis. Back to composition.

1.3 Motivations for CAI

1.3.1 The Ontological Commitment Puzzle

When we want to choose between multiple metaphysical theories that offer mutually exclusive explanations for the same phenomena, it helps to consider the theoretical virtues of those theories. If a theory possesses more theoretical virtues than its rivals, that is a reason to endorse it.

Kuhn was among the first to attempt to systematise theoretical virtues, and he identified five: accuracy, consistency, scope, simplicity, and fruitfulness.[25] But the idea of weighing such virtues to choose among competing theories goes back much further than Kuhn. Aristotle's principle of noncontradiction required theories to be consistent,[26] and his claim that "We may suppose that, other circumstances being similar, the demonstration which proceeds from fewer postulates, hypotheses, or premises is superior"[27] is a clear injunction to favour simpler

[25] Kuhn (1977, p.320-321).
[26] Aristotle (*Metaphysics*, Book IV, 3-6, particularly 1005b, 19-30).
[27] Aristotle (*Posterior Analytics*, Book I, Chapter 25).

theories. But simplicity can be measured by many metrics. The notion of simplicity captured by Occam's Razor is perhaps most well-known; it claims that one ought not to multiply entities beyond necessity. This treats simplicity as a function of how many kinds of entities a theory commits to. The fewer the simpler. This kind of simplicity is also called ontological parsimony and it drives many philosophical arguments. When deciding between two theories, if all other things are equal, the theory with fewer ontological commitments (the one that is more ontologically parsimonious) should be endorsed.

Given this background, we can wonder about the nature of composition. Some theories claim that wholes are something additional, over and above their parts. If you start with some bricks, and you put them together to make a house, you have an extra, new entity. Any list of all the things in the universe would be incomplete if it did not list the bricks *and* the house. But a theory that could say the opposite – that wholes are not any extra commitment, over and above their parts – would be more ontologically parsimonious. So, can it be done? Can we reasonably claim that wholes are nothing over and above their parts? That is the first puzzle.

If composition is identity, then composition comes with no ontological commitments at all because identity comes with no ontological commitments. Committing to the existence of George Orwell is no extra ontological commitment, if you already commit to the existence of Eric Blair, because they are the same person. If we were to draw up an inventory of all that exists, we would not need to list Eric Blair and George Orwell separately – that would be double counting. CAI says the same is true of parts and wholes; if you have already countenanced the parts, then the whole is no extra commitment (and vice versa). In general, it is no ontological cost to commit to entities that are identical with those you are already committed to. For that reason, CAI is more ontologically parsimonious than many of its rivals, which is a motivation to endorse it.

CAI is also a unifying theory. In much the same way that the separate domains of electricity and magnetism were unified by the discovery of electromagnetism, leading to a more elegant theory, CAI offers elegance by bringing together the previously separate domains of composition and identity. Insofar as more unified theories are also simpler and more elegant, this is another virtue for CAI. The theory I advocate in Chapter 3 takes this a step further. In much the same way that the separate domains of electromagnetism and the weak nuclear force experienced further unification in electro weak theory, super-CAI offers further unification by bringing together the previously distinct domains of CAI and location.

1.3.2 The Colocation Puzzle

Can two distinct objects have the same location? There is a substantial lineage of negative answers to that question. For example, Locke:

> For we never finding nor conceiving it possible, that two things of the same kind should exist at the same place at the same time, we rightly conclude that anything that exists anywhere at any time, excludes all of the same kind, and is there itself alone.[28]

The tide of philosophical orthodoxy has moved back and forth on this matter. The possibility of co-located objects became popular after Wiggins used co-location as a solution to the problem of material constitution,[29] but arguments from microphysical supervenience were successful in pushing back and making co-location appear implausible once again.[30] Interest in supervenience has waned in recent years, and the possibility of co-location is discussed more and more. Yet whatever the general rule is about co-location (I discuss co-location at length in

[28] Locke (*An Essay Concerning Human Understanding*, Bk. 2, Ch. 27, §1).
[29] Wiggins (1968) and (1980).
[30] Burke (1992, 1994), Heller (1990, Chapter 2), van Inwagen (1990, pp.126-127), and Zimmerman (1995).

Chapter 5), the specific case of wholes and their parts seem to be unusual. Perhaps an exception. Quinton explicitly notes this when denying the possibility of co-located objects:

> This type of solidity may be called impenetrability and it is […] the property that every material thing possesses of excluding every other material thing from simultaneous occupancy of the region of space where it is to be found. The concept of logical solidity or impenetrability is implicitly defined by the principle that no two things can be in the same place at the same time *unless one is part of the other*.[31]

I cannot occupy any region you occupy because you crowd me out of that space. Yet the many bricks that compose the house can share location with it. How is that? Why does the house not crowd the bricks out of that location, or vice-versa?

If CAI is true, then there is no mystery in parts and wholes sharing the same locations. I cannot occupy the region that you occupy because you are there. You crowd me out of that space. But I can occupy the space that *I* occupy – and since my parts are collectively identical to me, their ability to share the same space as me is just that fact restated. Mystery solved.

Sider and Cameron have both expressed concerns about this explanation.[32] They worry that it is not the whole story, and that there are more facts about the colocation of parts and wholes that require explanation. In particular, they want to know how it is that a part of you can occupy a location that you take up. Here is Cameron:

> [H]ow can one of my parts occupy an area that I pervade: I take up a greater space, a fortiori I completely take up *that* space, so how can my part which is distinct from me also fit in there? Composition being identity doesn't help until – as above – we make an assumption about the

[31] Quinton (1964, pp.341-42) emphasis my own.
[32] Sider (2007, p.79) and Cameron (2014).

> properties that pluralities of things collectively have and how this relates to the properties each of the things that are amongst that plurality singularly have.[33]

I do not find this a compelling complaint about CAI. For any object x, and any one of its parts y, this is a complaint that CAI does not explain some facts about the relationship between x and y. But that relationship is called *parthood*, not composition. Composition is certainly a similar relation to parthood, and we should certainly expect similarity in our approaches to the two relations, but we should also not be surprised that the core commitment of CAI does not settle some facts about parthood, all by itself. Parthood is not identity. However, Sider and Cameron's worry does point to a real puzzle, and more can be said about it. Recall that CAI accepts the carving conception of mereological structure, according to which, parts and wholes are just different ways of carving up the same portion of reality. Given this view of parthood, it is no surprise that you will never find a part of some object x at a portion of reality where x is not. The layered world view, with its associated building conception of parthood, struggles to explain this because it thinks of part and whole as somehow distinct things, on different layers of existence, sharing some location. But that is not the reality; parts and wholes are the same portions of reality, carved according to different concepts, so it is no wonder that they are found in the same locations. This mystery is only a mystery at all if you have the wrong conception of metaphysical structure.

[33] Ibid (p.98).

1.3.3 The Overdetermination Puzzle

The causal exclusion problem is a cornerstone of philosophy of mind. First articulated by Malcolm,[34] and refined and popularised by Kim,[35] it asks us to consider a consequence of accepting the following plausible theses:

- Supervenience of the mental on the physical (there can be no change in the mental without a change in the physical)
- Causal completeness of the physical (all physical effects have sufficient physical causes)
- No overdetermination (no effect is determined by multiple sufficient causes)

Together, these three propositions generate the conclusion that, if the mental is something distinct from the physical, there is simply no room for the mental to cause any physical effects. The mental decision I made to fix myself some dinner was not the cause of my body's moving to the kitchen and preparing food. Instead, the various physical brain events that make up the supervenience base for the mental event of my decision-making were a sufficient cause, and there cannot be multiple sufficient causes.

Merricks has applied this problem to physical objects, offering the following argument which he calls 'the Overdetermination Argument'.

> (1) The baseball—if it exists—is causally irrelevant to whether its constituent atoms, acting in concert, cause the shattering of the window.
>
> (2) The shattering of the window is caused by those atoms, acting in concert.
>
> (3) The shattering of the window is not overdetermined.
>
> Therefore,

[34] Malcolm (1968).
[35] Kim (1989) and (1993).

(4) If the baseball exists, it does not cause the shattering of the window.[36]

Since the baseball has no causal powers, it is a mere epiphenomenon at most. Merricks argues that the baseball does not exist "because baseballs would be at best causally redundant, [so] none of our ordinary reasons for believing in them are any good."[37] What is worse, this problem generalises to all composite objects. Therefore, if we believe there can be no overdetermination, there is compelling reason to think that composite objects do not exist.

Not everyone believes there can be no overdetermination. Some, like Merricks, think it is always objectionable to posit multiple sufficient causes for an effect. Others, like Sider and Yablo, accept some cases of overdetermination.[38] Mills argues we must accept overdetermination in the case of mind/body interaction.[39] But, since CAI offers an easy response to Merricks' argument, there is no need to adjudicate that debate here.

CAI's permits us to reject premise (1) of Merricks' argument. The baseball is *not* "causally irrelevant to whether its constituent atoms, acting in concert [which is to say, taken together], cause the shattering of the window" because the baseball *just is* the atoms in concert. In general, parts and wholes do not compete for causal efficacy because parts are (collectively) identical to the wholes they compose. So CAI gives us a way to accept the existence of composite objects in the face of worries about overdetermination. That is another motivation for CAI.

[36] Merricks (2001, p.56).
[37] Ibid (p.78).
[38] Sider (2003) and Yablo (2002).
[39] Mills (1996).

1.3.4 The Location Puzzle

Hume held that "There is no object, which implies the existence of any other if we consider these objects in themselves."[40] This has come to be known as Hume's Dictum, and it has wide-ranging support. Modern interpretations render it as a claim about modal connection, stating (roughly) that there are no necessary connections between distinct, contingent entities. Wilson has pointed to a diverse array of arguments that feature Hume's Dictum as an important premise, including (but not limited to) arguments against states of affairs, in favour of physicalism, and in favour of four-dimensionalism.[41] The most notable application is probably a family of principles called *recombination principles*, which use Hume's Dictum as a guide to possibility. Recombination principles were given shape in Armstrong's and Lewis's theories of modality,[42] the former of which in particular has its roots in Russell and Wittgenstein.[43] Lewis offers the following gloss of his principle of recombination:

> Roughly speaking, the principle is that anything can coexist with anything else, at least provided they occupy distinct spatiotemporal positions. Likewise, anything can fail to coexist with anything else.[44]

Schaffer makes this more precise by defining a notion of modal freedom which he then uses to define recombination.[45]

> Modal freedom: For any plurality of objects xx, xx are modally free iff for any ways that any objects among xx can be, there is a possible world at which they are respectively those ways.

[40] Hume (*A Treatise of Human Nature*, Book I, Part III, §VI).
[41] Wilson (2010) and (2015).
[42] Armstrong (1989) and Lewis (1986).
[43] Russell (1940) and Wittgenstein (1961).
[44] Lewis (1986, p.88).
[45] Schaffer (2010a).

Where 'way that x can be' is understood as all the intrinsic properties x can have, all the locations x can have, and the one way it can fail to be (i.e. to not exist). As an example, consider the plurality xx, which contains just x and y, such that each has all its properties (including location) essentially except colour properties, and each can be either red or blue. xx is modally free iff there is a world for each of the following ways x and y could be:

w_1:	x is red, y is red	w_5:	x is red, y does not exist
w_2:	x is red, y is blue	w_6:	x is blue, y does not exist
w_3:	x is blue, y is red	w_7:	x does not exist, y is red
w_4:	x is blue, y is blue	w_8:	x does not exist, y is blue

A principle of recombination for material objects can now be stated as:

> Recombination$_m$: For any plurality xx such that every one of xx occupies distinct spatiotemporal positions, xx is modally free.

Principles like these are called *recombination* principles because they permit us to freely recombine the various objects and their properties in any way. Except, notice that Lewis was careful to specify the objects we are recombining "occupy distinct spatiotemporal positions".[46] This prohibits recombinations involving parts and wholes.[47] For example:

[46] Lewis (1986, p.88).

[47] Some, such as Wang (2019, p.4), have omitted the "distinct spatiotemporal positions" requirement, but have instead restricted recombination to all the fundamental material objects.

> Recombination$_m$*: The fundamental objects are modally free.

(i) We cannot recombine the location of a whole and the collective location of its parts, resulting in wholes being somewhere other than where their parts collectively are.

(ii) We cannot recombine the location of a whole and the location of one of its parts, resulting in a whole having a part somewhere other than where it is.

It seems correct to restrict recombination in this way, but why on earth should this be? What explains these failures of an otherwise very general principle? This is the fourth puzzle.

CAI explains failures of type (i) easily. The parts are (collectively) identical to the whole so, of course, in general, we cannot recombine any properties that the parts have collectively with properties of the whole. (i) presents a specific case of that general rule. Wholes cannot be somewhere other than where their parts (collectively) are because, for any x, x cannot be where x is not. It is trivial.

Cameron has argued that CAI does not explain failures of type (ii), saying:

> It might follow trivially from composition as identity that the location of me is the same as the collective location of my parts: but what explains the relationship between where the parts are collectively and where each part is? [48]

Notice that, just like Sider and Cameron's worry about the colocation puzzle, Cameron is now worried that the core claim of CAI (which is about the composition relation) does not explain a feature of the parthood relation. It is not clear that we should worry about this, since

For most conceptions of parthood, this has the same effect (i.e. prohibiting recombinations involving parts and wholes) because no composite objects are fundamental (unless you're Schaffer (2010b), in which case no proper parts are fundamental). However, given the complexity of these issues, this alternative formulation would be too much of a diversion to examine now. Instead, I merely gesture at it as I pass it by.

[48] Cameron (2014, p.97).

composition and parthood are not the same relation. However, I do have an answer for Cameron.

Since failures of type (ii) are features of the parthood relation, our theory of parthood will affect what we can say about these failures. In Chapter 3, I prove that my version of CAI entails the Subregion Theory of Parthood which provides explanation for failures of type (ii). Consider this a promissory note.

At this stage, we have good reason to be excited about CAI's prospects. Its ability to solve these puzzles about composition makes it a compelling theory, worth studying. But CAI does raise some new puzzles of its own. Desire to solve these new puzzles has motivated various additions to CAI's core claim. My own additions are outlined in Chapter 3 and compared with other authors' additions, in Chapter 6. But before we reach this chapter's close, it will be useful to examine a sample of these new puzzles for CAI. The following four puzzles, were chosen because they give us some desiderata for a successful CAI theory and they motivate some assumptions that will play a role in the following chapters.

1.4 New Puzzles for CAI

1.4.1 The Logical Puzzle

Neither the '=' of classical logic nor the '=' of plural logic permit a singular term on one side and a plural term on the other, so logical expressions such as '$xx = y$' are not well formed. This problem is easily solved with the introduction of a many-one identity operator '=', that can accept a mix of singular and plural arguments. The introduction of this operator is often motivated by appealing to a more general notion of identity, of which one-one, many-many, many-one, and one-many are all instances.[49] (Or, less commonly, this problem is also solved

[49] See Lewis (1991), Bohn (2009a), Cotnoir (2013a), and Bricker (2016).

by merely stipulating a hybrid identity predicate to be used in conjunction with the classical singular identity and the identity of plural logic[50]).[51] I talk more about this in Chapter 3. However, the related semantic puzzle is not so easily solved.

1.4.2 The Semantic Puzzle

Being able to express many-one identities is one thing, but it is also important to know what they mean – that is, what they claim about the things they denote. If we cannot make sense of the idea of some many being identical to some one, as some have said we cannot,[52] then CAI is doomed to fail. It is incumbent on the advocates of CAI to show that we can. I will say no more about this puzzle here because it is the focus of most of Chapter 3. I merely flag it as something to keep in mind as we continue.

1.4.3 The Essentialism Puzzle

Whatever the relation between parts and wholes is, it is clearly an intimate one. The puzzles examined in Section 1.3 demonstrate that parts and wholes do not compete for causal efficacy, they do not crowd each other out of space, and they cannot be recombined in some important ways. Although CAI tells us why and how this is the case, many have worried that it does so by making the relation between them *too* intimate.[53]

Mereological essentialism is the view that objects have their parts essentially. Chisholm gave this view its name and claimed Abelard, Leibniz, Moore, and himself among its advocates.[54] Despite those acclaimed adherents, mereological essentialism is unpopular enough today that it is sometimes used as a *reductio*: if your theory can be shown to lead to

[50] Wallace (2011b, p.819).

[51] There is a similar challenge for ordinary language, which I will not explore here. I take it the problem for ordinary language is both poorly motivated and straightforwardly solved. For discussion, see Cotnoir (2013a).

[52] For example, van Inwagen (1994, particularly p.210), Yi (1999), and Lipman (forthcoming).

[53] For example, Lewis (1991), Merricks (1999), and Cameron (2014).

[54] Chisholm (1973). See also Chisholm (1975, 1976).

mereological essentialism, then your theory is surely false.[55] I will not pass judgment on whether mereological essentialism should be viewed so harshly, but I will argue that CAI does not lead to it.

Van Cleve noticed that mereological essentialist claims can be given temporal or modal formulations.[56] CAI's method of escape from the temporal formulations will be different from its method of escape from the modal formulations, so it is important to list both. Here are six mereological essentialist claims CAI might appear committed to, for any parts xx and any whole y, such that y is composed of xx:

Temporal

(1_t) y ceases to exist if any of xx cease to exist

(2_t) y cannot lose or change parts

(3_t) Breaking up and scattering xx does not destroy y

Modal

(1_m) at every world where y exists, every one of xx exists

(2_m) y could not exist with parts other than the ones it has (all and only xx)

(3_m) xx cannot exist without y; any world containing xx contains y also

Every one of these claims seems like a wrong result. Regarding the temporal formulations: plausibly, amputation is not murder, even if the amputated limb is destroyed (contrary to (1_t)), your car really can have its tyres changed (contrary to (2_t)), and explosions really do destroy things (contrary to (3_t)). Regarding the modal formulations: plausibly, I could have been born

[55] For example, Merricks (1999).
[56] Van Cleve (1986).

with one fewer skin cell (contrary to (1_m)), different bricks could have been used to build my house (contrary to (2_m)), and if the bricks that currently form my house were never arranged into my house, the parts could have existed without the whole (contrary to (3_m)). CAI theories need to say something about these issues.

Start with the temporal formulations. The standard response is to embrace *perdurantism*,[57] which is the view that objects persist through time by being four-dimensional fusions of temporal parts.[58] To see how this works, consider the stool depicted in Figure 1.1, below.

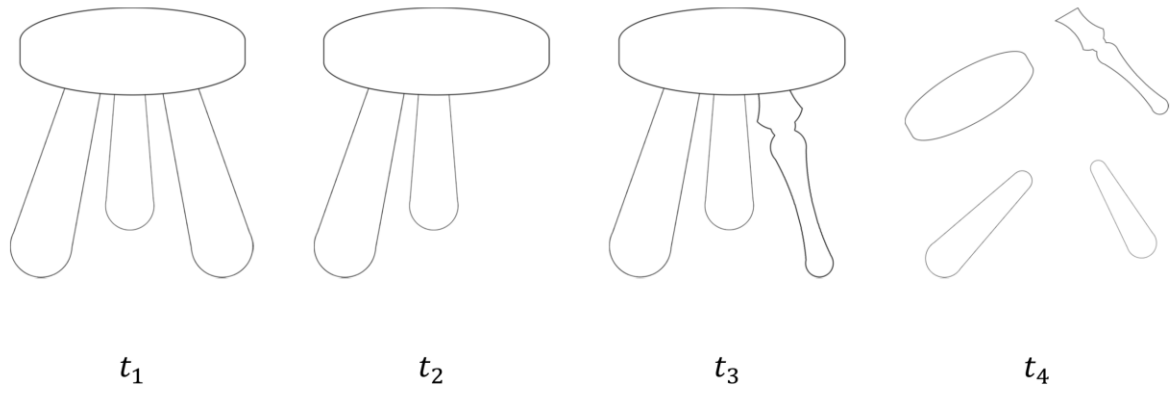

Figure 1.1

At time t_1, the stool has a temporal part composed of three legs and a top. At time t_2, one of the legs has been destroyed, so the stool's temporal part at this time is composed of just two legs and a top. At t_3, the missing leg is replaced so the stool's temporal part at this time is composed of three legs and a top. Finally, at t_4, the parts of the stool are scattered to the four

[57] See Bohn (2009a, p.viii) and Wallace (2011b, pp.822-823).

[58] Temporal parts are usually understood the way Sider (2001, pp.53-62) defined them: x is a temporal part of y at time $t =_{df}$ (1) x exists at, but only at, t; (2) x is a part of y at t; and (3) x overlaps everything that is part of y at t.

winds and common-sense tells us that the stool therefore does not have a temporal part at this time, despite its top and (some of) its legs having temporal parts here.[59]

By identifying the stool with the four-dimensional fusion of the temporal parts at t_1, t_2, and t_3 (but not t_4!), the perdurantist can avoid all the temporal mereological essentialist claims above. (1_t) is avoided because the stool has a temporal part at t_2 and thus continues to exist at that time, despite one of its legs being destroyed. (2_t) is avoided because the stool has a temporal part at t_2 and a temporal part at t_3 despite losing a part at the former and gaining a new one (thereby completing a change of parts) at the latter. And (3_t) is avoided because the stool has no temporal part at t_4 precisely because the top and the legs have been broken apart and scattered.[60] This is the standard perdurantist account of persistence. CAI does not change this account; it only adds the claim that the whole four-dimensional fusion is (collectively) identical to its temporal parts.

Perdurantism is the orthodox response to (temporal) mereological essentialism, but it is not the only possible response. An alternative solution that has not yet been marshalled in defence of CAI is called *Pardurantism* (after Parsons, who first described it[61]). On that view, objects are four-dimensional but have no temporal parts. They are simple objects that undergo change by having distributive properties. Pardurantism thus requires the existence of heterogeneous extended simples and is controversial.[62] Over the course of this work, I will point to Pardurantism several times, saying when it is an available alternative to perdurantism.

[59] None of the temporal parts is identical to any other. But this is not surprising; after all, none of your spatial parts is identical to any other.

[60] Although, if one endorses *universalism* (which is a view we will meet later), then one will say there *is* an object composed of the three legs and the top at t_4 – but that object just is not part of the stool.

[61] Parsons (2000). Effingham (2012) gave it the name 'Pardurantism'. It has also been called *terdurantism* (Miller, 2009) and *transdurantism* (Daniels, 2014).

[62] See Spencer (2010). Also, see McDaniel (2004, Chapter 3), and Nolan (2014) for discussion of this kind of extended simple.

However, since the view is uncommon and I have plenty of other things to be getting on with, I will not be discussing Pardurantism in much detail.

Now, the modal formulations. It is common to claim that identity is a relation that holds necessarily. If so, then CAI claims that composition holds necessarily: if xx compose y, then necessarily xx compose y. This produces some *prima facie* commitments to mereological essentialism. Two responses are notable, in the CAI literature. One comes from Wallace, who supplements CAI with a theory of modal parts.[63] On her theory, objects are not only extended in space and time; they are also extended across worlds by virtue of having modal parts that are analogous to spatial and temporal parts. In Wallace's words, "ordinary objects are trans-spatio-temporal-world sums of spatial, temporal, and world (or modal) parts".[64] I argue against this view in Chapter 6, so I will not say more about it here. Instead, I opt for the second response to the modal formulations: an Abelardian approach, specifically counterpart theory.[65] Counterpart theory denies that there are transworld identities and denies the necessity of identity. Instead, counterpart theory gives objects counterparts in other possible worlds. These counterparts represent possibilities for actual objects and are picked out by their resemblance to actual objects. In response to (1_m) and (2_m), we can say that y could have existed with different parts, because there is some world where something is sufficiently similar to y and has parts that are not sufficiently similar to xx. In response to (3_m), we can say that xx can exist without y because there is some world where there are things sufficiently similar to each of the xs, but nothing sufficiently similar to y (perhaps because xx is scattered at that world).

[63] Wallace (2011b pp.824-825, 2014, forthcoming).

[64] Wallace (2011b pp.824, 2014).

[65] See Lewis (1973, pp.39-43) for more on counterpart theory. See Bohn (2009a, p.viii) for a representative example of this response to modal essentialist problems. Though, note that I have not exhausted the possible solutions here. In fact, any interpretation of modal predicates as Abelardian will do the same job as counterpart theory. See Noonan (1991, p.190), or Sider (2001, p.112) for more on this. This is true wherever I make use of counterpart theory.

In Chapter 2, we will see that supersubstantivalism also motivates us to adopt a four-dimensionalist view of objects (such as perdurantism or Pardurantism) and counterpart theory. Thus, CAI and supersubstantivalism share commitments. This will be a common theme in what follows and is one strong motivation for unifying the two views.

1.4.4 The Indiscernibility Puzzle

Downstream of the requirement to provide a semantics for many-one identities, is the requirement to say something about *the Indiscernibility of Identicals*, which is a principle that characterises identity. It states:

Indiscernibility of Identicals (one-one): $\forall x\, \forall y\, (x = y \rightarrow \forall P(Px \leftrightarrow Py)$

For any x and any y, if x and y are identical, then for any property P, x is P if and only if y is P. This law is typically taken to be characteristic of identity, and I will not be bucking that trend. So, given that CAI alleges identities between wholes and their parts (collectively), counterexamples to CAI can be found wherever there is a property possessed by a whole but not its parts (collectively), or vice versa. Some alleged counterexamples can be dealt with quite straightforwardly, whereas others require a more involved response. In this section, I discuss three alleged counterexamples and offer straightforward responses to each. I pick up the subject of indiscernibility objections again in Chapter 3, where I give a more involved response that will work more generally. The alleged counterexamples I examine here pertain to cardinality properties, temporal properties, and modal properties.

First, cardinality properties. My house seems not to share all properties with the bricks that compose it because the bricks collectively are many, while the house is one. Since the parts

collectively have a property the whole does not have, the parts cannot be collectively identical to the whole.

In response to these kinds of arguments, CAI theorists tend to utilise the Fregean idea that there are different (equally fundamental) ways to carve up the world. Using this idea, CAI theorists claim that cardinality properties can be relativized to different ways of carving. A portion of reality might have a cardinality of one, when it is carved using a concept that corresponds to a single whole, and that same portion of reality might have a cardinality of more than one, when it is carved using a concept that corresponds to many parts. It only makes sense to say that a portion of reality has a particular cardinality if we have picked a way to carve it up. This cardinality relativization is a feature of the view I propose in Chapter 3 and I say a lot more about it there.

Next, temporal properties. The parts of the stool are broken up and scattered; the stool is destroyed, but its parts are not. So the stool exists for less time than its parts. It is therefore discernible from its parts and not identical to them. What can advocates of CAI say in this case?

The standard reply in cases like this involves temporal parts, again. Let us return to Figure 1.1, reproduced below for ease of reference.

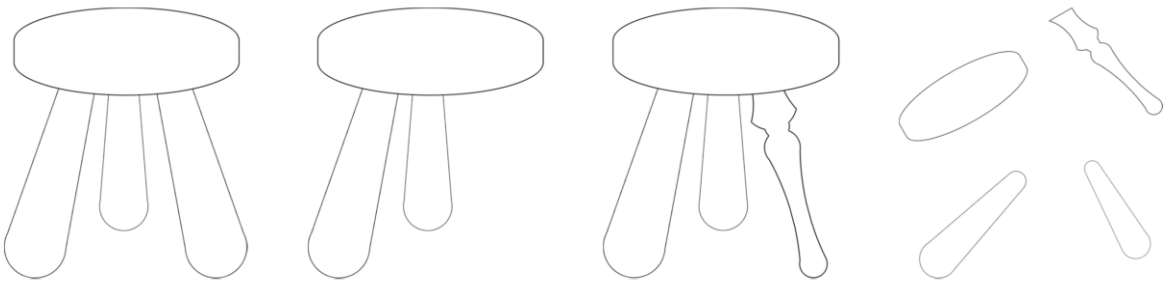

Figure 1.1 (reproduced)

Consider just the top of the stool. The top persists from t_1 to t_4 by having a temporal part at each of those times. But, importantly, no temporal part of the top is identical to any other temporal part of the top – just as none of your spatial parts is identical to any other – so we can simply say that, although the top does have a temporal part at t_4, *that* temporal part is not part of the stool (although the temporal parts of the top at t_1, t_2, and t_3 are). *Mutatis mutandis* for the legs. This blocks the temporal indiscernibility argument by letting us say that the stool does not exist at t_4 *and nor do any of its parts*.[66]

Finally, modal properties. The parts of the stool could survive being scattered across the universe, whereas the stool could not. The stool and its parts therefore have different modal properties, which makes them discernible and therefore not identical. So it goes for any composite object whatsoever. This argument does not rely on incorrectly identifying the parts of the stool (as the temporal indiscernibility argument did); it works if we consider the temporal part of the top at t_1 and the temporal parts of the legs at t_1, for example. They could all have existed at very different, disparate locations but, if they did, the stool would not exist.

In response to these kinds of arguments, we can follow Sider.[67] He provides us with the following argument. Given counterpart theory, the claim that the bricks of the house could survive scattering is the claim that the bricks (which are identical with the house) have *brick counterparts* that survive scattering, and the claim that the house could not survive scattering is the claim that the house (which is identical with the bricks) has no *house counterparts* that survive scattering. All of that is consistent with the bricks being collectively identical with the house. In fact, Sider observes that the apparent modal differences between parts (collectively) and wholes are "due in some way to a shift in our conceptualization of a single object, rather

[66] This response is modified from Wallace (2011b, p.823).
[67] Sider (2001, p.113).

than a difference between two objects". This is very much in keeping with the carving conception of metaphysical structure.

The reason that indiscernibility arguments often use cardinality, temporal, and modal properties is that arguments using these properties respect the distinction between collective and distributive predication. Any indiscernibility argument that does not respect this distinction is a non-starter. To illustrate, imagine a square composed of two triangles. One could try to argue that the square has a property (the property of *being square*) that the triangles do not (since they are each triangles), but the triangles *taken together* clearly are square. CAI advocates agree that the triangles are not square on a distributive reading of the plural predicate expressed by 'are square', but the triangles are square on a collective reading. Cardinality, temporal, and modal properties are used in indiscernibility objections to CAI because they appear to be possessed by the whole and not by its parts, *collectively*. In principle, the same objection to CAI can be made with any other properties that fit this bill, so it is not enough to just reply to the three most common versions of the argument, as I have done above. It will be useful to have a generalised response to these indiscernibility puzzles – one that can be applied to any and all properties whatsoever. I offer such a response in Chapter 3.

Another complication comes from the fact that, given that CAI is expressed using many-one identity, and the indiscernibility of identicals is expressed using the classical one-one or plural many-many identities, these puzzles do not straightforwardly threaten CAI. Nevertheless, given that all advocates of CAI need to generalise identity, they will also need to generalise the indiscernibility of identicals – or else they will raise concerns that they are not really talking about identity.[68] The puzzle, therefore, requires showing that the indiscernibility of identicals can be generalised to apply to the generalised many-one identities in a way that does not result in cardinality, temporal, and modal properties causing problems for CAI. It is

[68] Sider (2007, p.57).

important to say something about this puzzle because, as Bohn has noted, it forms the basis of the most common objections to CAI.[69] In Chapter 3, I give a thorough response to this problem based on my own version of CAI, including a generalisation of the Indiscernibility of Identicals.

1.5 Summary

CAI's core claim is that, for any plurality xx and any individual y, if xx compose y, then xx are (collectively) identical to y. To make sense of this, we must leave the layered world model behind and embrace the metaphor of carving. Once we do this, CAI has been shown to solve some significant problems facing any answer to the general composition question and, for this reason, it is a well-motivated theory, worth taking seriously. But CAI has some problems of its own, which need to be addressed. Four such problems were considered:

- The logic of many-one identity
- The semantics of many-one identity
- Mereological essentialism
- The indiscernibility of identicals

Responding to these revealed that there is good reason to pair CAI with four-dimensionalism and counterpart theory. Both are assumptions of this thesis, going forward. We also saw some common objections to CAI, which my theory must resolve, or else it will never make it out of the gate. I have promised to return to those with more detail in Chapter 3.

[69] Bohn (forthcoming, p.4).

Now that the basics of composition as identity are covered, the next step is to unpack the view that location is identity – also known as *supersubstantivalism*. Once that view and CAI are both are on the table, they can be combined.

CHAPTER 2:

SUPERSUBSTANTIVALISM

In my view, the best way to believe that composition is identity involves believing that location is also identity. The view that location is identity is called *supersubstantivalism*. This chapter gets supersubstantivalism onto the table and under a microscope. The first three sections are devoted to the core claim of supersubstantivalism: I introduce the core claim (in 2.1) and its motivations (in 2.2), then I discuss its commitments (in 2.3). The final two sections add to the core claim. I argue for a version of supersubstantivalism that I call *restricted supersubstantivalism* (in 2.4) and against the orthodox view that supersubstantivalism entails various mereological harmony principles (in 2.5). By the end of this chapter, readers should be well acquainted with supersubstantivalism and prepared for Chapter 3, wherein I combine it with CAI.

2.1 What is Supersubstantivalism?

Newton and Leibniz famously disagreed about the nature of space.[70] Newton argued that space is an independent substance, in which objects are located, and is not reducible to anything more fundamental. His view is called substantivalism.[71] Leibniz argued that space is reducible to relations between objects. His view is called relationism. Their debate rages on, though the views have evolved considerably to keep up with advances in physics.

Modern substantivalists have learned from special relativity that Newton's conception of space, as a three-dimensional, enduring substance is untenable. Instead space and time are unified into *spacetime*, which substantivalism claims is an independent substance that is not

[70] See Huggett (2000, Chapters 7 and 8) for discussion.

[71] Although, see Skow (2005, pp.64-67) for the ways that Newton flirted with supersubstantivalism.

reducible to something/s more fundamental. In what follows, I take it for granted that relativity has rendered futile any attempts to keep space and time truly separate.

It is common to report that those who are best acquainted with the relevant physics inform us that modern physics has given the advantage to substantivalism.[72] According to Schaffer, the advantage is so great that substantivalism has become "the consensus view among philosophers of physics".[73] Schaffer cites the following reasons, given by Earman:[74]

- "[T]he need to support the structures that define absolute motion,"
- "[T]he need to support fields,"
- "[T]he need to ground the left/right distinction when parity conservation fails."

This evaluation of the relevant science is not entirely uncontroversial but I will not be unpacking or appraising it here. I take substantivalism for granted, too. This means my view stands or falls with arguments made elsewhere, but that kind of philosophical division of labour is not uncommon. Hence, I merely mark this is a place where those who disagree with me might find grist for their mills.

Supersubstantivalism is a version of substantivalism. It notices that substantivalism is neutral with respect to what material objects are and it posits that material objects are not a second sort of substance. There is only one substance: spacetime. Schaffer states this in slogan form as:

> When God makes the world, she need only create spacetime. Then she can pin the fundamental properties directly to spacetime.[75]

[72] See Field (1989, p.181), Maudlin (1993), and Pooley (2013).
[73] Schaffer (2009, p.132).
[74] Earman (1989, p.173).
[75] Schaffer (2009, p.133).

Supersubstantivalism is compatible with several different views about what objects are. We might be eliminativist about objects, saying that material objects do not exist at all.[76] Or we might hold the *constitution view* which claims that material objects are constituted by, but not identical with, regions of spacetime.[77] Alternatively, we could hold the *composition view*, which says that material objects are composed of, but not identical to, regions of spacetime.[78] Or we might hold the *identity view* which claims that material objects are identical with regions of spacetime.

The identity view is most popular, and I join the ranks of those who endorse it. It has been suggested that the view goes back to Spinoza and Descartes.[79] More recent advocates include Lewis,[80] Sider,[81] Schaffer,[82] and Morganti.[83] The identity view could also be called 'location as identity' because it claims that being exactly located at a region is the same thing as being identical to that region. If we opted instead for the constitution view, we might call it 'location as constitution'. However, the literature on this subject has tended (with exceptions) to use the term 'supersubstantivalism' to refer only to the identity view, instead of the more precise phrase 'location as identity', despite the fact that the other views are equally supersubstantival. I will also refer to the identity view as 'supersubstantivalism' and I will be explicit whenever I mean anything else. If readers are interested in non-identity forms of supersubstantivalism, I leave it to them to decide which of my arguments may cross-pollinate.

[76] For example, Arntzenius (2012).
[77] For example, Hawthorne (2006) and Gilmore (2014).
[78] Thomas (2013, Chapter 3) attributes this view to Newton.
[79] For the claim that Spinoza was a supersubstantivalist, see Bennett (1984). For Descartes, see Skow (2005, p.59-61) and Chapter 7 of this work.
[80] Lewis (1986, p.76). It should be noted that Lewis and Sider's endorsements are conditional: they argue that if substantivalism is true, then supersubstantivalism is true.
[81] Sider (2001, pp.110-114).
[82] Schaffer (2009).
[83] Morganti (2011).

I take it there are times when my claims would apply equally to other forms of supersubstantivalism, but that does not concern me.

To summarise the above, supersubstantivalism is the view that space / spacetime really exists and that material objects are identical to regions of it. That is its core claim. We can express this core claim formally by introducing a new logical operator that expresses *exact location* (and is expressed by '@'). Following the road laid down by Parsons,[84] I take exact location as a primitive that can be glossed roughly as follows. An object's exact location is the same shape and size as that object and can be thought of as something like its shadow in spacetime. Hence, we can render the core claim of supersubstantivalism formally.

Supersubstantivalism (core claim): $\forall x \forall r (x@r \leftrightarrow x = r)$[85, 86]

But, why should we think that material objects are identical with their exact locations?

2.2 Motivations for Supersubstantivalism

Supersubstantivalism is typically motivated by its three great strengths: (1) it is parsimonious, (2) it coheres with our best science, and (3) it has explanatory power.

It is easy to see what makes supersubstantivalism parsimonious; by identifying material objects with regions of spacetime, it reduces the ontological cost of positing both. Once you have paid the cost of adding something to your ontology (spacetime, for instance), it is no

[84] Parsons (2007).

[85] If there are non-located things, then the right-to-left direction of this biconditional is false. Such things are identical with themselves but lack location. If there are such things, we could state the core claim of supersubstantivalism as $\forall x \forall r (Lx \& Lr \rightarrow (x@r \leftrightarrow x = r))$ where 'Lx' means x *is located*. In the present work, I have restricted my attention to only the located entities, so this complication can be ignored.

[86] This formalisation of supersubstantivalism invites some controversy because it commits to an *exact* location for everything. Supersubstantivalists do not have to commit to this but it is a very useful simplifying assumption. I adopt it because notions like overlap and subregionhood become much less manageable without it and, fortunately, there are not compelling reasons to reject it. See Parsons (2007) for discussion.

additional cost to posit things that are identical with that thing (material objects, for instance). This means that supersubstantivalism is more parsimonious than traditional substantivalism, which must pay an ontological cost for positing spacetime and an additional ontological cost for positing material objects. Indeed, the ontological extravagance of traditional substantivalism is the most common reason for rejecting it.[87] The fact that the ontological austerity of supersubstantivalism undermines the standard objection to substantivalism is a great boon.

The parsimony of supersubstantivalism does not end with its ontology. By identifying objects with spacetime regions, supersubstantivalism gains a more parsimonious ideology than other versions of substantivalism because it dispenses with the need for any kind of occupation relation. Other versions of substantivalism must describe and make sense of the way that material objects *occupy* regions of space/spacetime. If objects are identical with regions, no such relation is needed.

Of course, relationism is just as parsimonious as supersubstantivalism. However, as noted in the previous section, modern science appears to favour some form of substantivalism over relationism. Thus, those who think that parsimony *and* coherence with science are theoretical virtues should feel some motivation to endorse supersubstantivalism.

Speaking of science, we have already encountered the claim that modern science favours substantivalism. It has also been argued that modern science favours the move from substantivalism to *super*substantivalism. It is argued that quantum field theory can be interpreted in a way that involves no particles at all; properties are pinned directly to spacetime. Some have gone so far as to say that quantum field theory commits us to this,[88] but others have

[87] See Quine (1981, p.17) and Lewis (1986, p.76).

[88] See Field (1989, p.181), d'Espagnat (1983, pp.84-85), and Schaffer (2009, pp.142-144). Schaffer (ibid., p.142) also offers an analogous argument based on general relativity.

pushed back, arguing that it is consistent with other interpretations also.[89] Once again, I do not aim to adjudicate on the science here, but I do note that there is at least widespread agreement over the claim that the supersubstantival interpretation of quantum field theory is a very natural one.

Finally, supersubstantivalism has been alleged to explain many things, including:[90]

- Why material objects must have locations.
- What makes it the case that each material object has the particular exact location it has.
- The impossibility of colocation and interpenetration.
- The impossibility of extended simples.
- Why the structure of spacetime perfectly mirrors the structure of objects.

Why must material objects have spatial locations? One might think that no explanation is needed because it is analytic; all there is to being a *material* object is being an object with a spatial location.[91] Schaffer argues that there is a problem with this answer to the question.[92] Specifically, that *having a spatial location* is only one of several properties possessed by all and only material objects. Other properties include mass and charge, for instance. Yet objects cannot have mass or charge and *not* have a spatial location. By pointing this out, Schaffer is asking for an explanation of why we cannot recombine the properties of material objects such that they have things like mass and charge (which indicate that they are indeed material objects) but not locations. Supersubstantivalism explains this by positing that material objects simply *are* locations.[93]

[89] Malament (1982, p.531–532), Teller (1996, p.382), and Lehmkuhl (2018, pp.31-32).
[90] See Schaffer (2009) and Duncan and Miller (forthcoming).
[91] Markosian (2000).
[92] Schaffer (2009, p.141).
[93] Skow (2005, pp.62-64) makes this argument also. Although, see Lehmkuhl (2018, p.42 n.24) for a tentative expression of doubt about it.

Supersubstantivalism also answers Markosian's *question about spatial location*: "In virtue of what does each physical object occupy the region of space that it occupies?"[94] Markosian thinks that the only plausible answers will have to involve some brute facts and will, to the extent that they rely on those brute facts, be uninformative.[95] But supersubstantivalism can give a fully informative answer to this question: material objects occupy spacetime regions by virtue of being identical with them.[96]

Unfortunately, the rest of the alleged explanations are not quite the home runs that some supersubstantivalists have perceived them to be. Many people think colocation and interpenetration *are* possible. They are controversial topics in metaphysics. Thus, the best that can be said about them at this stage is that, if you already have independent reason to reject colocation and interpenetration, then supersubstantivalism can provide you with an explanation of why those things are impossible. That is a modest claim to explanatory power. In Chapter 5, I offer independent reasons for thinking co-location and interpenetration are impossible. By doing so, I hope to bolster the credibility of these claims about the explanatory power of supersubstantivalism.

Finally, supersubstantivalism does not explain the impossibility of extended simples and it does not explain why the structure of spacetime perfectly mirrors the structure of objects because, contrary to popular wisdom, supersubstantivalism is in fact consistent with extended simples and with widespread differences between the structure of spacetime and the structure of objects (as I show in 2.5).

[94] Markosian (2014, p.75).

[95] Ibid (pp.75-76).

[96] Markosian (ibid, p.76 n.18) notes that supersubstantivalism does answer his question, but he rejects it on the grounds that spacetime regions and material objects have different properties. In particular, he mentions temporal and modal properties, but these points can be easily addressed. For discussion of temporal properties, see Chapter 2.3.1. For discussion of modal properties, see Chapter 2.3.3.

The upshot is that, although supersubstantivalism does not have all the explanatory power that is typically attributed to it, it does have some.

Another mark in favour of supersubstantivalism is that it is part of the view I establish in Chapter 3. In that chapter, I combine composition as identity (CAI) and supersubstantivalism into a powerful and elegant new theory, which I call *super-CAI*. As will have emerged by this thesis's conclusion, I have not chosen to combine CAI and supersubstantivalism merely to "see what happens". Instead, I am independently motivated to unify several extremely closely related phenomena and I am compelled by the power and elegance of the resulting theory. Of course, it can be worthwhile to just slam things together and see what happens; physicists who use particle accelerators to slam atoms together, in the hopes of generating new, superheavy elements are surely not wasting their time. However, I have high hopes that the theory resulting from my attempt at unification will be much more stable than those superheavy elements and will not fall apart within fractions of a second, as they do.

2.3 Commitments

In this section and the next, I discuss the commitments of supersubstantivalism. Since objects are identical with regions of substantival spacetime, objects and spacetime must both be structured in the same kind of way. If objects have mereological structure, then regions cannot have set-like structure (for example). That is the first commitment of supersubstantivalism. In what follows, I assume that regions and objects are both mereological in structure and subregionhood is parthood.[97]

[97] This is a commonplace assumption. For example, see Tarski (1927), Simons (1987), Casati and Varzi (1999), McDaniel (2007c), Parsons (2007), Uzquiano (2011), and Markosian (2014). Although Nolan (2014) and Dumsday (2016) offer versions of supersubstantivalism which hold that spacetime is not mereological and subregionhood is not parthood. I argue against them in Chapter 7.

A number of other commitments for supersubstantivalism have been suggested.[98] I argue that we only need to accept two of them.

2.3.1 Perdurantism and Four-dimensionalism

We met perdurantism in Chapter 1; it is the view that each object that persists does so by being the four-dimensional fusion of multiple temporal parts. This is sometimes treated as if it were the same view as four-dimensionalism, which claims that objects persist by being exactly located at a temporally extended (i.e. four-dimensional) region of spacetime. Although usage of these terms has varied across time and space, I will be following Parsons in treating perdurantism and four-dimensionalism as different views.[99] As I intend the term, perdurantism's natural enemy is *endurantism*, which has struggled to find a precise formulation but which we can understand as the theory that objects persist without having temporal parts. In Chapter 1, we also briefly met an unusual version of endurantism called *Pardurantism* which says that some objects are four-dimensional but have no temporal parts. And, as I intend the term, four-dimensionalism's natural enemy is *three-dimensionalism*, which is the theory that objects persist by being multiply located at different times. Perdurance entails four-dimensionalism because being a diachronic fusion of multiple temporal parts means being exactly located at a four-dimensional region of spacetime. This entailment is extra strong, given supersubstantivalism, because supersubstantivalism declares that four-dimensional objects are identical with their four-dimensional exact locations. But four-dimensionalism does not entail

[98] For the list of suggested commitments that follows, I draw mostly on Schaffer (2009) and Effingham (2009). Other authors have discussed the commitments of supersubstantivalism, but I believe Schaffer and Effingham have all bases covered.

[99] Parsons (2000). This is a somewhat taxonomical point, and I recognise that there are many taxonomies of these views in the literature. What I call perdurantism and four-dimensionalism, Gilmore (2008) calls mereological perdurance and locational perdurance (respectively). Effingham (2012) calls them populationist perdurance and occupationalist perdurance (respectively). And so on. The important thing for my purposes is just that they are distinguished.

perdurance because being extended (in time or in space) does not entail having multiple parts (temporal or spatial). Pardurance shows us how.[100]

The orthodox view in the literature is that supersubstantivalists *must* commit to one or both of perdurantism and four-dimensionalism. [101] In virtue of the fact that the two views are often treated as interchangeable, it is hard to say exactly which is supposed to follow from supersubstantivalism. Perhaps both. In what follows, I argue that supersubstantivalists should commit to four-dimensionalism, but that they can accept either perdurantism or Pardurantism (just like advocates of CAI).

Let us start by observing the failure of some potential counterexamples to the alleged connection between supersubstantivalism and those views. We might try to articulate a version of supersubstantivalism that obtains in something like Newtonian space; where space endures and is not unified with time. In such a setting, objects are extended in space but not in time and they persist by being exactly located at each time they exist, thus neither perdurantism, Pardurantism, nor four-dimensionalism is true. Views like this are rarely (though not never) taken seriously because they clash with our best science, particularly special relativity which says that there is no absolute simultaneity and so there are no absolute facts of the matter about which objects are contemporaneous. From one reference frame, objects x and y might exist in the same moment and so might compose an object z, but from a different reference frame x and y might not exist in the same moment and so there can be no fusion of the two (for it would perdure and be four-dimensional). So z both exists and does not exist, depending on the reference frame. Like most, I find these sorts of arguments to be conclusive and I will not entertain the prospect of a merely three-dimensional spatial manifold, beyond this point.

[100] Gilmore (2008) and Nolan (2014) also discuss objects that are four-dimensional without temporal parts.

[101] See Sider (2001, p.110), Skow (2005, p.69), Effingham (2009, p.42 n.7), Schaffer (2009, p.135), Gilmore (2014), and (to an extent) Dumsday (2016, pp.199-200, n.7).

Instead, I assume that we have all learned our relativity and committed to the actual existence of a four-dimensional spacetime.

In general, supersubstantivalism is inconsistent with three-dimensionalism because three-dimensionalism requires multiple location, with which supersubstantivalism is plainly inconsistent. Here is a substitution argument that proves the matter.

1	(1)	$\forall x \forall r (x@r \rightarrow x = r)$	Supersubstantivalism
2	(2)	$\exists x \exists r \exists s (x@r \,\&\, x@s \,\&\, r \neq s)$	Multiple location
3	(3)	$x@r \,\&\, x@s \,\&\, r \neq s$	Assumption (for ∃E)
3	(4)	$x@r$	&E:3
3	(5)	$x@s$	&E:3
3	(6)	$r \neq s$	&E:3
1	(7)	$x@r \rightarrow x = r$	∀E:1
1,3	(8)	$x = r$	→E:4,7
1	(9)	$x@s \rightarrow x = s$	∀E:1
1,3	(10)	$x = s$	→E:5,9
1,3	(11)	$r = s$	Substitution:8,10
1,3	(12)	$\bot$	~E:6,11
1,2	(13)	$\bot$	∃E:2,3,12

Nevertheless, even in a four-dimensional spacetime, and even with three-dimensionalism ruled out, neither perdurantism nor four-dimensionalism is strictly entailed by supersubstantivalism. Both are trivially false if spacetime is made up of atomic, point-sized regions that never compose (i.e. if compositional nihilism is true for regions). In that case, no region has temporal parts, so no region perdures and there are no regions with temporal extension, so no objects are

located at such regions. Perdurantism and four-dimensionalism are also false if regions of spacetime can compose only across spatial dimensions, and not across time. However, both of these suggestions require a restriction on the composition of regions and, as I discuss later (in 2.3.3), there seems no good reason to restrict composition on regions. Regions are ontologically cheap. On top of that, the second suggestion runs into the same problems with special relativity as three-dimensional spatial manifolds because prohibiting composition across time requires there to be absolute facts about which regions are contemporaneous and special relativity tells us that there are no such absolute facts. For those reasons, I am inclined to dismiss these two cases. Compositional nihilism is a much more defensible position than those which cannot countenance special relativity, but this is not the place to engage with it. I am offering an analysis of composition (and of location) so I assume that composition occurs. Given that assumption, and the assumption that regions / objects persist, supersubstantivalism is thus committed to four-dimensionalism. Persisting objects are four-dimensional, not three-dimensional.

But do they have temporal parts? If they do, then they perdure. If they do not, then they Pardure. Both options are available to the supersubstantivalist. Perdurantism is (by far) the more popular theory and, in much of what follows, I will default to speaking as though it is true. If there are any Pardurantists among my readers, I hope they will not be too displeased.

I take this commitment to four-dimensionalism and perdurantism (or Pardurantism) to count in favour of, rather than against, supersubstantivalism. This is because the cost of alienating committed three-dimensionalists and traditional endurantists has already been paid; as I argued in 1.4.3 and 1.4.4, accepting CAI already provides powerful motivation for four-dimensionalism and perdurantism (or Pardurantism), so here we see the commitments of CAI and supersubstantivalism dovetailing nicely – foreshadowing the elegance of the combined view I advocate in the next chapter.

2.2.2 Priority Monism

The second commitment Schaffer alleges is to priority monism, which claims that the whole spacetime manifold is ontologically prior to (i.e. grounds) the regions. For Schaffer, this entailment becomes apparent when we notice that some topological and some geometrical notions (like disconnectedness and distance) that are used to describe regions of spacetime, make implicit reference to the whole manifold. It looks as though describing regions requires the whole. But this need not entail priority monism. One way we can avoid this commitment is by embracing CAI. Given CAI, the whole manifold is identical with the parts of the manifold (taken together) so cannot ground them (or be grounded in them) because identity and ground are inconsistent.

That might be too quick. It has recently been argued that composition as identity does not preclude *all* kinds of grounding relation from holding between the whole and its parts.[102] Certainly, it precludes any kind of ontological dependence, but existence facts are only one kind of fact, and maybe we can still have grounding relations between other facts about the whole and its parts. For example, grounding in terms of metaphysical explanation. If priority monists are willing to recast their theories in terms of metaphysical explanation, not ontological dependence, then maybe there is room for priority monism. But, of course, the CAI theorists could also recast CAI in terms of metaphysical explanation and claim that the identity between parts and wholes grounds the facts the priority monist wants to ground. Either way, I am not concerned by that debate. What concerns me here is ontological dependence. Insofar as ontological dependence is concerned, the parts being (collectively) identical with the whole precludes one being the ontological ground for the other.

The upshot of this is that CAI gives us the resources to commit to the identity version of supersubstantivalism without also committing to priority monism. To the extent that priority

[102] Loss (2016).

monism is an unwelcome commitment, this is another example of the benefits of the combined view.

A note on taxonomy. The combination of supersubstantivalism with priority monism is called *monistic supersubstantivalism* and the combination of supersubstantivalism with the view that the whole spacetime manifold is ontologically dependent on its parts is called *pluralistic supersubstantivalism*. No name has, as yet, been given to the combination of supersubstantivalism with CAI (which claims that the whole spacetime manifold and its parts are identical and so neither is ontologically prior to the other). I propose to call it *super-CAI*.

2.3.3 Counterpart Theory

The most common objections to supersubstantivalism are modal,[103] and facing those objections provides strong motivation for embracing counterpart theory. Consider the following argument, which is representative of the modal complaint against supersubstantivalism.

(1) Objects do not have their exact locations essentially.

(2) Spacetime regions do have their exact locations essentially.

(3) Therefore, objects are not identical with spacetime regions.

Premise (1) is obviously true. For example, I could have chosen to go to the park today, instead of staying at home (but here I am). Effingham calls the denial of (1) "reprehensible"[104] and I agree. It is a non-negotiable part of our understanding of ordinary material objects. Furthermore, premise (2) strikes me as eminently plausible, for reasons Newton observed.

[103] For example, Skow (2005), Effingham (2009), Schaffer (2009), Dumsday (2016), Markosian (2014, n.18), Morganti (2011, pp.193-194).

[104] Effingham (2009, p.40).

> [I]f yesterday could change places with today and become the later of the two, it would lose its individuality and would no longer be yesterday, but today; so the parts of space are individuated by their positions, so that if any two could exchange their positions, they would also exchange their identities, and would be converted into each other *qua* individuals.[105]

To be *this* region rather than *that* region is just to be located *here* rather than *there* in spacetime. Change in location in spacetime means change in identity of region. Skow has argued against premise (2) by pointing out that General Relativity tells us that the geometry of any given region of spacetime depends on the distribution of mass-energy and, therefore, if premise (2) is true then

> if I had raised my hand a moment ago, (part of) the region of spacetime I actually occupy would not have existed. But certainly it was up to me whether I raised my hand a moment ago; so if [premise (2)] is true, it was up to me whether a certain region of spacetime exists. But that is absurd.[106]

Not so. I confess, I do not find this absurd. It is surely possible that any given region of spacetime might not have existed (or do we think that this spacetime is necessary?), and why should it not be me that prevents some merely possible region from actually existing? After all, I have mass-energy and mass-energy affects spacetime. The consequence that Skow finds absurd is just a consequence of individuating regions by their locational properties, which is standard. Regions are fundamentally locational objects. Skow appears to be individuating regions some other way, but this threatens to imbue them with mysterious essences that require explanation. For these reasons, I think Skow fails to undermine premise (2). Of course, if I am

[105] Newton (1962, p.103).
[106] Skow (2005, p.41).

wrong about this then premise (2)'s falsity undermines the modal argument against supersubstantivalism and supersubstantivalists need say nothing more. However, since I believe I am not wrong, I will say the following. The premises of the argument appear true. Fortunately, the conclusion does not follow from them.

The best way for supersubstantivalists to resist the modal argument is to embrace counterpart theory. Counterpart theory denies that there are trans-world identities: nothing in any world is numerically identical to anything in any other world. Instead, objects have *counterparts* at other worlds. Whether something in another world counts as my counterpart depends on whether it is sufficiently similar to me in the relevant respects (we do not need the details of this, for present purposes) and, hence, to say that I could have gone to the park today is just to say that there is a possible world in which I have a counterpart that went to the park today.

Counterpart theory solves the modal problem for supersubstantivalism by permitting us to say that, when we consider a supersubstantival material object (which is identical with its exact location) *qua* material object, the relevant similarities are such that the object will have counterparts at different locations in different worlds. But when we consider that material object *qua* spacetime region, the relevant similarities are such that the object will have counterparts at the same exact location in different worlds.[107]

The above counterpart-theoretic response to the modal problem for supersubstantivalism is incredibly popular.[108] I would go so far as to call it the orthodox response. This is good news. We saw, in Chapter 1.5.1 that CAI is usually combined with a commitment to counterpart theory, in order to avoid some similarly essentialist concerns. That

[107] What is it to consider something *qua* some feature? There is a whole literature on this and I do not have an answer for you. I take it that there *is* something that it is to consider something *qua* some feature, but I leave the details of that for others to work out.

[108] See Sider (2001, p.113), Skow (2005, pp.70-71), Effingham (2009), Schaffer (2009), Nolan (2014).

makes counterpart theory another commitment shared between CAI and supersubstantivalism. It is as if the two theories are crying out for unification.

2.3.4 Unrestricted Composition and Decomposition for Material Objects

Another notable commitment that Schaffer alleges is unrestricted composition and decomposition for material objects. This is supposed to follow from unrestricted composition and decomposition for regions, which is supposed to follow from supersubstantivalism. So we really have four more entailments being alleged here:

(i) From supersubstantivalism to universal composition for regions.

(ii) From supersubstantivalism to universal decomposition for regions.

(iii) From supersubstantivalism and universal composition for regions to universal composition for objects.

(iv) From supersubstantivalism and universal decomposition for regions to universal decomposition for objects.

I accept both (i) and (ii), but I suggest that not much turns on either and both can be rejected if one so pleases. I reject (iii) and (iv), and I go on to argue (in 2.4) that the harmony principles that motivate them are false.

Regarding (i). Unrestricted composition for regions seems plausible, though not because of anything special about supersubstantivalism. It is plausible simply because whenever you have some plurality of regions, there seems no good reason to rule out the existence of a region that is the fusion of them. Regions are ontologically cheap, and the worries about unrestricted peculiar objects, like Lewis's trout-turkeys ("the mereological fusion of the

front half of a trout plus the back half of a turkey"),[109] do not apply when thinking about regions qua regions.

Nevertheless, it would be rash to suppose without argument that there is no possible world where regions do not universally compose. Particularly if one believes, as some do, that the answer to the special composition question is contingent.[110] For precisely this reason, Parsons chose to describe regions using minimal extensional mereology, which is the same as classical extensional mereology but without universal composition.[111] That was laudably neutral of Parsons, whose project was to describe theories of location in the most general terms possible, but I have a different project in mind which motivates the acceptance of universal composition for regions. My aim is to offer a compelling theory of composition and location (where both are identity). A key part of my theory involves recognising that although all objects are regions, not all regions are objects, since this allows for differences between the region mereology and the object mereology. Accepting universal composition for regions helps to draw out those differences between the two mereologies, so I am inclined to accept it. I do not think it is necessary to accept universal composition for regions, but I think it is part of the neatest package. Anyone worried by the commitment can rest assured that it is dispensable.

Regarding (ii). By 'unrestricted decomposition for regions' Schaffer means that "for any extended spacetime region, there are sub-regions that fission it."[112] In other words, for any region, either it can be decomposed into a plurality of disjoint regions, or it is point-like. (Call this *strong* unrestricted decomposition for regions.) That Schaffer commits to this is curious to me because unrestricted decomposition for regions, in the sense that it is a partner to unrestricted *composition* for regions, seems only committed to the weaker claim that, for any

[109] Lewis (1991, p.7).
[110] See Cameron (2007), Bohn (2009b), Parsons (2013), Nolan (2015, p.36). I also take this view in Chapter 4.
[111] Parsons (2007).
[112] Schaffer (2009, p.135).

region r, either r is decomposable into disjoint regions or r is an atom. (Call this *weak* unrestricted decomposition for regions.) Nothing about this says that atoms must be point-like. They might be, but nothing about the phrase 'unrestricted decomposition' requires it.

Weak unrestricted decomposition for regions seems uncontroversial, though, once again, not because of anything special about supersubstantivalism. It appears to be an analytic truth; true by virtue of the meaning of the word 'atom'. As such, I am happy to accept weak decomposition for regions. As for the stronger form (according to which, atomic regions of spacetime are pointlike), the jury is out.[113] The upshot is that I will remain neutral. I will not bake a commitment to spacetime points into the theory I advocate, but nor will I exclude them. Hence, you may accept them if you want or reject them if you do not. What I say in the following chapters will apply either way.

Regarding (iii). The time has not yet come, to talk about unrestricted composition for objects (also known as *universalism*). But trust me; it will. I speak about it briefly in the next section (2.4.2) and in more detail in Chapter 4. In those places, I argue that supersubstantivalism is not committed to unrestricted composition for objects.

Regarding (iv). Again, we can understand this claim in two ways – weak or strong. The weak version is just that for any object x, either x is decomposable into disjoint objects or x is an atom. That claim is plausibly analytic, and I have no quarrel with it. The stronger version, however, claims that for any object x, either x can be decomposed into disjoint objects, or x is point-sized. In a spacetime made of points, this claim is equivalent to a harmony principle called Arbitrary Partition, which I argue against in 2.5. I show that supersubstantivalism is not committed to it, and I give reasons for thinking it is false.

Schaffer alleges two more commitments, each of which deserves its own section. The first is a commitment to the claim that all regions are objects. The second is a commitment to

[113] See Arntzenius (2012, Chapter 4) for arguments against spacetime points.

a series of principles that allege a harmony between the structure of objects and the structure of spacetime. In the next section I debunk the former allegation. In the section after, I debunk the latter.

2.4 Restricted Supersubstantivalism

As we saw above, Schaffer thinks that supersubstantivalism is best paired with priority monism (which entails that wholes are more fundamental than their parts).[114] Theories that combine supersubstantivalism with priority monism are called *monistic supersubstantivalisms*. They are usually contrasted with *pluralistic supersubstantivalisms*, which claim that parts are more fundamental than wholes, so the whole spacetime manifold is less fundamental than one or more of its decompositions.[115] I have already indicated that I favour a third option according to which, wholes are (collectively) identical with their parts, so the whole spacetime manifold is collectively identical with all of its parts on any decomposition. I have called this view *super-CAI*, because it combines supersubstantivalism with CAI.

Another locus of disagreement among supersubstantivalists is centred on the question of whether spacetime is mereological or not. Material objects are mereologically structured, and supersubstantivalism claims that material objects are identical with their exact locations, so it would seem to follow that spacetime regions are mereologically structured too. Yet not everyone believes this.[116] I have said, above, that I assume spacetime *is* mereological. In doing so, I fall in with the majority view, but do not worry; I defend this assumption more fully in Chapter 7.

Finally, supersubstantivalists have also disagreed over which properties can be fundamentally instantiated by spacetime. *Radical* supersubstantivalists claim that only

[114] Schaffer (2009).
[115] See Sider (2001, p.110-114).
[116] See Dumsday (2016).

topological or geometric properties can be, and all other properties must be reduced to those.[117] Alternatively, *modest* supersubstantivalists are happy to say that many of the non-topological and non-geometric properties of material objects are among the fundamental properties pinned directly to spacetime. Lehmkuhl has noted that supersubstantivalist metaphysicians tend to be modest supersubstantivalists and radical supersubstantivalism gets much more attention in the scientific literature (perhaps partly because radical supersubstantivalism is more tractable to empirical testing).[118] I will stay silent on this debate. Although I will speak like a modest supersubstantivalist, it should be understood that I do not wish to rule out the possibility that there is some way to reduce all non-geometric, non-topologial properties of material objects to geometric or topological properties of spacetime.

Those are the choice points for supersubstantivalism that have generated the most discussion. But there is another.

The core claim of supersusbstantivalism tells us that each material object is identical with a region of spacetime (i.e. its exact location), but it does not tell us anything about *which* regions of spacetime are objects. Some claim that *all* spacetime regions are objects.[119] Their view is called *unrestricted supersubstantivalism*. Alternatively, we might claim that *some but not all* regions are objects. That view is called *restricted supersubstantivalism*. The possibility of restricted supersubstantivalisms has been noticed by many,[120] but defences of it are extremely limited.[121] Nobody has yet offered an argument explicitly designed to answer the question of which view is superior: restricted or unrestricted supersubstantivalism. That is what

[117] See Wheeler (1962). See Lehmkuhl (2018, pp.38-39) for a rundown of some such views.

[118] Lehmkuhl (2018, p.36-40).

[119] See Descartes view explained by Skow (2005, Chapter 3) and see Schaffer (2009).

[120] Williams (2008, n.15), Uzquiano (2011, pp.209-210), Nolan (2014), Lehmkuhl (2018, p.34), and Duncan and Miller (forthcoming).

[121] Nolan (2014) outlines a restricted supersubstantivalism but does not endorse it and does not give reasons to favour it over an unrestricted alternative. Lehmkuhl (2018, p.43, n.29) says that if he "had to choose" he would say that only regions of spacetime which have mass-energy are material objects but gives no more defence of this claim than that "there are strong reasons to regard mass-energy as an essential (or, if you want, necessary) property of matter". I will say much more than this.

I hope to do in this section. I argue against the unrestricted view and in favour of restricted supersubstantivalism.

Of course, there are plenty of restricted views available; one for each set of criteria we might use to restrict which regions qualify as material objects. For instance, we might think that all and only regions with certain fundamental physical properties (such as non-zero mass-energy[122]) are material objects, or perhaps all and only regions which satisfy certain geometrical or topological properties (such as being an open domain,[123] or being connected) qualify. Which constraint we endorse affects the expressive power of the theory. I say more about this in the next section and in Chapter 4, but I will stay neutral about which constraint for restriction is preferable. I am not neutral about the unrestricted view, however. I argue that it is false, and I think its falsity matters a great deal. This is contrary to comments by Schaffer, who, in the process of endorsing an unrestricted view, writes:

> Should a region with zero-mass energy be said to contain no material object, or be considered an empty material object? I see very little at stake in this semantic question, and little harm in saying that a region with zero-mass energy is an empty material object.[124]

Believing there is little at stake, he goes on to treat all regions as material objects. But there are lots of things at stake in this question. In the following subsections, I give four arguments for restricted supersubstantivalism; one for each of the four things I believe are at stake.

[122] See Lehmkuhl (2018).
[123] See Cartwright (1975).
[124] Schaffer (2009, p.146).

2.4.1 Common-sense

Let us start with the least interesting observation: the unrestricted view is incredibly revisionary. Common-sense and ordinary language use are both very much at odds with calling regions of empty space (whatever that means) material objects. This means that the ability to cohere with our common-sense and ordinary language use is somewhat at stake in the choice between restricted and unrestricted supersubstantivalism.

In reply to this point, one might observe that supersubstantivalism is already at odds with common sense. Sider, Schaffer, and Dumsady all think so, at least.[125] Sider points this out most vividly: "'A region of spacetime bounded out the door and barked at the mailman'—it sure sounds strange to say! Indeed, it sounds like a 'category mistake'".[126] But it is worth questioning, as Nolan has, whether we really do have common-sense views on the relationship between objects and spacetime:

> It is not entirely clear that we violate common-sense by suggesting such a reduction [of material objects to spacetime regions] or merely go beyond it—I may, of course, have occasion to mention me and my location separately, but outside a philosophical context I may be unlikely to explicitly say that they are different.[127]

This is especially true, he points out, of the four-dimensional spacetime regions at which four-dimensional objects are exactly located. Do we really have common-sense ideas about four-dimensional objects? Probably not. Nevertheless, suppose it is true that supersubstantivalism *is* deeply revisionary. Revisionaryness is additive. Adding the revisionary claim that empty

[125] Sider (2001, pp.110-111), Schaffer (2009, p.144), Dumsady (2016, p.188).
[126] Sider (2001, pp.110-111).
[127] Nolan (MS, p.20).

regions are objects to the revisionary claim that ordinary, everyday, material objects are spacetime regions may well take us beyond the pale.

I do not believe we should read our metaphysics off our folk theories or ordinary language practices, so I do not think an argument like this can carry an extraordinary amount of weight. But, when other things are equal, a theory's conflict with common sense can be a mark against it. When Schaffer says that nothing is at stake in the choice between restricted and unrestriceted supersubstantivalism, he indicates that he believes all other things *are* equal. Hence, this ought to be seen (by him, at least) as a mark against the unrestricted theory. But I do not believe all other things are equal; in fact, there are at least three more compelling reasons to favour restricted supersubstantivalism.

2.4.2 The Special Composition Question

If one accepts classical extensional mereology (CEM) for regions, as many do, then the ability to give anything other than a universalist response to the special composition question is at stake. Universalism can be stated as follows.

> Universalism: For any plurality of objects xx, there exists an object y such that y is composed of xx.

And it falls out of the combination of

- Supersubstantivalism (objects are identical with their locations)
- The unrestricted view (for every region r, there is some object identical with r)
- CEM for regions (an axiom of which is that regions always compose)

Because, for any plurality of regions rr, CEM guarantees that there is a region s that is composed of rr, and unrestricted supersubstantivalism guarantees there is some object identical with s.

There is resistance to the idea that material objects always compose. Many have wondered whether there are such exotic objects as trout-turkeys ("the mereological fusion of the front half of a trout plus the back half of a turkey").[128] There have been plenty of attempts to offer restricted accounts of when objects compose,[129] and some people have gone so far as to say that objects never compose; there are only simples.[130] Yet supersubstantivalists who make all the same common assumptions I have may only reject Universalism if they accept a restricted version of supersubstantivalism. This is because rejecting Universalism requires saying that there is some region that is not an object. More specifically, it requires that for some plurality of objects xx, there is a region r such that anything that overlaps r overlaps one of xx and anything that does not overlap r does not overlap any of xx, *and* r *is not an object.* Whether any particular restricted view can say this will, of course, depend on its criteria for restriction. More on this in 2.5 and 4.5. The fact that restricted supersubstantivalism is consistent with restricted *and* unrestricted composition means it is a more neutral theory and permits us to make decisions about mereological commitments on independent grounds. Regardless of whether you think this counts in favour of restricted views, it is certainly something at stake.

2.4.3 The Banach-Tarski Paradox

In spacetimes composed of point-sized regions, unrestricted supersubstantivalism posits the existence of point-sized objects. Point-sized objects lead to paradox, so we should reject the existence of point-sized objects. Ergo, in spacetimes composed of point-sized regions (which

[128] This example is from Lewis (1991, p.7), but Lewis was happy to accept their existence.

[129] Perhaps most famously, Van Inwagen (1990). See Markosian (2008) for discussion.

[130] See Rosen and Dorr (2002) and Sider (2013) for notable defences of nihilism. See Cotnoir and Varzi (forthcoming, pp.175-178) for discussion.

includes all the orthodox spacetimes of modern physics) we should reject unrestricted supersubstantivalism.

I have in mind the *Banach-Tarski paradox* (also called *the pea and the sun paradox*) which proves that we can take any sphere composed of infinitely many points, cut it into as few as five parts, and rearrange those parts to get two spheres of exactly the same size as the sphere we started with. We can even take one sphere the size of a pea, cut it up and rearrange it in this way, and end up with a sphere the size of the sun.[131] The parts we cut the spheres into are strange, scattered parts composed of infinitely many point-sized objects and lacking any well-defined measure but, on the unrestricted view, these count as objects. Of course, material objects do not actually work this way; you cannot actually get two spheres from one sphere, and you cannot actually get a sun from a pea, even in principle. So we had better say that the smallest actual objects are non-point-sized or that there are no actual objects like the strange, discontinuous, measureless parts of the spheres. Either response means rejecting unrestricted supersubstantivalism.

We might reply to this paradox by objecting that the transformations required do not preserve the identity of regions. Regions are individuated by their locations – different location means different region – so we cannot slice up and rotate regions in the requisite ways to generate the paradox. And, since supersubstantivalism identifies material objects with regions, the paradox does not arise for material objects (or mere regions), given supersubstantivalism.

Certainly, if we try to imagine a supersubstantival material object atemporally and imagine performing transformations on it, we will find we cannot. The thing we end up with is not identical to the thing we started with. The transformations require change, and there are two mechanisms supersubstantivalists use to account for objects changing: counterpart theory and four-dimensionalist theories of persistence.

[131] See Wagon (1985) for details.

A counterpart-theoretic version of the paradox is hard to motivate. Instead of preserving identity across the various transformations, this version of the paradox would rely on counterpart relations between regions. Perhaps, then, it would construct a series of counterparts from a pea-sized region to a sun-sized region. But there are several problems with this. For one thing, the counterpart relation need not be transitive. For another, we are now talking about something rather different from the original paradox and, I wonder: why think there is anything particularly paradoxical about saying a pea-sized region has a sun-sized counterpart?

Only a four-dimensionalist version of the paradox will have any traction on supersubstantivalism. Here I run the paradox using temporal parts, and I leave it to the reader to imagine how it might arise for a Pardurantist.

We can imagine a single supersubstantival object with a solid, continuous pea-sized temporal part at time t_1 which, at time t_2, is separated into five different parts (each of which is discontinuous and measureless) and then, at time t_3, has the relevant transformations performed upon each of those five parts before finally, at time t_4, those parts are merged into one solid, continuous sun-sized temporal part. The Banach-Tarski objection to unrestricted supersubstantivalism claims that this is nomologically impossible. Material objects cannot actually undergo this sort of change.

Of course, if we take an unrestricted view of composition, then we can imagine four-dimensional objects composed of pea-sized temporal parts at one time and sun-sized temporal parts at later times. Such objects do change from pea-sized things into sun-sized things, so perhaps they show us that we need not worry about the paradox? Not so. For one thing, such objects raise all sorts of questions about what counts as a proper continuant. For instance, suppose we have an object composed of your body at 2pm one day and Alpha Centuri at 2:01pm on the same day. That object not only changes dramatically in size but also travels faster than light – travelling 4.37 light years in one minute! It is fair to wonder whether those

sorts of objects can play a role in these sorts of arguments.[132] Fortunately, we can avoid all of those issues by observing that the paradox in question arises from the apparent impossibility of performing these particular cuts and these particular transformations on any material object. The paradox does not arise from the mere fact that an object could start its life at the size of a pea and end its life the size of the sun. There is nothing particularly paradoxical about growth simpliciter. The paradox arises from the thought that we can turn something which is the size of a pea into something the size of the sun simply by cutting it up and moving its parts around.

There are three ways to block this paradox:

(1) Deny that there are material objects exactly located at the sorts of discontinuous, measureless regions required by the paradox.
(2) Deny that there are point-sized material objects.
(3) Deny that spacetime actually features point-sized regions.

In spacetimes featuring point-sized regions, the first two options require restricting supersubstantivalism. Hence, if we think spacetime might actually be pointy, this paradox presents reasons to restrict supersubstantivalism. Of course, one could also bite the bullet and claim that this behaviour *is* nomologically possible for material objects. Perhaps if we had sharp enough knives, we could cut objects up in the required manner. But that is a large bullet to bite. We are better off restricting supersubstantivalism.

Here is an objection. The first two responses I have considered only block the paradox for material objects. If there are point-sized mere regions and discontinuous, measureless mere regions, then the paradox can still arise for mere regions. Does this not mean we are better off accepting option (3) (or biting the bullet), which blocks the paradox for both material objects *and* mere regions, and does not require restricting supersubstantivalism?

[132] See Hudson (2003, pp.21-22) or Effingham (2011, section 4 onwards) for discussion.

Here is a reply. The paradox causes indignation because it strikes us as absurd that we should be able to create two spherical material objects from one of the same size or increase a material object's size by merely cutting it up and rearranging the pieces. That is why it is a paradox. But our intuitions are much less stable when we think about whether a four-dimensional mere region could have temporal parts that differ in these ways. It is not as clear that there really is something objectionable about mere regions behaving this way. I, at least, am not as indignant about it.

Finally, a note on the modal strength of this argument. This strength of the argument depends on how impossible we think Banach-Tarski-style changes to objects are. If they are merely nomologically impossible, then the argument provides reason to think that supersubstantivalism is actually but not necessarily restricted.

2.4.4 Harmony

Finally, the unrestricted view entails a plethora of principles known as harmony principles which allege that the structure of objects perfectly mirrors the structure of the spacetime regions at which they are exactly located. For instance, one such principle states that, wherever an object's exact location has subregions, that object has parts. If every region is an object, as the unrestricted view claims, then there is no subregion of any object's exact location that does not contain an object. I discuss these principles in detail in the next section.

It is sometimes argued that supersubstantivalism's commitment to harmony is a good thing because it means supersubstantivalism can offer an explanation for why harmony obtains.[133] Unfortunately for people who hold that view, we have good reasons to think that at least some of the harmony principles are false. Reasons like the possibility of simple objects whose exact locations are complex (extended simples) and gunky objects in pointy space.

[133] See Schaffer (2009), Duncan and Miller (forthcoming).

Anybody who thinks that those phenomena are possible should be convinced that harmony fails and therefore that unrestricted supersubstantivalism (which entails it) is false.

There is a lot to say about the harmony principles, and I have treated them very quickly here. In the next section, I go into much more detail; I list all the harmony principles and demonstrate that restricted supersubstantivalism is consistent with the failure of each one. This means that restricted supersubstantivalism is able to express far more possibilities than unrestricted supersubstantivalism. This comes at the cost of some alleged explanatory power – i.e. the power to explain why harmony obtains – but we should not mourn that loss, since it was based on a false premise. In fact, harmony does not obtain.

2.4.5 Upshot

Every *modus tollens* has a *modus ponens*. In this section, I have attempted to tollens unrestricted supersubstantivalism by offering arguments against things it entails. I have said that it transgresses against common sense, it entails unrestricted composition (and is therefore less neutral than restricted supersubstantivalism), it results in paradox, and it commits us to full blown harmony. One could just as easily take some of these as arguments *for* unrestricted supersubstantivalism. Committed universalists will like that it lends independent reason for their view, as will anyone who thinks that spacetime does not feature point-sized regions or that spacetime and material objects *are* in harmony. Some of those views are more controversial than others (though all enjoy their fair share of controversy) but, whether you regard these as arguments against or for unrestricted supersubstantivalism, it can surely be denied no longer that there is a great deal at stake in the matter – contra the comments by Schaffer we saw at the beginning of this section.

My own view is that, since I am attempting to stay neutral on the special composition question and the existence of spacetime points, and since I think there are good reasons to

believe extended simples are possible (and therefore harmony fails), restricted supersubstantivalism is to be preferred over its unrestricted sibling.

2.5 Supersubstantivalism Does Not Entail Harmony

When there is a mirroring between the way that material objects are structured and the way that spacetime is structured, the two are said to be in harmony. Many have claimed that supersubstantivalism entails harmony. For example, Schaffer states that, for the supersubstantivalist, 'Material objects just are spacetime regions, so no possibility of disharmony arises'.[134] Saucedo states that 'if every material thing is its location, then, trivially, its mereological structure and that of its location are perfectly aligned.'[135] And here is Leonard:

> Since the supersubstantivalist contends that an object is located at a region only if it is identical with that region, a very strong form of harmony seems to naturally fall out of the supersubstantivalist picture of matter and spacetime.[136]

These claims are false. Supersubstantivalism does not entail harmony. In this section, I demonstrate that supersubstantivalism is consistent with failures of *every* principle of harmony. Along the way, I also show that supersubstantivalism is consistent with restricted composition, extended simples, and gunk. I begin, in 2.5.1, by outlining the relevant background (assumptions, definitions, harmony principles). Then, in 2.5.2, I offer cases which demonstrate the possibility of failures of harmony for supersubstantivalism. I conclude the section, in 2.5.3, by reflecting on the lesson this teaches us about the trade-offs supersubstantivalists must make, between explanatory power and expressive power.

[134] Schaffer (2009, p.138).
[135] Saucedo (2011, p.273).
[136] Leonard (2016, pp.1950-1951).

2.5.1 Background to Harmony

First, some definitions. We have already met *exact location* (expressed by '@'). Now let us meet some other definitions that can be given in terms of exact location.

An object x is *weakly located* at a region r iff r overlaps x's exact location.[137] Using '$@_\circ$' to express weak location, this definition can be formalised as:

Weak Location $\quad x@_\circ r =_{df} (\exists s)(x@s \,\&\, r \circ s)$

This can also be given a rough gloss, as follows. An object x is weakly located at a region r iff r is not completely free of x. The region I call my office is not completely free of me when I am inside it, at my desk, nor is it free of me when I stick my arm out the window, since some of me is still inside it. I am weakly located at any and all regions that are not completely free of me.

Lastly, an object x *pervades* a region r iff x is exactly located at a region s and r is part of s. Roughly, any region fully overlapped by x is pervaded by x. Using '$@_>$' to express the pervading relation, the definition can be formalised:

Pervades $\quad x@_> r =_{df} (\forall s)(x@s \,\&\, r \leq s)$

With these terms defined, I now turn to mereological harmony. Wherever the mereological structure of material objects mirrors the mereological structure of spacetime, the two are said

[137] These terms are interdefinable; we could start with weak location as a primitive and define the others in terms of it. For example, Parsons (2007) starts with exact location as primitive, and Uzquiano (2011) starts with weak location.

to be in harmony. There have been several attempts to articulate harmony principles in the literature. Here is a list of principles that have been discussed:[138]

Arbitrary Partition $x@_{>}r \rightarrow \exists y(y < x \ \& \ y@r)$

Every region x pervades contains a material object that is part of x.[139]

Simplicity $x@r \rightarrow (\neg\exists y(y < x) \leftrightarrow \neg\exists s(s < r))$

x is mereologically simple iff x's location is mereologically simple.

Complexity $x@r \rightarrow (\exists y(y < x) \leftrightarrow \exists s(s < r))$

x is mereologically complex iff x's location is mereologically complex.

Number of Parts $x@r \rightarrow (\exists y_1 \ldots \exists y_n((y_1 \neq y_2 \ \& \cdots \& \ y_{n-1} \neq y_n) \ \&$

$(y_1 \leq x \ \& \cdots \& \ y_n \leq x) \ \& \ \forall z(z \leq x \rightarrow z = y_1 \vee \cdots \vee \ z = y_n)) \leftrightarrow$

$\exists s_1 \ldots \exists s_n((s_1 \neq s_2 \ \& \cdots \& \ s_{n-1} \neq s_n) \ \& \ (s_1 \leq r \ \& \cdots \& \ s_n \leq r) \ \&$

$\forall t(t \leq r \rightarrow t = s_1 \vee \cdots \vee \ t = s_n))$

x has exactly n parts iff x's location has exactly n subregions.

Gunk $x@r \rightarrow \big(\forall y\big(y \leq x \rightarrow \exists z(z < y)\big) \leftrightarrow \forall s\big(s \leq r \rightarrow \exists t(t < s)\big)\big)$

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[138] Each of Parsons (2007), Saucedo (2011), and Leonard (2016) discusses some of these explicitly, and there is a wealth of other authors implicitly arguing for or against some number of these. Leonard (2016) formulates the principles he discusses as claims about what is necessary and what is impossible, but I leave it open for harmony principles to be contingent. Also, these principles are all fronted by universal quantifiers, which I leave implicit.

[139] This principle has been variously called the *Doctrine of Arbitrary Undetached Parts* (van Inwagen 1981), the *Geometric Correspondence Principle* (Simons 2004b, p.371), and *Arbitrary Partition* (Parsons 2007). I call it by the last of these names.

x is gunky iff x's location is gunky.

Parts $x@r \,\&\, y@s \rightarrow (x \leq y \leftrightarrow r \leq s)$

x is part of y iff x's location is a subregion of y's location.

Proper Parts $x@r \,\&\, y@s \rightarrow (x < y \leftrightarrow r < s)$

x is proper part of y iff x's location is a proper subregion of y's location.

Overlap $x@r \,\&\, y@s \rightarrow (x \circ y \leftrightarrow r \circ s)$

x and y overlap iff x's location and y's location overlap.

Fusion $x@r \,\&\, \forall y\big(y \prec yy \rightarrow \exists s(s \prec ss \,\&\, y@s)\big) \,\&$

$\forall s(s \prec ss \rightarrow \exists y(y \prec yy \,\&\, y@s)) \rightarrow (Fu(yy, x) \leftrightarrow Fu(ss, r))$

x is the fusion of the plurality yy iff x's location is the fusion of the locations of yy.

In 2.5.2, I show that supersubstantivalism is consistent with failures of every one of the principles above.

I do concede that the unrestricted view (according to which every region is an object) commits us to these principles. I see no way around that. I think that is probably why Schaffer et al have said that supersubstantivalism entails harmony; because they are wrongly thinking only of the unrestricted version. Or they wrongly think that restricted versions also entail harmony. But, as I show in the next section, harmony is not built into supersubstantivalism, nor is it an entailment of supersubstantivalism, because restricted versions permit failures of every harmony principle. These failures of harmony permit restricted views to countenance the

existence of objects like extended simples, and gunky objects in pointy space which, until now, have been thought to be inconsistent with supersubstantivalism.

The key observation driving much of what follows is this: restricted views claim that, although all objects are regions, not all regions are objects, and this means that there is room for differences in the behaviour of the spacetime and material object mereologies.[140, 141] They do not have to be in harmony.

Some new terms will be useful. Call a region that is not a material object a *mere region*. And call a region that is a material object a *host region*. When I wish to be as precise as possible, I will attach a subscript 'm' to an instance of a mereological term if it pertains to the material object mereology, and I will attach a subscript 'r' to an instance of a mereological term if it pertains to the spacetime region mereology. For example, '$x <_r y$' says that x is a part of y according to the region mereology, while '$x <_m y$' says that x is a part of y according to the material object mereology. Since all objects are regions, $x <_m y$ entails $x <_r y$,[142] but since not all regions are objects $x <_r y$ does not entail $x <_m y$. For this reason, '$<_m$' can only be flanked by terms that denote host regions, whereas '$<_r$' can be flanked by any mix of terms

[140] Uzquiano (2011, p.209-10) has briefly made this observation, in a more general discussion of harmony. However, what follows in 2.5.2 is much more detailed and has more significant consequences for supersubstantivalism than Uzquiano's observation. Furthermore, it seems that Uzquiano's observation has been overlooked in subsequent literature, as evidenced by the fact that authors such as Leonard (2016) and Duncan and Miller (forthcoming) are still claiming that supersubstantivalism entails harmony.

[141] I follow Markosian (2014) in thinking that since mereology is a tool for describing structure, and there is more than one structure in reality, it is natural to think there could be more than one mereology. As Markosian (2014, p.87) puts it, "mereology is part of what carves ontology, meaning that one crucial factor that can separate one ontological category from another is that the two categories are governed by different sets of mereological principles." Furthermore, I take it that the material object mereology and the region mereology are both mereologies worthy of our attention because they describe different ontological categories.

[142] This entailment is what Parsons (2007, p.213) calls *expansivity*, and it can be written as:

$$(x@r \,\&\, x <_m y) \rightarrow (\exists s)(y@s \,\&\, r <_r s).$$

If x is exactly located at r and x is a part_m of y, then there is an s such that y is exactly located at s and r is part_r of s. I have added the relevant subscripts to Parsons' formalisation, but this does not change the meaning. Parsons claimed this could be a conceptual truth, and I am inclined to agree.

denoting host or mere regions. Given this terminology, supersubstantivalists will need to clarify the harmony principles as follows:

Arbitrary Partition* $x@_{>}r \rightarrow (\exists y)(y <_m x \,\&\, y@r)$

Every region x pervades contains a material object that is part_m of x.

Simplicity* $x@_{>}r \rightarrow (\neg\exists y(y <_m x) \leftrightarrow \neg\exists s(s <_r r))$

x is mereologically simple_m iff x's location is mereologically simple_r.

Complexity* $x@r \rightarrow (\exists y(y <_m x) \leftrightarrow \exists s(s <_r r))$

x is mereologically complex_m iff x's location is mereologically complex_r.

Number of Parts* $x@r \rightarrow (\exists y_1 \ldots \exists y_n((y_1 \neq y_2 \,\&\, \cdots \,\&\, y_{n-1} \neq y_n) \,\&$

$(y_1 \leq_m x \,\&\, \cdots \,\&\, y_n \leq_m x) \,\&\, \forall z(z \leq_m x \rightarrow z = y_1 \vee \cdots \vee z = y_n)) \leftrightarrow$

$\exists s_1 \ldots \exists s_n((s_1 \neq s_2 \,\&\, \cdots \,\&\, s_{n-1} \neq s_n) \,\&\, (s_1 \leq_r r \,\&\, \cdots \,\&\, s_n \leq_r r) \,\&$

$\forall t(t \leq_r r \rightarrow t = s_1 \vee \cdots \vee t = s_n))$

x has exactly n parts_m iff x's location has exactly n parts_r.

Gunk* $x@_{>}r \rightarrow (\forall y(y \leq_m x \rightarrow \exists z(z <_m y)) \leftrightarrow \forall s(s \leq_r x \rightarrow \exists z(z <_r s)))$

x is gunky_m iff x's location is gunky_r.

Parts* $x@r \,\&\, y@s \rightarrow (x \leq_m y \leftrightarrow r \leq_r s)$

x is part_m of y iff x's location is a part_r of y's location.

Proper Parts* $x@r \,\&\, y@s \rightarrow (x <_m y \leftrightarrow r <_r s)$

x is proper part_m of y iff x's location is a proper part_r of y's location.

Overlap* $\quad x@r \,\&\, y@s \rightarrow (x \circ_m y \leftrightarrow r \circ_r s)$

x and y overlap_m iff x's location and y's location overlap_r.

Fusion* $\quad x@r \,\&\, \forall y\big(y \prec yy \rightarrow \exists s(s \prec ss \,\&\, y@s)\big) \,\&$

$\forall s(s \prec ss \rightarrow \exists y(y \prec yy \,\&\, y@s)) \rightarrow (Fu_m(yy, x) \leftrightarrow Fu_r(ss, r))$

x is the fusion_m of the plurality yy iff x's location is the fusion_r of the locations of yy.

It is important to clarify the harmony principles in the above ways. If, instead, they had terms referring to the same mereologies on either side of the biconditionals (e.g. x is gunky_r iff x's location is gunky_r) then they would not be harmony principles because they would not be alleging a mirroring between material objects and spacetime regions. Further, if the terms referred to the same mereologies on either side of the biconditionals, the resulting principles would be so uncontroversial and uninteresting that no theory would deny them.

2.5.2 Cases

What follows next are cases in which a variety of harmony principles fail (and each harmony principle fails in at least one case). I explain how restricted versions of supersubstantivalism are consistent with them. Then I conclude with some lessons to be learned from this.

Case 1: Extended Simples. For the moment, let us define extended simples as follows. A material object x is an extended simple iff x's exact location is complex and all of the proper subregions of x's exact location are mere regions (not host regions).[143] There are at least two

[143] Extended simples come in several varieties. It is most common to discuss *spanners* and *multi-locaters*. When I talk about extended simples here, I am talking about spanners.

good reasons to think that they might exist. For one thing, they seem conceivable. As Parsons has said:[144]

> I can conceive of an object being extended without having any proper parts. […] For example, there might be a completely solid sphere that had no proper parts. The left half of the region this sphere exactly occupies is pervaded, but not itself exactly occupied, by the sphere; and since the sphere has no proper parts, it has no proper part that exactly occupies that region either.

For another, they might be actual. McDaniel points to a passage of writing by physicist Greene, that seems to claim string theory commits to extended simples:[145]

> What are strings made of? There are two possible answers to this question. First, strings are truly fundamental – they are ‘‘atoms,’’ uncuttable constituents, in the truest sense of the ancient Greeks. As the absolute smallest constituents of everything, they represent the end of the line.... From this perspective, even though strings have spatial extent, the question of their composition is without any content. Were strings to be made of something smaller, they would not be fundamental.

In the absence of compelling arguments to the contrary, this strikes me as enough reason to take extended simples seriously.[146] Theories that make room for them are better than those that do not (all other things being equal).

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[144] Parsons (2007, p.211).

[145] McDaniel (2007b, p.131), citing Greene (1999, p.141).

[146] In addition to these reasons, some have given recombination arguments for extended simples (e.g. Sider (2007), McDaniel (2007a), Saucedo (2011)) but supersubstantivalists will not find those arguments convincing. Recombination of objects and their locations is not permitted because they are identical.

Here is a contested claim, which I endorse: if Arbitrary Partition is true, then extended simples are impossible. Braddon-Mitchell and Miller disagree.[147] They have argued that extended simples are consistent with Arbitrary Partition in spacetimes whose atomic regions are extended. They argue that, if an atomic region is extended, then even arbitrary partition cannot find anywhere to cut an object exactly located there into parts; the object is simple but it is exactly located at an extended region, so it is extended. The reason that I disagree with Braddon-Mitchell and Miller is that we are working with different definitions of extended simples. Many have been given in the literature, and they are not all equivalent. Here are a handful.

1. A simple, in my sense, occupies a greater than point-size region of space and is indivisible because it does not have, for instance, a right or a left half.[148]
2. An extended material simple is a material object extended in space (or spacetime) that nonetheless lacks proper parts.[149]
3. An extended simple is an entity without proper parts (so a simple) whose locus [i.e. exact location] does have proper parts.[150]
4. Extended simples are entities that are extended in space but have no (proper) parts. […] They would occupy a complex region of space.[151]
5. A simple is an entity that has no proper parts […] Say that an entity is extended just in case it is a spatiotemporal entity and does not have the shape and size of a point.[152]

[147] Braddon-Mitchell and Miller (2006). Although, as we shall see, our disagreement is merely verbal.
[148] Scala (2002, p.394).
[149] McDaniel (2007b, p.131).
[150] Simons (2014, p.63).
[151] Pickup (2016, p.257).
[152] Gilmore (2018).

6. [W]e take an extended simple to be a mereologically simple entity that is not point-like. […] If the standard real topology of space is assumed, this definition boils down to the following one: an extended simple is a mereological atom whose exact location is mereologically complex.[153]

Notice that all the above definitions have two components and, while they all agree on one component (that extended simples are simple objects), there is disagreement on the other. Definitions 1, 2, and 5 all say that they are not point-sized, whereas definitions 3 and 4 say that extended simples are exactly located at complex (i.e. not simple) regions. Definition 6 notes that the two are equivalent in spacetimes that are made up of points. So we have two candidate definitions for extended simples.

The Extended Definition: Extended simples are simple objects that are exactly located at *non-point-sized* regions.

The Complex Definition: Extended simples are simple objects that are exactly located at *complex* regions.

On the extended definition, Arbitrary Partition does not rule out extended simples in non-pointy spacetimes, where the smallest, simple regions are extended. But, on the complex definition, Arbitrary Partition rules out extended simples in every spacetime. So which definition is better? The complex definition is. To see why, ask yourself what makes extended simples interesting. They are interesting because they are failures of harmony. That is, they are cases where the structure of objects differs from the structure of spacetime. If spacetime is ultimately not made

[153] Costa and Calosi (forthcoming, §5).

of points and the smallest regions are extended, then the extended definition says that *all* simple objects are extended simples. Objects exactly located at the smallest possible regions still count as extended simples because they have extension. But that would not be at all interesting. Certainly, it would not be surprising or controversial. The fact is hardly worth our attention. In such non-pointy spacetimes (and in all other spacetimes, for that matter), we would be far more interested in objects that span multiple regions and yet have no proper parts. The existence of *those* objects would be a surprise and would be controversial. They demonstrate that the structures of spacetime and material objects do not perfectly mirror each other. Much more interesting. Ergo, insofar as we want our terms of art to track interesting or noteworthy phenomena, we have good reason to use the complex definition to define extended simples. Hence, I claim that extended simples are inconsistent with Arbitrary Partition.

There is obviously a verbal dimension to this dispute. Advocates of the extended definition can say "sure, Arbitrary Partition is inconsistent with those things you call extended simples, but they're not what we are talking about." But I am saying that advocates of that definition *should* be talking about the things I call extended simples.

However, the more important point is this. Irrespective of what we call them, the objects described by the complex definition appear possible and are inconsistent with Arbitrary Partition. Examples like the conceivability of Parsons' sphere and fundamental strings in pointy space go to show that much. And since we have reasons to believe they are possible, we therefore have reason to believe Arbitrary Partition is false.[154]

How does supersubstantivalism fit into this? Versions of supersubstantivalism count as restricted if they posit constraints on which regions can be material objects. Different restricted versions of supersubstantivalism will posit different constraints. Consider the following constraint, which entails the existence of extended simples.

[154] For more reasons to think that Arbitrary Partition is false, see van Inwagen (1981).

Restricted Constraint: Size

Only regions above a certain size can be host regions – where that size is bigger than the smallest mere regions.

The string theory argument for extended simples showcases a version of this constraint. The argument reasons that, according to string theory, the most fine-grained decomposition of any material object is a decomposition into one-dimensional, extended strings. Each string is extended across regions of spacetime, but none of the proper subregions of a string count as a material object – they are all only mere regions. Whether this interpretation of string theory is warranted has been disputed,[155] but I do not need to make a judgement on that. For present purposes it is enough to show that the possibility of extended simples, given supersubstantivalism, depends crucially on what constraint is used for determining which regions are objects and which are not, and there seems to be no good reason to rule out the possibility of every candidate constraint that permits them.

In general, any restricted version of supersubstantivalism whose constraints for material objecthood (i.e. for being a host region) do not rule out the possibility of host regions that have only mere regions as proper subregions is consistent with extended simples. This is important because extended simples are inconsistent with several harmony principles. Hence, by showing that supersubstantivalism is consistent with extended simples, I show that supersubstantivalism is consistent with failures of those principles. They are:

- Arbitrary Partition*
- Simplicity*

[155] Baker (2016).

- Complexity*
- Number of Parts*
- Parts*
- Proper Parts*

We have already seen that, given extended simples, Arbitrary Partition* fails because for any extended simple x, x pervades all of the proper subregions of its location but extended simples are such that there are no objects at any of the proper subregions of x's location.

Simplicity* and Complexity* fail because extended simples are objects that are simple_m (not complex_m) and complex_r (not simple_r).

Number of Parts* fails because for any extended simple x, x is a simple_m material object, so it has no proper parts_m, but its location is complex_r so it has a non-zero number of proper sub-regions.

Parts* and Proper Parts* fail in the case of extended simples because, when the antecedents and the left-to-right direction of each biconditional are true, the right-to-left direction of each biconditional is false. For any extended simple y, by hypothesis, the location of y has proper subregions. Call one of those proper subregions x. x's location is a proper part_r of y's location, but x is not a proper part_m of y because x is, by hypothesis, not a host region. (Since proper parthood is a special case of parthood, this also invalidates Parts*.)

Ergo, any claim that supersubstantivalism is committed to those principles is false (for example, the claims made by Schaffer, Saucedo, and Leonard, included at the start of 2.5). Supersubstantivalists can reject those principles, and extended simples show us how.

I anticipate an objection. On my system, there are at least three parthood relations we could define up: parthood on the region mereology; parthood on the material object mereology; and what we might call generic parthood, which is disjunctive – for any x and any y, x counts

as a generic part of y iff there is some mereology on which x is part of y. So, here is a concern: it looks as though I am interpreting my opponents as making claims about the *material object* parthood relation, and perhaps that is unfair. Perhaps those who would say that supersubstantivalism is not consistent with extended simples are more interested in is the *generic* parthood relation. Certainly, they speak truly when they say that supersubstantivalism is inconsistent with extended simples, if generic parthood is what we care about. The problem is that I have not yet been clear about how or whether our definition of extended simples ought to have its mereological terms relativised. Authors not working in my system will not have relativised definitions in mind, so the best method of translation into my system is unclear. But I offer the following argument against considering generic parthood in cases of extended simples.

Combine the view that material objects are *constituted* by their spacetime locations with the view that constituted objects have that which constitutes them as parts (the clay is part of the statue, for example[156]). Now imagine a simple_m object exactly located at an atomic region. Does this count as a simple object in the way relevant to extended simples? It has its location as a part, but should that prohibit us from calling it a simple? Or, what about a hylomorphist who believes that material objects all have structural parts?[157] Should we say that their view is inconsistent with simples (extended or not) because they are committed to all material objects having *structural* parts? Or consider someone who endorses a mereological bundle theory, believing that objects have *qualitative* parts.[158] Should we say that their view is inconsistent with simples (extended or not) because all material objects have qualitative parts? If we want to claim that supersubstantivalism is inconsistent with extended simples, on the grounds that the candidates for extended simples have regions as parts, we must also claim that all of the

[156] See Doepke (1982), Fine (2008), and Koslicki (2008).
[157] See Koslicki (ibid) or Toner (2013).
[158] Paul (2002).

above theories (and others like them) are also inconsistent with extended simples. That strikes me as throwing the baby out with the bathwater; surely hylomorphists, bundle theorists, and so on do have a notion of simple material objects. If so, then what matters for x being an extended simple is just that x does not have any material objects as proper parts. This would render our definition of extended simples as follows:

> Extended simples: Extended simples are simple_m objects that are exactly located at complex_r regions.

Of course, you are free to disagree with what I have said above and to insist on a usage of the phrase 'extended simples' that attributes simple entities no parts *of any kind whatsoever* and that I am talking about something else (perhaps merely 'extended simples_m'). I have tried to insist that I am talking about the same extended simples as other authors, but I recognise that what I have said here might not convince everyone. However, to the unconvinced, I would reply that my usage is far more interesting than the alternative. As I have argued above, the reason extended simples are interesting is that they are failures of harmony. All the theories alluded to in the cases above are capable of countenancing failures of harmony, so we should not exclude them from discussions of extended simples on the grounds that their objects have regions as parts, structural parts, or properties as parts, etc. Hence, what makes something an extended simple is *not* that it has no parts *simpliciter*; just that it has no material objects as parts and is extended. If we accept this lesson, we see that objecting to supersubstantivalist extended simples on the grounds that they have mere regions as parts is misplaced. If we do not accept this lesson, then my argument applies only to extended simples_m, but that will be enough to secure the conclusions for which I am arguing. By pointing out that supersubstantivalism is

consistent with extended simples$_m$ I still show that supersubstantivalism is consistent with failures of harmony.

Another objection might come from Parson's proof that supersubstantivalism entails Arbitrary Partition.[159] It runs as follows:

(1)	$x@_{>}r$	(assumption for conditional proof)
(2)	$(\exists s)(x@s \,\&\, r \leq s)$	(1, definition of $@_{>}$)
(3)	$x@s \,\&\, r \leq s$	(2, ∃-elimination)
(4)	$x@r \leftrightarrow x = r$	(supersubstantivalism)
(5)	$x = s$	(3, 4, *modus ponens*)
(6)	$r \leq x$	(3,5, &-elimination, substitution)
(7)	$r = r$	(=-introduction)
(8)	$r@r$	(7, 4, *modus ponens*)
(9)	$(\exists y)(y \leq x \,\&\, y@r)$	(6, 8, ∃-introduction, &-introduction)
(10)	$x@_{>}\, r \rightarrow (\exists y)(y \leq x \,\&\, y@r)$	(9, conditional proof, discharging 1)

If this proof is correct, then supersubstantivalism must be inconsistent with extended simples. Fortunately, there are several ways to block this proof. It can be blocked by noticing that the move from line (7) to line (8) relies on the claim that exact location is reflexive. That is, that regions are exactly located at themselves. Some people are happy with that claim,[160] but not everyone is.[161] Parsons himself says he has "no quarrel with [it]; but nor with its denial".[162] Those who dislike it think there is something strange about saying that a mere region is located

[159] Parsons (2007, p.232).
[160] Casati and Varzi (1999).
[161] Simons (2004a).
[162] Parsons (2007, p.224).

anywhere; it is just not the sort of thing that has a location. We could, as part of a package with the restricted view, take the view that only host regions have locations and mere regions do not. We are already restricting which regions are objects, so why not also restrict which regions are locations? This would invalidate Parsons' argument by blocking the move from (7) to (8).

The question of whether mere regions are located is one I admit to having no strong feelings about. It is not unusual to see the matter left open or identified as a choice point.[163] If mere regions are not located, then the quantifiers in the various principles and proofs that follow can just be restricted to all the material objects and host regions. Such a restriction would still be in the spirit of the common restrictions of attention in the literature. Nevertheless, I lean towards believing mere regions *are* located because I see no way to deny that, in general, the way we talk about locations does not depend at all on whether the locations are empty or full of objects. I might say "this is a great location for a house" while looking at an empty plot and thinking about building a house there, or while looking at a house and celebrating the fact someone chose that spot on which to build it. So, it is not clear to me what we could mean by 'location' if we do not mean region *simpliciter* – whether it hosts a material object or not. This can be seen in Casati and Varzi's definition of regionhood. Given the predicate 'R' to denote the property of being a region, they define regionhood as:[164]

Regionhood: $Rx =_{df} x@x$

On their view, to be a region is just to be something that is exactly located at itself. I think this is probably right. I see no good reason to deny it. Of course, philosophers are free to stipulate that their use of the word 'location' does not apply to mere regions, but I take it that doing so

[163] For example, Casati and Varzi (1999, p.123), Parsons (2007, p.224), and Varzi (2007, p.1016).
[164] Casati and Varzi (1999, p.123).

makes an *unmotivated* departure from ordinary language use (and that is bad). For those reasons, I think we should look for a different way to block Parsons' proof.

Here is a way that does not rest on rejecting the reflexivity of exact location. Once again, we will employ subscript 'r' and subscript 'm' to disambiguate the region mereology from the material object mereology, respectively. Doing so, we can recast Parsons' proof as follows:

(11)	$x@_{>}r$	(assumption for conditional proof)
(12)	$(\exists s)(x@s \,\&\, r \leq_{\mathrm{r}} s)$	(1, definition of $@_{>}$)
(13)	$x@s \,\&\, r \leq_{\mathrm{r}} s$	(2, ∃-elimination)
(14)	$x@r \leftrightarrow x = r$	(supersubstantivalism)
(15)	$x = s$	(3, 4, *modus ponens*)
(16)	$r \leq_{\mathrm{r}} x$	(3,5, &-elimination, substitution)
(17)	$r = r$	(=-introduction)
(18)	$r@r$	(7, 4, *modus ponens*)
(19)	$(\exists y)(y \leq_{\mathrm{r}} x \,\&\, y@r)$	(6, 8, ∃-introduction, &-introduction)
(20)	$x@_{>} r \rightarrow (\exists y)(y \leq_{\mathrm{r}} x \,\&\, y@r)$	(9, conditional proof, discharging 1)

On line (12), I claim that the definition of $@_{>}$ is $(\exists s)(x@s \,\&\, r \leq_{\mathrm{r}} s)$, with a subscript '$r$', not a subscript '$m$'. The reason for this is that the definition of pervading conveys a fact about regions in general, not just host regions. It tells us that when an object x pervades a region r, r *is a subregion* of x's exact location. It does not tell us that there must be an object there (if it did, it would entail Arbitrary Partition all on its own, without supersubstantivalism). The rest of the subscript 'r's in the recast proof just follow from the first one, on line (12).

But the conclusion of the recast proof is perfectly consistent with extended simples. It says that if x pervades r, then there is some y such that y is a part of x *on the region mereology*, and y is exactly located at r. This is consistent with extended simples because it is consistent with y *not* being part of x on the material object mereology – because y is a mere region.

Case 2: Regular Closed Regions. Some more definitions are required. These are not precise formal definitions, since those would require a lot more groundwork, but they should convey enough of what is going on to be useful.[165] For any region r:

- An *open ball about* r is a region composed of all and only the points less than some fixed distance from r.
- A point p is a *boundary point* of r iff every open ball about p contains subregions of both r and some region that does not overlap r.
- The *interior* of r is the biggest subregion of r that has none of r's boundary points as parts.
- The *closure* of r is the fusion of r and all r's boundary points.
- r is a *regular open* region iff r is identical to the interior of the closure of r.
- r is a *regular closed* region iff r is identical to the closure of the interior of r.

Now, imagine a supersubstantivalist who has taken the following restricted view about which regions can be objects.

Restricted Constraint: Regular Closed

Only regular closed regions can be host regions.

[165] This approach to exposition of these concepts is taken (and modified) from Uzquiano (2006). Unlike Uzquiano, I give definitions in mereological terms, rather than set-theoretic terms, because I have assumed that the structure of spacetime regions is mereological (see 2.3).

Notice that this constraint precludes any subregion (proper or improper) of a region's boundary from being a host region, because the interior of any such region is the empty space, and the closure of the empty space is all space. This fact means that the Regular Closed constraint generates failures of the following harmony principles:

- Arbitrary Partition*
- Parts*
- Proper Parts*
- Overlap*

Since I have already demonstrated that supersubstantivalism is consistent with failures of Arbitrary Partition*, Parts*, and Proper Parts*, I now focus only on failures of Overlap*. Recall that it states:

Overlap* $x@r \,\&\, y@s \rightarrow (x \circ_m y \leftrightarrow r \circ_r s)$

x and y overlap_m iff x's location and y's location overlap_r.

The Regular Closed constraint generates failures of this principle wherever the antecedent is true and r and s overlap only by sharing some number of boundary points. The fact that r and s share boundary points means that they overlap in the region mereology (i.e. they overlap_r), but since no part of any boundary is a host region, there is no host region that x and y have in common, so they do not overlap in the material object mereology (i.e. they do not overlap_m). Thus, the left-to-right direction of the biconditional is true, but the right-to-left direction is false. Overlap* fails.

Case 3: Regular Open Regions. Finally, consider a supersubstantivalist who endorses the following restricted constraint:

Restricted Constraint: Regular Open

Only regular open regions can be host regions.

This constraint generates failures of the last two principles – Fusion* and Gunk*. Recall that they state:

Fusion* $x@r \,\&\, \forall y\big(y \prec yy \rightarrow \exists s(s \prec ss \,\&\, y@s)\big) \,\&$

$\forall s(s \prec ss \rightarrow \exists y(y \prec yy \,\&\, y@s)) \rightarrow (Fu_m(yy, x) \leftrightarrow Fu_r(ss, r))$

x is the fusion$_m$ of the plurality yy iff x's location is the fusion$_r$ of the locations of yy.

Gunk* $x@_> r \rightarrow (\forall y(y \leq_m x \rightarrow \exists z(z <_m y)) \leftrightarrow \forall s(s \leq_r x \rightarrow \exists z(z <_r s)))$

x is gunky$_m$ iff x's location is gunky$_r$.

To demonstrate a failure of Fusion*, start with a one-dimensional metric space defined from the real numbers, $\mathbb{R}$. Imagine two objects, x and y, which are exactly located at the regular open regions (0,1) and (1, 2), respectively. The fusion of those locations is (0,1) ∪ (1, 2) but, since (0,1) ∪ (1, 2) is not a regular open region, the fusion of x and y cannot be located there. Given the Regular Open constraint, the fusion of x and y must be located at the regular open

region (0, 2),[166] which is the interior of the closure of (0,1) ∪ (1, 2). The region (0, 2) includes point 1, but the region (0,1) ∪ (1, 2) does not. This means that the fusion of x and y is not located at the fusion of the locations of x and y. Hence, Fusion* fails.

For failures of Gunk*, imagine the supersubstantivalist who endorses the Regular Open constraint also claims that for any regular open host region r, all regular open subregions (proper or improper) of r are also host regions. This is a model for Tarski's gunk.[167] Notice that every regular open host region will have regular open host proper subregions, even in pointy space. For example, imagine a spherical region with radius 1, without any of its boundary points, in a three-dimensional metric space defined from the real numbers, $\mathbb{R}^3$. There are uncountably many more boundaryless spherical regions with smaller and smaller radii contained in that spherical region, as proper subregions, even though the space is ultimately composed of points. This example demonstrates that supersubstantivalists can countenance objects that are gunky_m, the locations of which are not gunky_r. Once again, we have a case where the antecedent of the harmony principle is true, the left-to-right direction of the biconditional is true, but the right-to-left direction of the biconditional is false. So Gunk* fails.

2.5.3 Upshot

What have we learned? Firstly, that, contrary to what is usually supposed, supersubstantivalism is consistent with failures of harmony principles. Other lessons have been learned along the way to that conclusion. I have shown that there is something at stake in the decision to endorse a restricted or an unrestricted version of supersubstantivalism; what is at stake is the power to countenance a restricted answer to the special composition question, and the power to

[166] That is, if there is a fusion of these objects at all. Anyone who takes the popular view that universalism is necessarily true (for example, Lewis (1986), Armstrong (1997), and Sider (2001)) will say there is such a fusion.

[167] Tarski (1927).

countenance failures of harmony (including extended simples, and gunky objects in pointy space).

The diminished expressive power of the unrestricted view is, I think, enough reason to prefer a restricted version of supersubstantivalism. In response to this claim, advocates of the unrestricted view are likely to say that commitment to all the harmony principles is a virtue, not a drawback, of their view because it comes with more explanatory power, by rendering many problems about location utterly unmysterious. Why are there subregions of my location wherever there are parts of me? There cannot not be, because of the Parts principle. And so on. Those who like the unrestricted view will say that accepting the relevant harmony principles gives answers to these questions, and they will say that other views struggle to give answers of their own.[168] I suspect that restricted views can still do all the same explaining by leaning on the identity relation: there are subregions of your location wherever there are parts of you because your parts are identical with regions and parthood is subregionhood. But nobody has given an exhaustive list of the questions about location that the unrestricted view is alleged to solve and attempting to do so here would be too much of a diversion. Instead, I simply add that, even supposing there are some things that the unrestricted view can explain, which restricted views cannot, the upshot is just a common trade-off between explanatory power at the expense of expressive power (or vice-versa). Thankfully, I do not need to weigh in on metametaphysical discussions about which theoretical virtue is more desirable; my aim in these sections has been more modest.

I have shown that we have reason to be wary of Parsons' argument that supersubstantivalism entails Arbitrary Partition. I have also shown more generally that

[168] Schaffer (2009, pp.138-140) and Duncan and Miller (forthcoming) have made something like this argument in favour of supersubstantivalism. None of them recognised that supersubstantivalism does not entail harmony, but they argued that entailing harmony is a virtue of supersubstantivalism because it offers explanatory power. Perhaps this means they would favour unrestricted views.

supersubstantivalism is consistent with failures of the harmony principles. Most importantly, I have shown that endorsing a restricted version of supersubstantivalism comes with benefits in expressive power that have, until now, been thought off-limits to supersubstantivalists.

2.6 Summary

The view that location is identity has been established as the identity version of super-substantivalism. It claims that spacetime is a fundamental substance and material objects are nothing over and above it. Material objects are identical with regions of spacetime.

Some commitments of the view were discussed and, paired with those of the previous chapter, we now have a list of commitments made by the theory I lay out in the next chapter. They are:

Core commitments

- Composition as identity
- Four-dimensionalism
- Counterpart theory
- Supersubstantivalism
- Classical extensional mereology (which includes unrestricted composition) for regions
- Weak unrestricted decomposition for regions

I have also added a commitment to rejecting some harmony principles. I am not including this in the list of core commitments, because the view I advocate in the next chapter could be amended to cohere with all the harmony principles – though it would look slightly different

and it would require accepting unrestricted composition for objects and rejecting extended simples.

CHAPTER 3:

SUPER-CAI

Now the rubber meets the road. The previous chapters have introduced composition as identity and supersubstantivalism. In this chapter, I combine the two views into the view I am calling *supersubstantival composition as identity*. Or *super-CAI*, for short.

Here is the plan. In the first half of the chapter (3.1), I establish the semantics for super-CAI. I start by giving models for understanding how composition works on my theory and, once the technical detail is explained, I offer a more philosophical explanation. Then, in the second half (3.2), I make good on some promises from Chapter 1, by looking back to some puzzles discussed there and showing that super-CAI solves them.

3.1 Semantics for Super-CAI

My aim in this section is to provide a model that describes how I understand many-one identities. By the end of this section, readers should also have an understanding of how I use those many-one identities to offer reductive metaphysical explanations of the nature of location and composition. Providing this model will also permit me to state my view as precisely as possible, to prove that it provides responses to the puzzles we have encountered before now, and to equip us for future chapters where I explore the prospect of restricted composition (Chapter 4), respond to objections (Chapter 5), and argue that super-CAI fares better than its rivals (Chapters 6 and 7).

In what follows, I help myself to a mereology for regions (classical extensional mereology), which I bake into the model, and I use that to explain the structure of objects. This is informative because although all objects are regions, not all regions are objects. Crucially,

my view is that classical extensional mereology (CEM) describes the relations between regions simpliciter, but not between regions that host material objects (see 2.3 and 2.4 for discussion of this).

3.1.1 Syntax

The vocabulary I use combines elements from classical and plural logic. It includes:

- Singular constants: $a, b, c \ldots$
- Plural constants: $aa, bb, cc \ldots$
- Singular variables: $x, y, z \ldots$
- Plural variables: $xx, yy, zz \ldots$
- Predicates: $F, G, H \ldots R, S, T \ldots$
- Connectives: ¬, ∨, &, →, ↔
- Quantifiers: ∀, ∃[169]
- Primitive binary relations: $=, \prec$ (These are 'is identical to' and 'is one of' respectively. Parthood and overlap in the object language can be defined in terms of these.)

The rules I use to govern the construction of well-formed formulae (wffs) and sentences also contain nothing out of the ordinary:

- If t is a term either singular or plural, and P is a unary predicate, then Pt is a wff.[170]
- If t_1 is a singular term, and t_2 is a plural term, then $t_1 \prec t_2$ is a wff.

[169] Precision requires me to note that the plural and singular quantifiers are in fact different quantifiers, but for simplicity I will be allowing the standard '∀' and '∃' symbols to do double duty.

[170] I am only offering a semantics for unary predication (not n-ary predication) here. This is for two reasons. First, a core aim of this chapter is to prove that my view solves problems and is immune to objections – n-ary predication is not necessary for that. Second, the semantics for unary predication is simple and elegant, but the semantics for n-ary predication is more space-consuming and represents a significant diversion from my aims in this chapter.

- If t_1 and t_2 are terms either singular or plural, then $t_1 = t_2$ is a wff.
- If A and B are wffs, then so are $\neg A$, A & B, $A \vee B$, $A \rightarrow B$, and $A \leftrightarrow B$.
- If A is a wff, then $\forall xFx$, $\forall xxFxx$, $\exists xFx$, and $\exists xxFxx$ are wffs.
- Nothing else is a wff.

I use the normal definitions of free and bound variables, and a wff with all variables bound is a sentence. Next, the semantics. What follows are models and satisfaction conditions for formulae relative to the models. First, the models.

3.1.2 Model ($\boldsymbol{M} = < \boldsymbol{D}, \boldsymbol{I}, \boldsymbol{R}, \circ >$)

- Domain (D): Is a non-empty domain of spacetime regions.[171] The structure of these satisfies CEM.
- Interpretation function (I): Is a function from predicates to subsets of D.
- Denotation relation (R): Relates singular constants in the object language to single spacetime regions in the domain and relates plural constants to pluralities of regions in the domain.
- Overlap ($\circ$): Is the overlap relation on regions. I use overlap in the metalanguage, to give semantic clauses for various wffs. This overlap relation satisfies CEM. Given the primacy of overlap in my model, I use Goodman's axiomatisation of CEM because it treats overlap as primitive.[172]

[171] I have not said whether these regions are point-sized or not. They might be, but they need not be. In fact, these can be any regions whatsoever. This is deliberate. I wish to remain neutral over whether spacetime is ultimately composed of point-sized regions because I agree with Nolan (MS) that there are some good reasons to think that physics points us away from models that build spacetime out of points, and we should therefore be careful not to "legislate tomorrow's physics out of contention from the armchair." (MS, p.4).

[172] Goodman's axiomatisation of CEM is as follows:

Overlapping Parts: $\forall x \, \forall y \, (x \circ y \leftrightarrow \exists z(z \leq x \,\&\, z \leq y))$

Extensionality: $\forall x \, \forall y \, (\forall z(z \circ x \leftrightarrow z \circ y) \rightarrow x = y)$

This is an unusual model for several reasons. Let us examine three. First, this model is unusual because it contains a denotation *relation*. This is because we cannot use an interpretation *function* to map constants to spacetime regions since, when a function is given an input, it must produce one unique output. That does not work here, because the object language has plural terms which denote more than one spacetime region. Thankfully, we can use a relation instead. One individual can bear the same relation to many other individuals, such as when I am the cousin of Stephen, while also being the cousin of Raymond and Jess and Lucy et al.[173]

Since I am using a denotation relation, relating plural terms to pluralities, which is not standard practice, a note is needed about notation. Where functional notation might say '$R(tt)$' to indicate that the function R is being applied to the term 'tt', I also write '$R(tt)$' which should be read as saying that the term 'tt' stands in the relation R (which is denotation) to something(s). In the semantic clauses given below, I write '$R(tt)$' to denote whatever things the term 'tt' is related to by R (this has the benefit of looking the same as the functional notation). And where functional notation might say '$R(tt) = x$' to indicate that the function R maps the term 'tt' to x, I write '$R(tt; x_1, x_2, x_3)$' to say that the term 'tt' bears the denotation relation to the plurality that contains x_1, x_2, and x_3.

A second reason these models are unusual is that the interpretation function only deals with predication – not with mapping first order constants and variables to objects in the domain. But this is well-motivated: the need for a denotation relation for first order mapping has just been discussed, but there is no need to similarly complicate the picture for predication. Predication can work just as it is standardly taken to. I talk more about this below, when discussing the satisfaction conditions for sentences.

Unrestricted Composition: $\forall xx\ \exists z\ Fu(z, xx)$

Where '$x \leq y$' means 'x is a part of y', '$x \circ y$' means 'x overlaps y', and '$Fu(z, xx)$' means 'z is the fusion of xx'.

[173] This trick is a version of an innovation by Boolos (1985).

The third peculiarity about these models is not a component of the models at all; it is the variable assignment. Because I cannot use assignment functions to map plural variables to multiple things (again, because functions have unique outputs), I must use an assignment relation. Just like the denotation relation, the assignment relation is functional on singular variables and relational on plural variables. I call the assignment relation σ.

All three of these unusual features of the models are really the same unusual feature: because I am dealing with plural terms, things like denotation and variable assignment must be relational rather than functional. With that established, I now move on to give satisfaction conditions for wffs.

3.1.3 Satisfaction Conditions

In what follows, I detail the satisfaction conditions for wffs, in the order they were listed in the wff and sentence formation list at the start of this chapter. First, the atomics of the object language, which are predicated terms. For predication (in non-quantified formulae) of singular terms, the standard account of satisfaction is true:

$$M, \sigma \Vdash Pa \Leftrightarrow R(a) \in I(P)$$

This says that the non-quantified formula (which predicates a singular term) 'Pa' is satisfied by any model M and assignment σ iff the denotation of 'a' is a member of the denotation of 'P'. As mentioned above, nothing special is needed for this. Since the denotation relation is functional on singular terms, this is exactly the standard understanding of singular predication. When it comes to plural predication though, more needs to be said.

Inspired by a suggestion from Hovda,[174] I treat all plural predication as collective, not distributive. I think this is something composition as identity theorists can benefit from doing.

[174] Hovda (2014, p.196-197).

Something like it is seen in Wallace's writing.[175] This does not sacrifice any expressive power, since there are translations available for distributive readings of plural predication. I simply take expressions of the form 'Φxx' to be predicating Φ of the xs collectively, and require expressions of the form '$\forall x(x \prec xx \rightarrow \Phi x)$' to predicate Φ of the xs distributively.

Treating all plural predication as collective is a key simplifying assumption, but what does it mean for the metaphysics? It just means that whatever is true of a many is instantiated by the whole region they occupy together. That region, which I call the *maximal region of the plurality*, is defined as the Lésniewski fusion of the regions of the individuals. So, for any plurality xx, the maximal region of that plurality is defined as the region, r, such that:

$$\forall x(x \prec xx \rightarrow x \leq r)\ \&\ \forall y(y \leq r \rightarrow \exists x(x \prec xx\ \&\ y \circ x))^{176}$$

For the sake of simplicity, in what follows, I refer to the maximal region of a plurality by writing the plurality with an overline, instead of writing the definition of the Lésniewski fusion out each time. Hence, in the context of a variable assignment or a denotation relation, the maximal region of the plurality aa is written as '$\overline{aa}$', and the maximal region of the regions denoted by the plurality aa is written as '$\overline{R(aa)}$'. Given these tools, the satisfaction conditions for predication (in non-quantified formulae) of plural terms can be written simply as:[177]

$$M, \sigma \Vdash Paa \Leftrightarrow \overline{R(aa)} \in I(P)$$

[175] As I discuss in Chapter 6.3, Wallace (2011a, p.810) introduces logical notation to treat predication of parts as collective.

[176] I take the term 'Lésniewski fusion' from Cotnoir and Varzi (forthcoming, p.158) and I take it that this definition of fusion is the one best suited to CAI for reasons set out in Cotnoir and Varzi (forthcoming, p.187). The existence of a region that is the Lésniewski fusion of the regions of the individuals is guaranteed by the assumption of CEM for regions.

[177] In what follows, I use quantifiers, overlap, and the *is one of* relation in the metalanguage when giving semantic clauses. I talk more about this below, but it is worth noting at this stage that these are all homophonic.

This states that the non-quantified formula (which predicates a plural term) 'Paa', is satisfied by any model M and assignment σ iff the maximal region of the denotation of 'aa' is a member of the denotation of 'P'.[178] In fact, the sematic clause for plural predication is a more general form of the semantic clause for singular predication. By rewriting it with 't_1' instead of 'aa' (to be neutral between plural and singular terms) we get the general satisfaction condition for unary predication:

$$M, \sigma \Vdash Pt_1 \Leftrightarrow \overline{R(t_1)} \in I(P)$$

This works for the singular case because the denotation of a singular term is an object and, given the commitment to supersubstantivalism, that object *is* its maximal region.

Satisfaction for '$\prec$' is straightforward because it is homophonic with 'is one of' in the metalanguage:

$$M, \sigma \Vdash t_1 \prec t_2 \Leftrightarrow R(t_1) \text{ is one of } R(t_2)$$

By offering the next satisfaction condition, I officially join the ranks of those who claim that composition is the many-one form of a more general identity relation which also has the one-one identity of classical logic and the many-many identity of plural logic as instances.[179] In fact, I claim that identity has four forms. It is one-one, one-many, many-one, and many-many. Composition is many-one identity, and decomposition is one-many identity. All instances of the general identity relation relate portions of reality to each other, and portions of reality are regions of spacetime. The satisfaction conditions for all four forms are the same. Using the terms 't_1' and 't_2', to stay neutral between singular and plural terms, it is:

[178] This does not presume that CAI is true in the metalanguage because it does not require the maximal region of the denotation of 'aa' to be identical to aa (collectively) in the metalanguage.

[179] Lewis (1991, section 3.6), Bohn (2009a, forthcoming), Cotnoir (2013a), Bricker (2016).

$$M, \sigma \Vdash t_1 = t_2 \Leftrightarrow (\overline{R(t_1)} = \overline{R(t_2)})$$

This states that the identity '$t_1 = t_2$' is true, relative to a model M and an assignment σ, iff the maximal region of the denotation of t_1 is identical (in the metalanguage) to the maximal region of the denotation of t_2. This means t_1 and t_2 denote the same maximal region.

Next are the connectives:

$M, \sigma \Vdash \neg A \Leftrightarrow$ it is not the case that $M, \sigma \Vdash A$

$M, \sigma \Vdash A \,\&\, B \Leftrightarrow M, \sigma \Vdash A$ and $M, \sigma \Vdash B$

$M, \sigma \Vdash A \vee B \Leftrightarrow M, \sigma \Vdash A$ or $M, \sigma \Vdash B$

$M, \sigma \Vdash A \rightarrow B \Leftrightarrow M, \sigma \Vdash B$ or it is not the case that $M, \sigma \Vdash A$

$M, \sigma \Vdash A \leftrightarrow B \Leftrightarrow M, \sigma \Vdash A \rightarrow B$ and $M, \sigma \Vdash B \rightarrow A$

For first-order quantification, more notation is needed. If x is a singular variable and r is a region in the domain, D, then 'σ_r^x' is the assignment relation identical with σ except it relates x to r. Further, if xx is a plural variable, and r is a region in the domain D, then 'σ_r^{xx}' is the assignment relation identical with σ except that it relates each member of xx to a subregion of r and $\overline{xx}$ is r.[180]

$M, \sigma \Vdash \forall x Fx \Leftrightarrow$ for every $r \in D, M, \sigma_r^x \Vdash Fx$

$M, \sigma \Vdash \forall xx Fxx \Leftrightarrow$ for every $r \in D, M, \sigma_r^{xx} \Vdash Fxx$

$M, \sigma \Vdash \exists x Fx \Leftrightarrow$ there is some $r \in D, M, \sigma_r^x \Vdash Fx$

$M, \sigma \Vdash \exists xx Fxx \Leftrightarrow$ there is some $r \in D, M, \sigma_r^{xx} \Vdash Fxx$

[180] Once again, the plural case is perfectly general. The singular cases are instances of it.

For the sake of clarity, I now apply all this to an example. Imagine a copse, composed of five trees (this recalls the Fregean example from 1.2). We can model this in the following way.

The domain (D) is the Boolean algebra with five atoms. The atoms are the regions identical with the five trees. Call them 'r_1', 'r_2', 'r_3', 'r_4', and 'r_5'. For our purposes, we are only interested in those five regions plus the region composed of those five regions. Let us call that complex region 'r'. There are other regions in the domain because regions compose universally, but super-CAI alone does not tell us whether those regions are objects, so I ignore them here.

The interpretation function (I) maps the predicate *is a tree* (T) to the following subset of D: $\{r_1, r_2, r_3, r_4, r_5\}$ and it maps the predicate *is a copse* (C) to the subset $\{r\}$.[181]

The denotation relation (R) maps terms in the object language to regions in the domain. There are lots of terms in the object language that we might use for things in D, but only a couple of them are relevant here. The term for the copse (call it 'c') is mapped to the region r, and the term for the plurality made up of the five trees (call it 'tt') is mapped to the five atomic regions in D. That is to say, $R(c) = r$ and $R(tt; r_1, r_2, r_3, r_4, r_5)$.

Now, given the commitment to unrestricted composition for regions, there is a region s which is the maximal region of the plurality tt. This is the relevant region because all plural predication is collective, so predication of the five trees is most naturally read as predication of the maximal region of their plurality. In this scenario '$r = s$' is true in the meta-language,

[181] I am supposing that smaller groups of trees within the copse do not make up smaller copses. I think this supposition most accurately reflects the way we talk about copses. If you were to point in the direction of a large copse and ask me 'how many copses do you see?', you'd think me quite strange if I replied 'in order to answer that, I need to know how many trees there are.' Of course, anyone who does not like this supposition can think of the predicate *is a copse* as mapped to a much larger subset of D. Whatever the appropriate subset is, though, it will contain r.

and therefore the many-one identity '$tt = c$' is true in the model. That is what it means to say that the five trees compose the copse. Composition is (many-one) identity!

We know that the denotation of 'r' is a region that is among the members of the set of regions assigned to the predicate *is a copse* by the model's interpretation function. But since r is identical to s, and s is the maximal region of tt (i.e. the region that exactly overlaps r_1, r_2, r_3, r_4, r_5 collectively), this means that 'tt are a copse' is made true by the model. *Mutatis mutandis* for 'c is some trees'. We can see that the carving conception of metaphysical structure is at work here. The trees and the copse are not different entities, on different levels of fundamentality; they are just the same region (r aka s) carved up by different properties.

Notice that this semantics renders identity symmetric; if '$c = tt$' is true in the model, then '$tt = c$' is true in the model because if '$r = s$' is true in the meta-language, then '$s = r$' is true in the meta-language. This is what we would expect.[182] This account also makes identity reflexive and transitive. It is reflexive because, for any term t_1, '$t_1 = t_1$' will be true in the model because '$\overline{t_1} = \overline{t_1}$' will be true in the metalanguage. It is transitive because whenever '$t_1 = t_2$' and '$t_2 = t_3$' are true in the model, then '$\overline{t_1} = \overline{t_2}$' and '$\overline{t_2} = \overline{t_3}$' are true in the metalanguage and, by metalinguistic substitution of identicals, '$\overline{t_1} = \overline{t_3}$' is true in the metalanguage, which makes '$t_1 = t_3$' true in the model.

Given the above, we can define mereological terms in the following ways:

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[182] Since I am claiming that composition is many-one identity, I anticipate the following objection. "Identity is symmetric, but surely composition is not. The trees compose the copse, but the copse does not compose the trees." Not so fast. I regard it as a contingent quirk of history that the mereology literature mentions composition far more often than decomposition, despite the fact the two are clearly partners. On my view, composition and decomposition are just different ways of describing the same relation. And that relation is identity. The statements 'xx compose y' and 'y decomposes into xx' are no more different from each other than the statements 'x loves y' and 'y is loved by x' – despite often being treated as containing different predicates, they clearly express the same relation. All CAI advocates should claim this about composition and decomposition, because identity is symmetric. Fine (2000) and Dorr (2004) show that this is a general issue for relations.

Parthood	$x \leq y =_{df} \exists xx(x \prec xx \,\&\, xx = y)$
Proper parthood	$x < y =_{df}\ x \leq y \,\&\, x \neq y$
Overlap	$x \circ y =_{df}\ \exists z(z \leq x \,\&\, z \leq y)$
Disjointness	$x \wr y =_{df}\ \neg x \circ y$

This means we can dispense with mereological primitives, which makes for a more parsimonious ideology.

One might wonder whether I have really dispensed with the need for mereological primitives, since the satisfaction conditions I have given for identity involve mereological terms (the definition of maximal region involves parthood and overlap). But we should be careful not to misunderstand what is going on here. In giving a satisfaction condition for the identity predicate, I am not saying that the right-hand side of the material biconditional explains the left. I have presupposed CEM in the object language, and I am using mereological predicates in the object language, but the real story is that all mereology is explained in terms of many-one identity.

Think of it this way. If I were to take identity as primitive at the outset and use it to explain everything, then I would have no hope of explaining super-CAI to someone who does not already understand many-one identity. What I have done is assume some common vocabulary to help readers come to terms with what I mean when I say that many and one can be identical. Ultimately, however, those many-one identities are the source of metaphysical explanation.

3.2 Puzzles Revisited

The expository work is done. Now I return to some of the puzzles from 1.3 and 1.4, to make good on promises made there.

3.2.1 Recombination Revisited

In 1.4.4, I promised an explanation of the fact that we cannot recombine the location of one of your parts and the location of you, resulting in a part of you being located somewhere you are not. With super-CAI fully explained, such an explanation is straightforward, but we first need to focus on what super-CAI says parthood requires. Namely, it requires commitment to the following principle, known as the *subregion theory of parthood*:[183]

Subregion Theory of Parthood: $\forall x \forall y((x \leq y) \leftrightarrow \exists r \exists s(x@r \,\&\, y@s \,\&\, r \leq s))$[184]

For any x and any y, x is a part of y iff, x is exactly located at a subregion of the exact location of y. The left-to-right direction is entailed by the fact that, according to super-CAI, a necessary condition on x being part of y is that x is a member of some plurality whose maximal region is identical to the region y is exactly located at. There must be some property that carves the exact location of the whole into a plurality of subregions, one of which is the exact location of the part. This bakes into parthood the requirement of being at a subregion.

The entailment of the right-to-left direction of the Subregion Theory of Parthood can be shown by the following substitution argument:

1	(1)	$\forall x \forall r(x@r \rightarrow x = r)$	Supersubstantivalism
2	(2)	$\exists r \exists s(x@r \,\&\, y@s \,\&\, r \leq s)$	Assumption
3	(3)	$x@a \,\&\, y@b \,\&\, a \leq b$	Assumption (for ∃E)

[183] I take the name of this principle from Markosian (2014, p.73). It has been called other things, such as "Inclusion" (Cotnoir, 2013c) and the "Inclusion Model of Parthood" (Walters, 2019, p.28).

[184] I have spoken, in Chapter 2, about the need to relativise mereological operators to either the region mereology or the material object mereology. Here, I will speak about the Subregion Theory of Parthood in a neutral way (without relativising it), but it should be understood that being as precise as possible requires relativising both of the '≤' operators to the same mereology.

3	(4)	$x@a$	&E: 3
3	(5)	$y@b$	&E: 3
3	(6)	$a \leq b$	&E: 3
1	(7)	$x@a \rightarrow x = a$	∀E: 1
1,3	(8)	$x = a$	→E: 4,7
1	(9)	$y@b \rightarrow y = b$	∀E: 1
1,3	(10)	$y = b$	→E: 5,9
1,3	(11)	$x \leq y$	Substitution of identicals: 6,8,10
1,2	(12)	$x \leq y$	∃E: 2,3,11

Ergo, super-CAI entails the subregion theory of parthood.

This resolves the mystery of why we cannot recombine the locations of parts and wholes, resulting in parts being somewhere wholes are not. The subregion theory of parthood prohibits it. And, since the subregion theory of parthood is entailed by super-CAI, super-CAI explains why those recombinations are not possible. It should also be noted that, as Markosian has pointed out, "of all the main answers to all the various questions concerning the mereology of physical objects, [the Subregion Theory of Parthood] is probably the most intuitive."[185] This is exactly right. As further evidence of the intuitive appeal of the Subregion Theory of Parthood, we might observe that it is common for introductions to mereology to accompany definitions of parthood, overlap, and so on with diagrams which explicitly display parthood by analogy with subregionhood.[186] Its intuitive appeal is a mark in favour of the Subregion Theory of Parthood and, by extension, a mark in favour of super-CAI which entails it.

[185] Markosian (2014, p.73).

[186] For example, Casati and Varzi (1999, p.37), Varzi (2019), Cotnoir and Varzi (forthcoming, p.24).

3.2.2 A Generalised Identity Predicate

I promised to offer a generalised identity predicate that accepts a mix of plural and singular terms, rendering many-one identities well-formed, and I promised to say what it means. This was achieved in 3.1 – it was the last of the satisfaction conditions I discussed.

3.2.3 Indiscernibility and Collapse

As discussed in 1.4.4, the law of the indiscernibility of identicals has been the source of many challenges to composition as identity. I can now formally prove that my view is consistent with an appropriately generalised form of the law, which states that:

Generalised Indiscernibility of Identicals: $\forall t_1 \forall t_2 (t_1 = t_2 \rightarrow (\varphi t_1 \leftrightarrow \varphi t_2))$

Whenever the referents of two terms (plural or singular) are identical, whatever is true of one is true of the other, and *vice versa*. Since I am examining the indiscernibility of identicals in a first-order setting, I cannot quantify over predicates. Instead, I have introduced schematic variables (e.g. φ) for predicates and I will show, in the metalanguage, that no matter what value we give φ, whenever '$x = y$' is true, then φ is true of x iff φ is true of y.

I want to show that $t_1 = t_2 \models \varphi t_1 \leftrightarrow \varphi t_2$. I start by assuming for an arbitrary model M and an arbitrary assignment σ, that $M, \sigma \Vdash t_1 = t_2$, and assuming that $M, \sigma \Vdash \varphi t_1$. From those assumptions, I need to show that $M, \sigma \Vdash \varphi t_2$ follows. That shows the left-to-right direction of the biconditionals holds. *Mutatis mutandis* for the right-to-left direction. The proof is as follows. Start by assuming that the model and the variable assignment satisfy '$t_1 = t_2$'. Given the semantic clauses above, this means that the maximal region of the denotation of t_1 is the same as the maximal region of the denotation of t_2.

$$\overline{R(t_1)} = \overline{R(t_2)}$$

Next, assume that the same model and variable assignment satisfy that t_1 has the property φ. Given the semantic clauses above, this means that the maximal region of the denotation of t_1 is a member of the interpretation of φ.

$$\overline{R(t_1)} \in I(\varphi)$$

So, by the substitutivity of identicals in the metalanguage, the maximal region of the denotation of t_2 is a member of the interpretation of φ.

$$\overline{R(t_2)} \in I(\varphi)$$

That is all it is to say that t_2 has the property φ. Hence, given some model and variable assignment, if $t_1 = t_2$ and φt_1, then φt_2. Ergo, the indiscernibility of identicals holds. This will work for any predicate whatsoever. But there is one hitch; when we perform this sort of substitution into *is one of* predications, we find that plurals behave in "unexpected ways".[187] That strange behaviour has seemed, to some, to be good enough reason to reject or weaken CAI.[188] Hence, my defence of super-CAI from indiscernibility objections cannot be considered complete until I have addressed those worries, which are captured by Sider's argument that CAI commits to a principle called *Collapse*.[189]

[187] Sider (2007, p.57).
[188] See Lewis (1991, section 3.6), Yi (1999, p.146), and Sider (2007), for discussion.
[189] Sider (2007).

Collapse $\forall x \forall xx(x \leq Fu(xx) \leftrightarrow x \prec xx)$

For any x and any xx, x is part of the fusion of xx iff x is one of xx. This principle is false. Consider that, although the copse is the fusion of the trees, no atom that is part of the copse is one of the trees, contra Collapse. So we must reject Collapse. The right-to-left direction is straightforward and uncontroversial: any x that is one of xx will be part of the fusion of xx on any standard definition of fusion. The problem comes from the left-to-right direction, which Sider argues is entailed by CAI, as follows.

Consider the scenario depicted in Figure 3.1, below. We have one spherical object, c, which is carved up in three ways. The first carving counts the object as one, but the other two carvings divide it into pieces. One divides it into a left half l and a right half r (call this plurality lr). The other divides it into three pieces, x, y, and z (call this plurality xx).

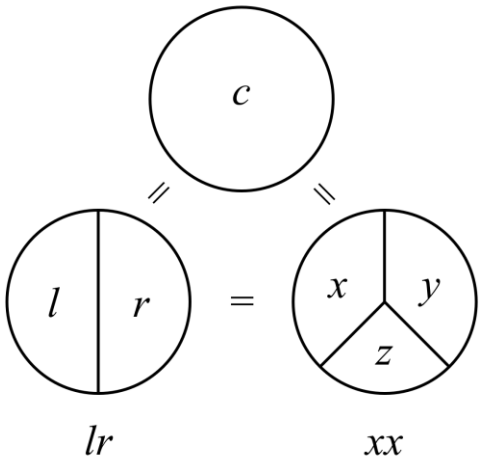

Figure 3.1

In this scenario, c is the fusion of the plurality lr and c is also the fusion of xx. Given CAI, c is identical with lr and c is also identical with xx. By substitution of identicals, this means lr is identical with xx and, since l is one of lr, substitution also gets us $l \prec xx$. But we can see

from the diagram that l is not one of xx. We have a contradiction. This works for any part of c; since the pluralities are identical, they can be substituted for each other, so any part of c must be a member of any plurality of which c is a fusion. Ergo, the left-to-right direction of Collapse.

The problem comes from CAI's identity claims licencing substitutions of pluralities into *is one of* predications. If such substitutions are permitted, then all the ways of carving any given object are identical and any plural term that picks out one decomposition of an object can be used to pick out *any* decomposition of that object. So it seems that CAI prevents us from talking about specific carvings or decompositions, without talking about all carvings or decompositions. That is not good.

At least four solutions have been suggested. We can (1) relativise the *is one of* operator to ways of carving;[190] (2) restrict plural comprehension so that there are "fewer pluralities than one normally expects";[191] (3) restrict the substitutivity of identicals;[192] or (4) restrict or reject the indiscernibility of identicals.[193, 194] Officially, I take up suggestion (3): the semantics offered in section 3.1, should be read as including a ban on substitution into *is one of* predications. Hence, that theory does not commit to Collapse. Of course, it would be fair to ask what justifies this ban, and my response to that question is that *is one of* predications are carving-relative, so they make such substitutions invalid. That relativity does not show up in

[190] Cotnoir (2013a) and Bohn (2014).

[191] Sider (2014, p.213). See also, Loss (forthcoming).

[192] Hovda (2014).

[193] Baxter (1988a, 1988b, 1999, 2018).

[194] Note also that each of these four options provides a solution to a related problem that Loss (forthcoming) has called the 'Wall-Bricks-Atoms Problem' but which I call the 'Problematic Many-Manys Objection'. It goes like this. Assume that some stool s can be decomposed into atoms aa or molecules mm. Since composition is identity, s is identical to aa and s is identical to mm and therefore, by the transitivity of identity, $aa = mm$. But we have reasons to think $aa \neq mm$. For one thing, they are discernible because (for example) there is some atom that is one of aa but which is not one of mm. For another thing, the standard definition of plural identity is given in terms of *is one of*, such that '$xx = yy$' is defined as: $xx = yy =_{df} \forall z(z \prec xx \leftrightarrow z \prec yy)$. That is, for any z, z is one of xx iff z is one of yy. This causes a problem for CAI because nothing that is one of the atoms is also one of the molecules, or *vice-versa*. So something has gone wrong. But both of the problems alleged by the Problematic Many-Manys Objection can be defused by each of the options (1) – (4).

the semantics I offered in 3.1, but it is the philosophical justification for the ban. In order to have the relativity of *is one of* show up in the semantics, we would need to introduce all sorts of complications that would have frustrated the exposition in section 3.1. Nevertheless, we are at a place now, where I can explore some of those complications. Let us see what it would be like to relativise *is one of* to ways of carving. As it happens, I think the theory which is closest to the truth combines the semantics from 3.1 with the relativised *is one of* operator I discuss below, but I have left this discussion until now because there was enough novelty and complexity in the semantics of 3.1 to be getting on with. Now for some more.

I choose this solution to the Collapse problem because it is not *merely* a solution to the Collapse problem; it is independently motivated by the Fregean thoughts about relativising cardinality ascriptions we encountered in Chapter 1. We will see below that relativising *is one of* entails relativising cardinality ascriptions. Further, cardinality ascriptions and *is one of* predications both obviously relate to counting, so it is natural that they should be treated in the same way.

3.2.4 Relativising Is One Of

I claim that facts about what is one of what are relative to ways of carving the world, and we carve by properties. To express this, I take it that the *is one of* operator has a third argument place, which is occupied by a property,[195] and I write the property in a subscript, attached to the *is one of* operator: '$x \prec_P xx$'.[196] An illustration will be useful. Imagine we have carved a portion of reality into five trees tt, using the property *tree* (expressed by 'T'). We can say that a tree t is one of tt, relative to the property *tree*: '$t \prec_T tt$'. The fact that we have carved using

[195] Bohn (2014, forthcoming) makes this suggestion and claims we carve by concepts, not properties, so Bohn's third argument place is occupied by a concept. Another alternative, which I do not consider here but which might be acceptable, is that the third argument place is occupied by a predicate.

[196] I intend this as a three-place relation, rather than a family of two-place relations or a long list of primitive logical connectives.

the property *tree* means we should read this as saying 't is one of the trees tt'. The property in that third argument place determines what we call the things we get by carving that way. Carve by the property *tree* to get trees. Carve by the property *atoms* to get atoms. And so on.[197]

With relative *is one of* in place, we can block the argument from CAI to Collapse. Let us say that the carving of c into lr is done according to the property *halves* which we can represent with the predicate 'H'. In reality, the property would have to be more specific than this, because there are many ways to halve c,[198] but we can ignore those complications here.[199] Let us also say that the carving of c into xx is done according to the property *thirds* which we can represent with the predicate 'T'. This means we can render the crucial step in the argument for the left-to-right direction of Collapse as follows.

1	(1)	$l \prec_H lr$	Assumption
2	(2)	$lr = xx$	Assumption
1,2	(3)	$l \prec_H xx$	Substitution of identicals

But '$l \prec_H xx$' is not the same as '$l \prec_T xx$'. The former says 'l is one of the halves xx' whereas the latter says 'l is one of the thirds xx'. I will now argue that '$l \prec_H xx$' is true and unproblematic.

One objection to relativising *is one of* is that it leads to expressions that look strange. What can it mean to say that l is one of xx relative to the carving into halves? xx are not halves,

[197] Sometimes, we will want to talk about arbitrary pluralities containing miscellaneous objects. Consider the plurality containing only my shirt and your shoes. As long as we take an abundant view of properties, such talk is perfectly acceptable. The plurality of my shirt and your shoes has a maximal region. If we carve it by the property *molecules* we will get molecules. If we carve it by the property *atoms*, we get atoms. And if we carve it by the property *shirt or shoes* we get my shirt and your shoes.

[198] Notwithstanding worries about whether it is impossible to halve anything.

[199] I ignore the discussion over *how* specific the relevant properties should be. See Yi (2014) for the view that this is a problem, and see Carrara and Lando (2017, p.496) for a reply.

so this sounds very strange.[200] I have said what it means: it means that l is one of the halves xx. I agree that this is a strange thing to say, but not because it is false. The source of the strangeness is nothing to do with relativising something that should not be relativised or substituting a term that cannot be substituted; the source of the strangeness is that, by saying it, we are breaking the Gricean conversational maxim of relevance.[201] Saying "l is one of the halves xx" obscures or distracts from a relevant fact (i.e. that we have carved the region by the property *halves*) by presenting the portion of reality in an irrelevant way (i.e. with the name 'xx'). Portions of reality often have many modes of presentation, and we invite strangeness and discomfort (but not outright falsity!) when we carve by a property that implies one mode of presentation and refer to the plurality with a term that implies another. Of course, we know that we can break Gricean maxims and still say things that are literally true. If I ask a librarian for the book *Nineteen Eighty-Four* and they ask "who is the author?" I can tell them "Eric Blair". Our resistance to giving that reply comes from the fact that it breaks the Gricean conversational maxim of relevance by focusing on an irrelevant mode of presentation of the object George Orwell. Nevertheless, that reply to the librarian is literally true. Exactly the same thing is happening when we say things like "l is one of the halves xx". The upshot is that the argument from CAI to Collapse only gives us a problematic result if we can get from $l \prec_H lr$ to $l \prec_T xx$, but we cannot.

Relativising *is one of* in this way comes with other benefits. Recall that, in Chapter 1, we saw that CAI can involve relativising cardinality ascriptions like 'lr are two in number' to ways of carving the world. Carrara and Lando have noted that these are the same relativisation because cardinality predicates like 'are two in number' have logical paraphrases that involve

[200] Carrara and Lando (ibid, p.510).

[201] Originally called the maxim of 'relation' (Grice 1975), this has come to be known as the maxim of relevance.

the *is one of* operator.[202] For instance, by letting 'N_2' stand for the predicate 'are two in number', we can say 'N_2lr', which can always be paraphrased into:

$$\exists x \exists y (l \neq r \;\&\; l \prec lr \;\&\; r \prec lr \;\&\; \forall z \big(z \prec lr \rightarrow (z = l \;\vee z = r)\big))$$

Once we have relativised *is one of*, this becomes:

$$\exists x \exists y (l \neq r \;\&\; l \prec_H lr \;\&\; r \prec_H lr \;\&\; \forall z \big(z \prec_H lr \rightarrow (z = l \;\vee z = r)\big))$$

So cardinality ascriptions are relativised to ways of carving.

Carrara and Lando have objected that relativising *is one of* means relativising the definition of plural identity. Plural identity has traditionally been defined as:

$$xx = yy =_{df} \forall z (z \prec xx \leftrightarrow z \prec yy)$$

Whatever is one of xx is one of yy and vice versa. Carrara and Lando argue that, if plural identity is relativised, it will be hard to defend not also relativising singular identity because there can be pluralities of one, so '$xx = yy$' could express a singular identity. But there are reasons to worry about relativising singular identity. Bohn states it dramatically, saying "relative identity is worse than death."[203] Carrara and Lando point out that it would be very bad news for CAI if it had to commit to relative identity because advocates of CAI are trying to show that composition behaves just like the trusty, old numerical identity relation that we all

[202] Carrara and Lando (2017).
[203] Bohn (2014, p.166, n.10).

know and love. If it turns out that CAI's identity relation behaves very differently, then CAI looks an awful lot less palatable.[204] We should avoid relative identity.

We can resist the slide from relativising *is one of* to relativising plural (and therefore singular) identity by recognising that my semantic clause for identity suggests a different definition of plural identity. The semantic clause states that, '$t_1 = t_2$' is satisfied by a model M and a variable assignment σ iff t_1 and t_2 have the same maximal region:

$$M, \sigma \Vdash t_1 = t_2 \Leftrightarrow (\overline{R(t_1)} = \overline{R(t_2)})$$

Hence, we should give a definition of plural identity according to which what it is for two pluralities xx and yy to be identical is just that xx and yy have the same maximal region. We can do this using relative *is one of* predications by requiring there to be some region r such that for any z, z overlaps r iff it overlaps something in xx and something in yy (on some carving of each). This can be formalised as:

$$xx = yy =_{df} \exists r(\exists P(\forall x(x \prec_P xx \rightarrow x \leq r) \,\&\, \forall z\big(z \leq r \rightarrow \exists x(x \prec_P xx \,\&\, z \circ x)\big) \,\&\,$$
$$\exists P(\forall y(y \prec_P yy \rightarrow y \leq r) \,\&\, \forall z\big(z \leq r \rightarrow \exists y(y \prec_P yy \,\&\, z \circ y)\big))$$

This looks complicated, but it just says that xx and yy have the same maximal region. They are the same portion of reality. And, despite including relativised *is one of* operators, this does not make plural identity relative; whether or not any two pluralities xx and yy are identical does not change depending on how we carve because, as long as there is *some* way to carve

[204] Carrara and Lando (2017, Section 5).

that fulfils the definition above, $xx = yy$. So Carrara and Lando's objection is avoided. This definition of plural identity is a deviation from the traditional definition. That is a cost. But the deviation is philosophically well-motivated: the new definition maintains that identical pluralities are the same portion of reality, which is an idea at the heart of CAI, and means that the plural terms xx and yy co-refer, which Carrara and Lando have elsewhere argued is a necessary and sufficient condition for the truth of identity statements (including plural identity statements).[205] Furthermore, this is how we make sense of CAI (and super-CAI) which brings with it the many benefits already alluded to throughout this thesis (see Chapters 1 and 2, and a summary in Chapter 8).[206]

Note that I am not suggesting we dispose of the traditional notion of plural identity. My definition of plural identity is not count-relative, but there might be uses for an additional notion of plural identity that *is* count-relative. For that purpose, we can use the traditional definition. Of course, in the face of two definitions, one might wonder "okay, so which is the *real* notion of plural identity?" to which I would reply that Carrara and Lando objected to relative *is one of* on the grounds that it relativises identity (and I have shown that it does not), so their objection presupposes the correct notion of plural identity is not relative. I think the traditional notion of plural identity is still an interesting relation, but mine is a better way to characterise plural identity, given a commitment to super-CAI.

Finally, I wish to say something brief about which regions can be carved by which properties. There are choice points here. We could simply say that any region can be carved by any property, but I suggest the following restriction. Given any model M and assignment σ, for any region r, and any property P, r can be carved by P iff r is a member of the set of regions

[205] Carrara and Lando (2016).

[206] Note also that relativising *is one of* results in the need for an update to the definition I gave for parthood, at the end of section 4. The updated definition is as follows. $x \leq y =_{df} \exists P \exists xx(x \prec_P xx \,\&\, xx = y)$. This does not result in parthood being relative because whether you carve this way or that does not change whether there is *some* carving on which the definition is satisfied.

assigned to P by the model's interpretation function, or r is the maximal region of some plurality of regions each of which is assigned to P by the model's interpretation function. This is because, although it is clear what it means to carve a deck of fifty-two playing cards by the property *is a suit* (resulting in four distinct objects), it is not clear what it would mean to carve that deck of cards by the property *is a four* or the property *is a lawnmower* (what objects are there, on these carvings?). Motivation for this restriction is made even clearer when we recall that the words 'carving' and 'counting' are used to express the same Fregean idea – that the deck is the same portion of reality as the fifty-two cards. I have already said that 'carving' and 'counting' are synonyms in this context. But we cannot count the deck by counting the fours, and we certainly cannot count it by counting the lawnmowers. To do so would leave out large swathes of the deck. It would be undercounting. What I have suggested above ensures that whenever we are counting a portion of reality, we count the entire portion.

Whether *is one of* can be successfully relativised has been a source of controversy. Bohn has suggested it can be,[207] while Carrara and Lando have argued it cannot.[208] I have hereby provided a detailed demonstration of one way it can be done. In doing so, I have shown that super-CAI avoids collapse and provided an explanation for relative cardinality ascriptions.

[207] Bohn (forthcoming).

[208] Carrara and Lando (2017).

CHAPTER 4:

THE SPECIAL COMPOSITION QUESTION

Here are two more things that CAI and supersubstantivalism have in common: (1) each of them has been alleged to entail a particular answer to the special composition question and (2) neither of them does, in fact, entail any particular answer to the special composition question. In this chapter, I explore the relationship between super-CAI and that question. I argue that super-CAI is consistent with any answer – nihilism, universalism, or restricted composition – and I reach this conclusion by rebutting the extant arguments that CAI entails a specific answer (in 4.2-4.3) or that supersubstantivalism does (in 4.4) and then explaining in more detail what super-CAI plus restricted composition might look like (in 4.5). Along the way, I express sympathy with various arguments, but I do not commit the special composition question to any particular solution. Before all that, though, a note on what we are even talking about.

4.1 Metaphysics versus Logic

It is not uncommon to suggest that those of us who disagree about the answer to the special composition question are merely talking past each other.[209] Perhaps we have in mind different notions of whole or object or individual (I will treat these as synonymous). It is important, therefore, that I be as precise as I can about what I mean.

There are two ways we might think of wholes (aka individuals, aka objects). We can think of them as logical constructions or metaphysically substantive entities. Leonard and Goodman tell us that they favour the former sense:

[209] The allegation that a dispute is merely verbal has been levelled at almost every field in metaphysics. For a discussion of verbal disputes and the special composition question, see Miller (2014).

> The concept of an individual and that of a class may be regarded as different devices for distinguishing one segment of the total universe from all that remains. In both cases, the differentiated segment is potentially divisible, and may even be physically discontinuous. The difference in the concepts lies in this: that to conceive a segment as a whole or individual offers no suggestion as to what these subdivisions, if any, must be, whereas to conceive a segment as a class imposes a definite scheme of subdivision-into subclasses and members.[210]

For them, speaking of some plurality as a single whole does not mean committing to some metaphysically substantive, singular entity; instead, it is just a way of talking about a portion of the universe of discourse that is neutral about the various ways it can be divided. They explicitly claim to have performed "the important service of divorcing the logical concept of an individual from metaphysical and practical prejudices".[211] However, this claim to neutrality is mistaken. When we treat a plurality as a whole, we are not neutral about all the ways we can carve it up; instead, we are making salient the one way of carving that treats the plurality as one entity. Those who think of wholes as metaphysically substantive entities, rather than just a way of talking about a portion of the universe of discourse, will worry about whether there is any single thing that corresponds to that way of carving. They will worry about whether that way of carving matches nature's joints.

Bohn is not worried about that. He is another proponent of the logical notion of whole. According to him, a whole is "just something we can singularly quantify over"[212] and we can singularly quantify over any plurality whatsoever. Hence Bohn renders the difference between individuals and pluralities as merely grammatical.

[210] Leonard and Goodman (1940, p.45).
[211] Ibid (p.55).
[212] Bohn (2014, p.151).

Van Inwagen, disagrees with Leonard, Goodman, and Bohn about what wholes are. He thinks they are something substantively metaphysical. To this end, he writes:

> Certain formal systems (descended either from Lesniewski's "mereology" or the Leonard-Goodman "Calculus of Individuals") include among their axioms something very much like 'For any xs, those xs have a sum'. These formal systems express, on their intended interpretations, substantive metaphysical theories.[213]

Bohn is right to say van Inwagen is wrong about the "intended interpretations" of Leonard and Goodman;[214] after all, Leonard and Goodman explicitly deny that they are committing to substantive metaphysical theories. They regard the sum of xx as just a singular way of referring to xx, not any metaphysically deep individual entity out there, in the world. Nevertheless, it is an open question whether Leonard and Goodman (and Bohn) *should* mean what van Inwagen takes them to mean.

Following Bohn,[215] let us call the Leonard, Goodman, and Bohn view of objects *thin* and the van Inwagen view *thick*. There are considerations to recommend each conception.

In defence of the thin conception, we have seen Leonard and Goodman suggest that it is more metaphysically neutral (though I think we should resist this, as we have also seen). One might also point to the fact that it dissolves the difference between semantically singular and semantically plural reference, which can provide a new and interesting solution to an old debate about the semantics of plural terms.[216] It also seems that the thin notion of objects pushes us

[213] Van Inwagen (1990, p.52)
[214] Bohn (2014, p.156).
[215] Ibid (p.151).
[216] The debate is between those who think that plural reference is semantically singular (see Quine (1982)) and those who think it is semantically plural (see Lewis (1991, Chapter 3.2)). The thin notion of objects undermines the difference between the two positions, and therefore undermines their disagreement. For more on this debate, see Florio (2010) and Florio and Linnebo (2018).

towards CAI because, if the difference between one and many is merely grammatical, then it is natural to think that there can be identities between things referred to with singular terms and things referred to with plural terms. Hence, the thin notion gives us traction on questions about composition.

In defence of the thick conception, one might say that when we are doing mereology, we are trying to describe the structure of the mind-independent world. When we speak of wholes, we aim to be speaking in something close to Ontologese;[217] that is, we aim to say something that matches the most fundamental or most natural quantifier(s) and carves reality at its joints.[218] When we say that some plurality composes an object, we are not merely choosing to refer to a portion of reality with a singular term. I could call a strawberry by the term 'piano', but the world does not care; doing so will not make it any easier to play a song with it. We *can*, of course, quantify over anything or things singularly, just as we *can* call a strawberry 'a piano'. Bohn is right about that. But that fact alone tells us nothing of the world, so advocates of the thick conception might struggle to see why those of us doing metaphysics should be moved by such facts.

A lot more can be said, but I do not want to adjudicate between these two views, so I am content to only scratch the surface of that dispute. Instead, my aim in this chapter is to show that super-CAI can be paired with a restricted view of composition. The dispute between thin and thick notions of objects is important to this because, on the thin notion of objects, restricted composition is a non-starter. Restricted composition requires there to be a *metaphysical* difference between a many that compose a singular entity and a *mere many* that does not compose anything. As such, my use of terms like 'object', 'whole', and 'individual' should be

[217] See Sider (2009, Sections 7–10; 2011, ch.1).

[218] I am keen to note that I do not think these are the only concerns metaphysicians should have. For instance, social ontology is an important field of metaphysics that plausibly does not share these concerns with fundamental or natural quantification and structure. See Bennett (2017, Chapter 8) for discussion.

read in the thick sense, at least in this chapter.[219] What I say below should be understood as committing to substantive metaphysical theses. I will be interpreting the arguments of others in the same way.[220]

4.2 Universalism and CAI

Now let us consider the relationship between universalism and CAI. Universalism is the view that, for any plurality xx, there is some y such that xx compose y. It is popular to claim that universalism is a consequence of CAI.[221] In this section, I examine two arguments for that claim and find them unsound. Then I offer support for an argument to the contrary.

4.2.1 Lewis and Ontological Innocence

David Lewis claimed that because composition is identity, mereology is ontologically innocent.[222] By this, he means that:

> In general, if you are already committed to some things, you incur no further commitment when you affirm the existence of their fusion. The new commitment is redundant, given the old one.[223]

From the ontological innocence of mereology, he infers that composition is unrestricted (i.e. universalism is true). I agree, wholeheartedly, that mereology is ontologically innocent, but deny that it entails universalism. Consider an analogy.

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[219] Thus, I act as a counterexample to Bohn's (2014, p.151) assertion (made without argument) that "obviously no proponent of CAI has the thick notion in mind". I am not sure why he should say this. As I have said, the thin notion does push us towards CAI, but I do not see why CAI should push us towards the thin notion.

[220] This means we do not need to engage with Bohn's (2014) argument that CAI entails universalism since, by his own admission, it relies on the thin notion of material object. I have already accepted that the thin notion pushes us towards CAI and universalism, so I do not disagree with Bohn on that.

[221] Harte (2002, p.114), Merricks (2005, p.630), Sider (2007), Bohn (2014), and Loss (forthcoming).

[222] Lewis (1991, p.82).

[223] Ibid (pp.81-82).

You are organising a party, and you are a generous and welcoming host. All of the friends whom you invite know this, and so infer correctly that each invitation comes with an implicit plus one. When you commit to hosting one guest, you commit to hosting their plus one. An invite to your friend *just is* an invite to their plus one. We might say that bringing a plus one is invitationally innocent. Nevertheless, not all guests will bring plus ones to your party. Some of your friends are not in the right circumstances; they are not seeing anyone, or they would rather go alone, for instance. Equally, not all pluralities of objects will bring a fusion to the ontological party. Some pluralities are mere manys, *even though it would be free for them to compose something*. This might be because they are also not in the right circumstances; the members of the plurality are not in contact, or the fusion of their exact locations does not meet the criteria for being a material object, for instance. The point is this: the mere fact that something is free to acquire does not mean it will be acquired. Not when it comes to party invitations, and not when it comes to ontology. The ontological innocence of fusion does not entail that fusion always occurs. This is why Cameron is right to say "Allowing that identity can be many-one simply doesn't tell us how *ubiquitous* cases of many-one identity are."[224, 225]

4.2.2 Sider's Modal Argument

Ted Sider offers the following argument, to demonstrate that CAI entails universalism:[226]

(1) For any xx, it is possible that xx compose some y.

[224] Cameron (2012, p.534). See also Cotnoir and Varzi (forthcoming, p.190). This observation also undermines Sider's "dodgy move" argument (Sider 2007, p.61).

[225] This will not be convincing to anyone who, like Armstrong (1997, p.12), thinks of ontological innocence in terms of mutual supervenience. On such a view, the existence of any given whole is necessitated by the existence of the parts and vice versa. You cannot have one without the other. I reject this view of ontological innocence.

[226] Sider (2007). Merricks (2005, p.630) offers a temporal version of this argument which can be defused using four-dimensionalism in the same way that I use counterpart theory, below.

(2) CAI is necessarily true.

(3) Necessarily, for any xx and any y, if $xx = y$, then necessarily, if xx exist then y exists and is identical to xx.

(4) xx exist.

(5) Therefore, there is some y that exists and is identical to xx.

(6) Many-one identity is composition.

(7) Therefore, there is some y that is composed of xx.

There are many reasons we might resist this argument. Here are a handful.

The case against premise (1) is weakest, but not non-existent. The thought behind this premise is that whatever the correct criterion for composition turns out to be, it is surely possible that any plurality of objects xx could meet it. If contact is needed, go to a possible world where xx are touching. And so on. But this might be false when we consider entities from different ontological categories.[227] Nevertheless, since my attention is here focussed only on material objects, that is not a good enough reason to reject (1).

Alternatively, we might worry that some restricted views are inconsistent with premise (1), such as van Inwagen's organicism, according to which composition only occurs when parts compose a life.[228] But whether such views are inconsistent with (1) will depend on other theoretical commitments. For instance, many theories of mind eschew biochauvinism and instead declare that a conscious mind can, in principle, be composed out of any sort of stuff. Perhaps even the population of an entire nation could come together to jointly compose a mind.[229] I do not intend to get into the weeds on this issue.

[227] Sider (2007, p.61, n.26).
[228] Van Inwagen (1990).
[229] Block (1980).

Another reason to reject (1) comes from Cameron, who observes that it will be denied by those who think that nihilism is necessarily true,[230] but I have already said (in 2.3.1) that I assume nihilism is actually false, so that observation is unhelpful here.

All in all, the case against premise (1) is not too strong, given my position in the dialectic. However, the argument has bigger problems.

Premise (2) is more contentious and anyone who thinks the principles of mereology are like laws of nature, rather than logical truths (as I have said I am assuming in this chapter), will probably reject it. We tend to think of laws of nature as contingent.

Furthermore, as we saw in Chapter 1.4, the motivations for CAI are largely abductive; of all the available answers to the general composition question, CAI exhibits the most theoretical virtues and so we have strong reason to believe it. However, as Nolan has pointed out:

> When we believe the simplest or most parsimonious option elsewhere in our theorizing, it is not usually because we think that it is *impossible* for things to be more complicated or arbitrary than they seem.[231]

There might be worlds at which the most theoretically virtuous theories are false; degenerate worlds where entities are multiplied beyond necessity and the least elegant theories hold true. At those worlds, CAI may well be false. This is an interesting subject about which much more can be said, but it is beyond the scope of this work.

More fault can be found in premise (3). It is a formulation of the necessity of identity and it relies on the existence of trans-world identities. Yet counterpart theory denies the necessity of identity and the existence of trans-world identities, so any view that commits to

[230] Cameron (2007).
[231] Nolan (2015, p.36).

counterpart theory will reject this premise. Sider acknowledges as much.[232] Given that many CAI theorists explicitly commit to counterpart theory in order to explain the differences in the modal profiles of objects and their parts,[233] this takes the sting out of Sider's argument. At best, we can see it as yet another reason advocates of CAI should adopt counterpart theory.

But what are the Kripkean enemies of counterpart theory to make of Sider's argument? Cameron argues that even they should reject it because although (5) tells us that there must actually be some y that is identical to the actual xx, it does not tell us whether the actual y is many or one. Perhaps the statement '$xx = y$' really relates two manys in the same way that '$xx = xx$' does. In support of this, I add the observation that CAI tells us many-one identities are possible, therefore, the transworld identity between y at some merely possible world and y at the actual world could be many-one too. Nothing seems to prohibit y from being a many here. In which case, '$xx = y$' expresses a many-many identity (despite the singular term) which is not composition. Sider's argument is thus invalid.

4.2.3 McDaniel's Nihilistic Argument

Kris McDaniel argues that CAI does not entail universalism.[234] In doing so, he does not aim to show that CAI is true or that universalism is false; he merely aims to show that there is a collection of claims from which CAI follows and which entail that universalism is false. Given this objective, it is not important that the collection of claims is well motivated or even true; it is only important that they are consistent (internally and with each other). That is enough to show that universalism is not entailed by CAI. The collection of claims on which McDaniel builds his argument are:

[232] Sider (2007, p.62).

[233] See Bohn (2009a), Wallace (2011b), Bricker (2016), and this work. See Chapter 6 for more about these theories.

[234] McDaniel (2010).

Modest Pluralism: There are at least two non-overlapping material objects.

Necessary Compositional Nihilism: Necessarily, for any xx and any y, xx compose y iff there is exactly one of xx and it is identical to y.[235]

Property Extensionalism: For any two properties, P_1 and P_2, $P_1 = P_2$ iff they are necessarily equivalent (for any world w, they are predicated of all and only the same things at w).

CAI follows from the combination of Necessary Compositional Nihilism and Property Extensionalism because the former tells us that composition is necessarily equivalent to identity and the latter tells us that necessarily equivalent properties are identical. Hence, composition is identical with identity.

The falsity of universalism follows from Modest Pluralism and Necessary Compositional Nihilism because the former tells us that there is some plurality xx containing at least two non-overlapping objects and the latter tells us that xx do not compose anything (because there is not exactly one of them).

Although the three claims on which McDaniel's argument is built are controversial, the argument goes to show that CAI does not strictly entail universalism. As he puts it, this "entitles us to conclude that there is something wrong with any argument for [the claim that CAI entails universalism], even if we aren't certain what it is."[236]

[235] This formulation of Necessary Compositional Nihilism is interesting because it does not hold that composition never occurs. Instead, it holds that composition is reflexive but there are no complex objects. Other formulations are available, and I use a different one below, but this one is best for present purposes. The differences between them need not concern us, here. Also, see van Inwagen (1990, pp.28-29) for defence of reflexive composition.

[236] McDaniel (2010, p.97).

Bohn disagrees.[237] His response is to point out that McDaniel's argument renders CAI as saying $xxCy =_{df} x = y$ which is "just a bad definition of CAI in the sense of not at all capturing what is intended" he claims that the correct definition is '$xxCy =_{df} xx = y$', which is not entailed by Necessary Compositional Nihilism and Property Extensionalism. I think this response is right but can be rebutted. Let us start by unpacking it.

If we leave the quantifiers implicit, and we take the view that whenever we have a plurality of one, we can substitute the plural term for a singular term that refers to the one member of the plurality, then we can formalise Necessary Compositional Nihilism as:

$$\Box(xxCy \leftrightarrow x = y)$$

And (again, leaving quantifiers implicit) Property Extensionalism can be formalised as:

$$\Box(P_1 \leftrightarrow P_2) \leftrightarrow P_1 = P_2$$

From those two, we get the following definition of CAI by simple *modus ponens* of the left-to-right direction of Property Extensionalism:

$$xxCy =_{df} x = y$$

Bohn is right; this is not CAI.[238] So McDaniel's argument fails because it only shows that universalism is not entailed by something nobody would call CAI. However, we can recover

[237] Bohn (2014).

[238] This derivation requires treating 'xx' and 'x' as the same term, bound by the same implicit quantifier. In order for this to be valid, we need Bohn's view that the difference between plural and singular terms is merely

the point McDaniel was making. The spirit of his argument was correct, but it requires different premises. I suggest using the following:

Modest Pluralism: There are at least two non-overlapping material objects.

We still need this premise, to guarantee that universalism fails. If there is only one object, then universalism is trivially true since composition is reflexive and idempotent.

Composition as Identity: $xxCy =_{df} \ xx = y$

McDaniel's argument did not assume CAI. Instead, he derived CAI (or what he took to be CAI) and the falsity of universalism from independent premises. That was a nice flair, but unnecessary. By building CAI into the premises, I guarantee that no Bohn-style objection will be available.

No Many-One Identities: Identity can be one-one or many-many. There are no many-one identities.

In Chapter 1, we saw some common reasons for thinking this. For example, some think that many-one identities are syntactically dubious, while others are compelled by objections based on the Indiscernibility of Identicals. Obviously, I think many-one identities are possible and

grammatical (see Section 4.1). Without that claim, treating 'xx' and 'x' will not work but a different derivation can be given to arrive at a different (but equally wrong) definition of CAI. It goes like this.

Necessary Compositional Nihilism: $\Box(xxCy \leftrightarrow (xx = y \ \& \ \exists x \forall z(z \prec xx \leftrightarrow x = z)))$

Property Extensionalism: $\Box(P_1 \leftrightarrow P_2) \leftrightarrow P_1 = P_2)$

Then, by *modus ponens* of the left-to-right direction of Property Extensionalism, we get the following definition, which is also not CAI: $xxCy =_{df} \ (xx = y \ \& \ \exists x \forall z(z \prec xx \leftrightarrow x = z))$

believe I have addressed those worries in previous chapters. Nevertheless, we do not need the premises of the present argument to be true; just consistent.

We need not worry that No Many-One Identities is inconsistent with CAI because it is widely accepted (including by Bohn) that there are pluralities of one. When the 'xx' in the definition of CAI refers to a plurality of one, then '$xx = y$' expresses a one-one identity. We need not be concerned about calling that one-one identity composition because composition is reflexive. So CAI is consistent with No Many-One Identities.[239]

But if CAI is true and there can be no many-one identities, then no plurality of more than one can compose anything. If no plurality of more than one can compose anything, and there are at least two objects (as per Modest Pluralism), then universalism is false. Ergo, CAI is consistent with universalism being false. CAI does not entail universalism.

We have seen three arguments in this section: two that claim to show CAI entails universalism and one that claims there is no such entailment. I have argued that the first two arguments are flawed, and I have reformulated the last one to defend it from an objection. I therefore conclude that CAI does not entail universalism.

4.3 Nihilism and CAI

A variety of arguments have been offered by Calosi and Loss to show that CAI entails nihilism.[240] I take nihilism to be the view that no objects have proper parts. All but one of Calosi and Loss's arguments rely on first showing that CAI entails the principle Collapse, which I discussed in the previous chapter.

Collapse $\quad \forall x \forall xx(x \leq Fu(xx) \leftrightarrow x \prec xx)$

[239] Calosi (2018) acknowledges this but calls the one-one version of CAI boring. I agree. We can aim higher.
[240] Calosi (2016a, 2016b, 2018) and Loss (2018).

For any x and any xx, x is part of the fusion of xx iff x is one of xx. Calosi and Loss offer some ingenious arguments to show that nihilism follows from CAI and this principle. But Collapse is false. Almost nobody accepts it.[241] The copse c is the fusion of the trees tt and it is the fusion of the atoms aa, so CAI tells us that $c = Fu(tt) = Fu(aa)$, but although there is some atom that is part of the fusion of the trees (by substitution, because it is part of the copse), no atom is one of the trees. This means that advocates of CAI should reject Collapse. In fact, we do.[242] But this undermines Calosi and Loss's argumentative strategy because their arguments that CAI entails nihilism rest on a premise that CAI theorists reject. I am perfectly happy to accept that nihilism follows from Collapse (Calosi and Loss have shown it well), but I reject the claim that Collapse follows from CAI (see Chapter 3.2.3 for details). Hence, I reject that these arguments show that nihilism follows from CAI.

The final argument that CAI entails nihilism, is offered by Calosi.[243] First, he argues that CAI plus Plural Covering entails Parthood is Identity. For the purposes of this argument, we can understand Calosi's versions of these principles as:

CAI (Calosi's statement): $\forall xx \forall y(Fu(y, xx) \rightarrow xx = y)$

Plural Covering: $\forall x \forall y(x \leq y \rightarrow \exists ww(Fu(y, ww)\ \&\ x \prec ww))$

Parthood is Identity: $\forall x \forall y(x \leq y \rightarrow x = y)$

[241] The only exception I know of is Sider (2014). Calosi (2018) suggests that CAI theorists could accept a version of plural comprehension that is compatible with Collapse. However, he does not endorse that view, so he cannot really be said to accept Collapse.

[242] For example, Cotnoir (2013a), Bricker (2016), Bohn (forthcoming), Loss (forthcoming) all explicitly reject Collapse. I have done the same in Chapter 3.

[243] Calosi (2018, pp.287-288). This appears to be the same as Yi's (1999, p.146) argument that CAI gets facts about pluralities wrong, taken to a different conclusion.

CAI is formulated with the fusion operator instead of the more usual composition operator, but that will not matter. What is more important is that the *is one of* operator is not relativised as I said it should be, in the last chapter. Spoiler: that will be the source of my response to Calosi's argument. I have rendered the argument formally.

1	(1)	$\forall xx \forall y(Fu(y, xx) \rightarrow xx = y)$	CAI
2	(2)	$\forall x \forall y(x \leq y \rightarrow \exists ww(Fu(y, ww) \,\&\, x \prec ww))$	Plural Covering
3	(3)	$x \leq y$	Assumption
2	(4)	$x \leq y \rightarrow \exists ww(Fu(y, ww) \,\&\, x \prec ww)$	∀E:2
2,3	(5)	$\exists ww(Fu(y, ww) \,\&\, x \prec ww)$	→E:3,4
6	(6)	$Fu(y, ww) \,\&\, x \prec ww$	Assumption
6	(7)	$Fu(y, ww)$	&E:6
6	(8)	$x \prec ww$	&E:6
1	(9)	$Fu(y, ww) \rightarrow ww = y$	∀E:1
6,1	(10)	$ww = y$	→E:7,9
6,1	(11)	$x \prec y$	Substitution:8,10
6,1	(12)	$x = y$	From 11, see below for explanation
1,2,3	(13)	$x = y$	∃E:5,6,12
1,2	(14)	$x \leq y \rightarrow x = y$	→I:3,13
1,2	(15)	$\forall x \forall y(x \leq y \rightarrow x = y)$	∀I:14

But if parthood is identity, then nothing has proper parts. This can be shown most easily by *reductio*, using the classical definition of proper parthood.[244]

[244] It can also be shown using the Goodman definition of proper parthood ($x < y =_{df} x \leq y \,\&\, \neg y \leq x$), but that proof is much more involved and since I take this point to be fairly obvious, I will not labour it by offering that proof also.

Classical Proper Parthood $x < y =_{df} x \leq y \,\&\, \neg x = y$

16	(16)	$\forall x \forall y(x \leq y \rightarrow x = y)$	Parthood is Identity
17	(17)	$x < y$	Assumption for *reductio*
17	(18)	$x \leq y \,\&\, \neg x = y$	Classical definition of $<$
17	(19)	$x \leq y$	&E:18
17	(20)	$\neg x = y$	&E:18
16	(21)	$x \leq y \rightarrow x = y$	∀E:16
16,17	(22)	$x = y$	→E:19,21
16,17	(23)	$\perp$	¬E:20,22

Parthood is Identity therefore entails that nothing has proper parts, which is nihilism.

In Chapter 3.2.3, I imposed a ban on substitution into *is one of* predications. That means the inference from (8) and (10) to (11) is blocked and the argument fails. However, I have also explored how we might relativise *is one of* to ways of carving. I will now explain how relative *is one of* also blocks the argument.

The key inference is the step from (11) to (12), which I have marked in the formal proof with the justification 'From (11), see below for explanation'. Calosi makes this inference because he reasons that when the *is one of* operator relates two singular terms, it expresses identity. This might strike one as plausible. It will look less plausible once we have relativised *is one of.*

I argued that the *is one of* operator should be relativised to the properties we use to carve the world. I suggested doing this by using a subscript letter on the operator to denote the property used to do the carving. For example, when we carve the region identical with the copse

c by the property *tree* we get five trees tt. Call one of those trees 't'. Using the term 'T' to stand for the property *tree*, we can say that $t \prec_T tt$. This should be read as 't is one of the trees tt'. The property plays a role in how we interpret this expression; it characterises the plurality because we used that property to carve out the plurality. If you carve by the property *tree* you get trees. If you carve by the property *molecule*, you get molecules. Furthermore, if we substitute 'c' for 'tt' (on the grounds that $c = tt$), the characterisation does not change. As long as the *is one of* operator is still relativised to the property tree, we are carving by that property and we will get trees by doing so. So '$t \prec_T c$' says 't is one of the trees c'.[245] Note that '$t \prec_T c$' relates two singular terms, 't' and 'c'. Yet no tree is a copse. But '$t \prec_T c$' does not say t is a copse; it says t is a tree. So we cannot infer $t = c$ from $t \prec_T c$. That means the move from (11) to (12) will not be valid once we have properly relativised the *is one of* operators in Calosi's argument.[246] Of course, I admit that there is some peculiarity to expressions like '$t \prec_T c$' and 't is one of the trees c', but I have addressed that concern in the previous chapter.

So we see that the arguments that CAI entails nihilism are defeated by provisions put in place (for independent reasons) in the previous chapter. CAI does not entail nihilism.

4.4 Universalism and Supersubstantivalism

In Chapter 2, I promised to return to the issue of universalism and supersubstantivalism. That time has come.

Schaffer has claimed that supersubstantivalism entails universalism. He writes:

[245] See Chapter 3.2.3 for more discussion – including a response to the objection that 't is one of the trees c' is a very peculiar thing to say, and we feel some resistance to saying it.

[246] I have chosen not to explicitly recast the whole argument with relativised *is one of* operators here because doing so will require settling the best way to relativise the *is one of* operator in Plural Covering (without relativising Plural Covering). I take it that there are multiple good ways to do that, and I do not wish to get bogged down in that discussion.

> Given unrestricted composition and decomposition for spacetime regions […], and the monistic identification of material objects with spacetime regions [i.e. supersubstantivalism], unrestricted composition and decomposition for material objects follows immediately.[247]

I have given reasons to believe matters are more complicated than this. In Chapter 2.4.2, I distinguished between the unrestricted and restricted versions of supersubstantivalism:

> Unrestricted supersubstantivalism: For any spacetime region r, there is some material object x such that $r = x$.

> Restricted supersubstantivalism: For any object x there is some region r such that $x = r$ *and* there is some region s such that, for any material object y, $s \neq y$.

Given the plausible assumption of CEM for regions, universalism is entailed by unrestricted supersubstantivalism because for any plurality of objects xx, identical with their locations rr, CEM guarantees that there is a region s that is composed of rr, and unrestricted supersubstantivalism guarantees there is some object y identical with s. But universalism is not guaranteed by restricted supersubstantivalism. If all we know is that some regions are identical with objects and others are not, then we do not know whether the region that fuses any given plurality of regions rr is identical with an object – even if every member of rr is an object.[248] This alone should be enough to put the matter to bed; clearly, supersubstantivalism

[247] Schaffer (2009, p.135).

[248] I will offer more detail on precisely how supersubstantivalists can restrict composition in Section 4.5.1.

simpliciter does not entail universalism. Furthermore, I have even given reasons for favouring restricted supersubstantivalism over its unrestricted sibling (see Chapter 2.4.2).

But we might wonder whether there are other reasons to think that identifying material objects with regions of spacetime leads to universalism. In fact, the opposite appears to be true: the most-cited reason for endorsing universalism is the Vagueness Argument,[249] but there are good reasons to think that it is undermined by supersubstantivalism.[250] Allow me to explain.

4.4.1 The Vagueness Argument

In brief, the Vagueness Argument claims that restricting composition results in indeterminacy in what exists but, since there cannot be indeterminacy in what exists, this means composition is not restricted.[251] Now let us add more detail, drawing on the most well-known version of the argument (the version by Sider).[252]

For the purposes of this argument, define a *case* as a situation with at least the following three components: some objects, some properties instantiated by those objects, and some spatio-temporal relations between those objects. After this section, we will abandon this definition of 'case', but it will help us for now. If composition is restricted, then there is a case C_1 in which composition occurs (for example, some bricks compose a house) and a case C_n in which composition does not occur (for example, some bricks scattered across the universe) and we can construct a sorites series between them: a series of cases starting from one and ending with the other such that each adjacent member of the series differs from its immediate neighbours by some incredibly small degree. The difference between adjacent cases in this

[249] Given its most influential articulation by Sider (2001, pp.120-132), but seen earlier in Quine (1981, p.10) and Lewis (1986, pp.212-213).

[250] Effingham (2009), Wake (2011), and Nolan (2014).

[251] As is customary, I take vagueness to be sorites-susceptible indeterminacy. See Greenough (2003) and Barnes (2006), for example. This means I sometimes switch between talking about vagueness and talking about indeterminacy. The differences will not matter here.

[252] Sider (2001, pp.120-132).

series is so small as to be implausible that it could be the difference between some objects composing or not composing. The result is a series between composition and non-composition at which it is impossible to draw any non-arbitrary line such that all cases on one side are cases of composition and all cases on the other are cases of non-composition. The fact we can construct a series like this means composition is vague. It admits of indeterminate cases. But, Sider says, composition is not vague because, if it were, the truth values of certain numerical sentences like "there are n-many concrete entities" would be indeterminate, which they are not. Existence is not indeterminate.

Sider offers an argument for the claim that numerical sentences like the above are not indeterminate. It is worth lingering on.[253]

(1) All sentences of the form "there are n-many concrete entities" can be expressed with nothing other than logical terms and the predicate *concrete*.

(2) Logical terms are not vague.

(3) The predicate *concrete* is not vague.

(4) Therefore, all sentences of the form "there are n-many concrete entities" have determinate truth values.

I do not wish to fight Sider on any of the premises (1)-(3); they all seem plausible to me and there are other ways to push back against the Vagueness Argument. Let us examine two responses that show how supersubstantivalism, specifically, can handle it.

First, a response from Effingham.[254] Since we are showing that supersubstantivalism rebuts the Vagueness Argument, let us assume supersubstantivalism is true. Next, ask the

[253] Sider (2001, pp.127-128).
[254] Effingham (2009).

question "Are all regions concrete?" Surely *some* are, since there are concrete material objects identical with regions. But if *all* regions are concrete, then the Vagueness Argument fails because the union of the exact locations of any plurality of material objects will be a concrete region whether or not that plurality of material objects composes a material object. So, whether that plurality of material objects composes a material object or not makes no difference to the number of concrete entities![255] Ergo, given supersubstantivalism, the Vagueness Argument requires that *some but not all* regions are concrete. This is only an intermediate conclusion for Effingham, but we might think it already provides a *reductio* since, as Effingham notes:

> [M]ost philosophers think regions (as in all regions) are concrete or that regions (as in all regions) are abstract. It has never been suggested that some regions can be concrete and some abstract.[256]

But Effingham pushes his objection further. His final step is to offer a version of the Vagueness Argument that does to concreteness what the original Vagueness Argument does to composition.

Recall, from Chapter 2.3.3, that counterpart theory permits supersubstantivalists to say that any given host region may have material object counterparts at different locations, despite not having region counterparts at any other locations. This is how supersubstantivalists capture the idea that material objects do not have their locations essentially, but regions do.

[255] We should note that this argument requires the assumption that, for any plurality of material objects, there is some region that qualifies as the union of all their exact locations. That is to say, the assumption that regions compose unrestrictedly. Sider could resist the argument by denying that premise but, as I have said above (in Chapter 2), I am assuming CEM for regions, so I do not object to this component of Effingham's response.

[256] Effingham (2009, p.38).

Now imagine two objects, x and y, each of which has a left half and a right half. The two objects are located directly next to each other, with x on the left and y on the right. We have restricted composition, so we can make some stipulations:

(S1) The left and right halves of x compose x.

(S2) The left and right halves of y compose y.

(S3) Nothing else composes.

(S4) The exact locations of x and y are concrete regions.

(S5) The region that fuses the right half of x and the left half of y is not concrete.

Stipulations (S1)-(S3) reflect the fact that composition is restricted. (S4) is not really a stipulation since it follows from the fact that material objects are concrete and identical with their exact locations. Even though this is not really a stipulation, I include it among the stipulations for the sake of clarity. Finally, we are free to stipulate (S5) because we cannot endorse the principle that the fusion of any two concrete regions is a concrete region. If we did, then whether that region is also a material object would not affect the number of concrete entities. So composition between material objects would, once again, not affect the number of concrete entities and the Vagueness Argument would fail. (S5) is also a fairly natural thought, since the region it describes is not a material object.

Now, let us think about the exact locations of the material objects under consideration, as represented in Figure 4.1, below.

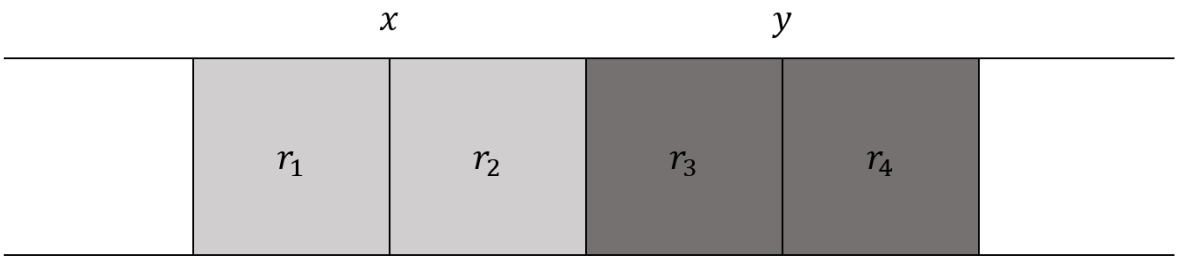

Figure 4.1

The left and right halves of x are located at r_1 and r_2, respectively, while the left and right halves of y are located at r_3 and r_4, respectively. So (S5) tells us that the region that fuses r_2 and r_3 is not concrete. Let us call that region R. The problem for the Vagueness Argument is that we can construct a sorites series with Figure 4.1 at one end, where R is not concrete, and a case at the other end, where R *is* concrete. Figure 4.2 shows us how.

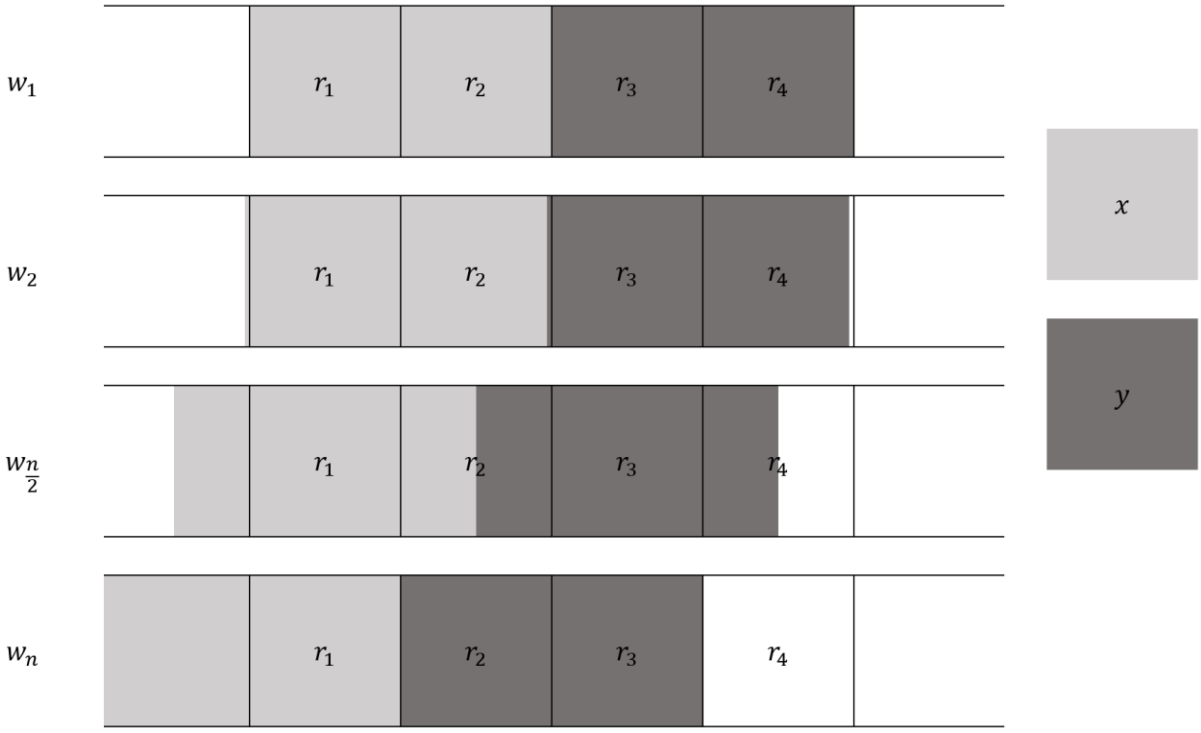

Figure 4.2

We have a series that starts at world w_1 (depicted in the top row of Figure 4.2) and ends at world w_n (depicted in the bottom row of Figure 4.2). As we progress along the series, from start to end, we see the material object counterparts of x and y are exactly located ever so slightly further and further to the left, until we reach w_n. The problem is (S5) tells us that R (the region that fuses r_3 and r_4) is not concrete at w_1 but (S4) tells us that R is concrete at w_n. So, we have a sorites series that starts with R being not concrete and ends with it being concrete. So, concreteness is vague! This contradicts premise (3) of the Vagueness Argument above. So the Vagueness Argument fails.

Effingham's reply to Sider is compelling insofar as it reveals a problem with Sider's version of the Vagueness Argument. But the argument can be rehabilitated. Effingham has not undermined the claim that restricted composition leads to composition being vague and therefore there being indeterminacy in what composes what. Instead, he has undermined the reason Sider says this indeterminacy is bad. Sider has said the problem with such indeterminacy is tied to statements about the number of concrete entities there are, but the problem for Effingham is that Sider's diagnosis was wrong (in fact, Effingham has shown that much!). Why should the badness of ontic vagueness be tied to facts about number? If vagueness in composition is a problem, it would surely still be a problem if it turned out that there were no finite worlds or if concreteness were not also vague. I suspect that, if it is a problem, it is for the same reasons that ontic vagueness is generally thought to be a problem. The problem with ontic vagueness has been diagnosed in different ways by different people,[257] and I will stay out of that matter. The point I am making here is just that Sider has surely *mis*diagnosed the problem and so we supersubstantivalists should perhaps not be too content to rest on our laurels: nothing Effingham says undermines the first step in Sider's argument, which shows that restricted composition does in fact involve vagueness.

[257] See Barnes (2006) for a rundown.

Nolan provides a more promising solution.[258] Like Effingham, he also does not resist the claim that restricted composition involves vagueness, but he argues that the vagueness is not in what exists or is concrete and therefore need not be ontic vagueness at all. Recast in the terms of super-CAI, his response to the Vagueness Argument is as follows.

A tenet of super-CAI is that the region mereology obeys CEM.[259] This means that entities in the region mereology always compose. There is no vagueness there. In spite of this, super-CAI is consistent with restricted composition in the material object mereology because nothing about super-CAI guarantees that entities in the material object mereology will always compose. Therefore, there is always an entity that is the fusion of any two regions – it is just not guaranteed to always be a material object. Sometimes it will be a mere region. Ergo, there is no vagueness in existence, after all: for any plurality of regions, there is guaranteed to exist a fusion of those regions. Furthermore, assuming that supersubstantival regions are concrete, there is no vagueness in concreteness either. Instead, there might be vagueness in which predicates particular regions satisfy and therefore in whether any given region is a mere region or a material object. But, Nolan notes,[260] this does not have to be ontic vagueness – it can be vagueness as a result of imprecise language. Linguistic vagueness is garden variety and not the kind of vagueness that Sider has expressed objection to, so the Vagueness Argument has no hold here.

We have seen that supersubstantivalism does not entail universalism (unless we are talking about *unrestricted* supersubstantivalism) and it can motivate rejection of the most powerful and most popular argument for universalism: the Vagueness Argument. In previous sections, we have seen that CAI also does not entail universalism or nihilism. We therefore

[258] Nolan (2014, Section 5).

[259] Nolan's supersubstantivalism (which we will meet in Chapter 7) makes a claim that functions similarly to this claim, though Nolan does not think mere regions are mereologically structured.

[260] Nolan (2014, p.111-112).

have no good reason to think that super-CAI will require any particular answer to the special composition question. Advocates of super-CAI are free to endorse universalism, restricted composition, or (dare I say it) nihilism. The final thing I want to do in this chapter is gesture at the sorts of things an advocate of super-CAI would be likely to say, if she wanted to restrict composition.

4.5 How to Restrict Composition

The task of developing a novel answer to the special composition question is beyond the scope of this thesis. Instead, I will very briefly gesture at the levers and dials which can be pulled or turned to affect the way super-CAI restricts composition. This will give us some indication of what restricted composition will look like for super-CAI, but I am not going to make judgements about where those levers and dials should be set. As I have said above, I do not even make a judgement about whether we should endorse a restricted view of composition – it is interesting enough to note that super-CAI can be combined with a restricted theory.

Advocates of super-CAI can try to restrict composition in all the usual ways,[261] but we have two additional tools at our disposal. We can either restrict the regions that can count as host regions (this is the method that supersubstantivalists would use) or restrict the properties by which we can carve portions of reality (this is the method that advocates of CAI would use). But it turns out that these two methods of restriction look remarkably similar, which provides yet another reason for combining CAI and supersubstantivalism.

4.5.1 Constraints on Host Regions

A *host region* is a region of spacetime at which some material object is exactly located. According to supersubstantivalism, material objects are identical with their host regions.

[261] See Markosian (2008) for an overview.

According to *restricted* supersubstantivalism, some regions of spacetime are host regions but others are mere regions, at which no material object is exactly located (and which are therefore identical to no material object).

By placing constraints on which regions can be counted as host regions, we can restrict composition. Think of these constraints as necessary conditions for counting as a material object – on some views, they might be sufficient also, but it is the fact that they are necessary conditions that will work to restrict composition. But not just any restriction will do the job. In Chapter 2, we saw some candidates that will not work, for example:

Restricted Constraint: Size

Only regions above a certain size can be material objects.

This constraint will not entail that composition is restricted because the union of any regions over a given size will also be over that size. Fortunately, there are other restrictions we might consider.

Restricted Constraint: Regular Closed

Only regular closed regions can be material objects.

This is an interesting case because although the finite union of any regular closed regions is regular closed, the same is not guaranteed of infinite cases. This means finitary composition is not restricted by this constraint, but infinitary composition is. Perhaps this counts as restricted composition, perhaps it does not.[262] Whether it does is clearly a terminological issue; what

[262] Bohn (2009b) claims it does count as restricted, whereas Contessa (2012) claims finitary *binary* composition does not count as restricted (although see Cotnoir (2014b) for a rebuttal of Contessa's view).

matters more is the fact that the Regular Closed constraint does not deliver the results usually desired of a restricted theory of composition, such as ruling out objects like trout-turkeys or the fusion of all cats (assuming a finite number of cats). But there are still more options.

Restricted Constraint: Connection

Only topologically connected regions of spacetime can be material objects.

Restricted Constraint: Size*

Only regions below a certain size can be material objects.

The connection constraint will have similar benefits to some of the first answers to the special composition question that van Inwagen considered. Answers like *contact* and *fastening*,[263] with benefits like simplicity and intuitive appeal. Furthermore, since we are only thinking of these constraints as necessary (not sufficient) conditions, this constraint will not feature some of the drawbacks of those views, such as claiming that people who shake hands become a new object while they do so. It is also interesting to note that, since the notion of topological connection is not vague, this will not be a source of vagueness in composition – though, of course, vagueness might be introduced by whatever the sufficient conditions turn out to be.

Alternatively, we might opt for something like the Size* constraint. This says that regions over a certain size (to be specified by whomever advocates the constraint) cannot be material objects. Considerations of causal unity might push us towards this view.

[263] For contact, see van Inwagen (1990, Chapter 3). For fastening, see van Inwagen (ibid, p.56). See also Markosian (2008, Section 5) for a discussion of both.

Following Casati and Varzi's definition, I take it that any object x is causally unified iff "operations performed on certain parts [of x] have systematic effects on other parts [of x]"[264] For example, pushing on any part of the object will move all the parts of the object.

The advocate of Size* might join Mellor in thinking that causal unity is necessary for being a material object,[265] and might be motivated to endorse Size* by the thought that it is possible to be too large and cumbersome to have this kind of causal unity. Although the notion of causal unity is surely vague, magnitudes of size need not be. There is scope, therefore, for the Size* constraint to leave vagueness out of the picture.

A final consideration worth noting is that restricted supersubstantivalists will probably think that the correct constraints on host regions will guarantee they contain matter. Something like the following has shown up in the literature:[266]

Restricted Constraint: Mass-Energy

Only regions of spacetime with non-zero mass-energy can be material objects.

Or we might choose to render van Inwagen's restricted view in terms of a restriction on host regions.[267]

Restricted Constraint: Living Organism

Only simple_{m} regions of spacetime and regions that instantiate the property *is alive* can be material objects.

[264] Casati and Varzi (1999, p.14).
[265] Mellor (2008).
[266] See Lehmkuhl (2018) and Schaffer (2009).
[267] van Inwagen (1990).

These constraints can be mixed and matched with other constraints above. I am inclined to think that a combination of something like the *connection* constraint and the *mass-energy* constraint will produce a *prima facie* plausible, necessary and sufficient condition for being a host region which constitutes a restricted answer to the special composition question and involves no vagueness. Regardless of how plausible you find that view (I would certainly need to do more to defend it), it is clear that there are lots of options available in this space. It would be interesting to see a full and proper discussion of them, but I have other fish to fry.

4.5.2 Restricting How We Carve

There is another way super-CAI might restrict composition. This method restricts the properties by which we can carve any region. There are lots of things to say here, but my aim is just to establish that there are ways to restrict composition by restricting which carvings are permissible. In the process, I will be gesturing at – but skirting around – various issues related to which carvings are permissible and which are not.

Carving is a process of decomposition; we start with a host region and carve it up into host subregions. You cannot carve your way to a super-region. So, what can principles of *de*composition tell us about restricting composition? Well, we need our principles of composition and decomposition to match. If only the spherical objects compose, then we cannot carve a single material object into a plurality of non-spherical material objects. Equally, if we can only carve host regions by members of some set of properties S, then regions which do not instantiate any of those properties cannot compose. Now, let us think about why and how we might impose such restrictions.

If, like Lewis,[268] we accept an *abundant* view of properties, then we will have good reason to restrict the properties we can carve by. On abundant views, there is a property (or

[268] Lewis (1983, 1986).

relation) for any predicate whatsoever – no matter how arbitrary or gerrymandered. As Lewis has noted, this means that "Properties carve reality at the joints—and everywhere else as well."[269] If we believe Arbitrary Partition is false (as I have urged in Chapter 2), then this will not do. When we carve a material object by a property and hope to end up with a plurality of material objects, we had better make sure it is a joint-carving property. So, how do we restrict the properties by which we can carve?

First, we might simply reject the abundant view, opting instead for a *sparse* view of properties on which there are only joint-carving properties. Or we might employ a notion of naturalness to sort the joint-carving from the non-joint-carving abundant properties. This, in itself, might be enough to restrict composition because disjunctive properties such as *either my left shoe or the Eiffel tower* are standard examples of non-natural properties that are excluded on sparse conceptions. Ergo, a restriction of this sort would preclude the existence of any material object that is composed of just my left shoe and the Eiffel tower.

This would seem an easy solution, but it might not be the best fit with CAI. If the sparse properties or the sufficiently natural properties are just the ones that (on the layered world view) are typically thought of as most fundamental, then we will find we can only carve macro-level objects into their finest partitions, to the exclusion of many of the ways we want to carve. If *tree* is not a sparse or sufficiently natural property, then we cannot carve the copse into trees after all.[270] But we should be able to carve the copse into trees, or into molecules, or atoms, and so on. Given CAI's rejection of the layered world view (see Chapter 1), we should be careful to not privilege any particular way of carving over others, which is precisely what this solution is in danger of doing.

[269] Lewis (1983, p.346).

[270] Loss (forthcoming) advocates a view called Atomic Composition as Identity which claims something like this. I briefly discuss and reject it in Chapter 6.

So the abundant view of properties gives us too many carvings for a restricted view of composition, while the sparse view gives us too few for CAI. Hence, articulating a version of CAI that restricts composition by restricting the properties by which we carve requires threading a needle: we must find a way to establish a position between these two extremes. I have confidence it can be done but, as I have said, I will merely gesture at the solution I have in mind. It goes like this.

Take the abundant view of properties. There is a property for every predicate. In Chapter 3, when we were exploring models for understanding super-CAI, I said that the denotation of any predicate P is a subset of the domain D, which is a set of regions. I now claim that, if we wish to say (for example) that *being a connected region* is a necessary condition on material objecthood, we simply need to say that we cannot carve by properties for which the denotation of the associated predicates are subsets of D that have any unconnected regions as members. Alternatively, if we wish to say that only regions below a certain size can be objects, we will have to say that we cannot carve by properties for which the denotation of the associated predicates are subsets of D that have regions above that size as members. And so on. In general, any restriction you wish to place on composition will require you to say that we cannot carve by some properties for which the denotation of the associated predicate includes some specified subset of D. This way of understanding restriction on carving lines up with the constraints on host regions, mentioned in the previous subsection above: for any way of constraining which regions are host regions, there is an associated subset of D of which we can mandate that the properties we carve by (or, rather, the predicates associate with them) denote subsets. Thus we know, from the previous section, that this can result in restricted composition, and we see yet more agreement between CAI and supersubstantivalism.

There is an additional, specific restriction we ought to consider. Yi has expressed worries about how precise the properties we carve by must be.[271] Observe Figure 4.3, below, and reflect on how many regions satisfy the property *black-outlined square*.[272]

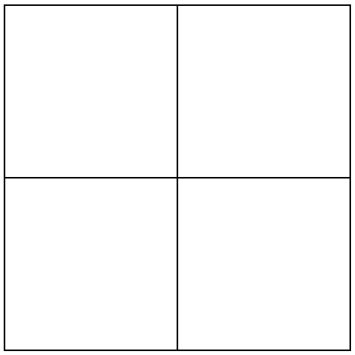

Figure 4.3

The answer is five. There are five regions that instantiate the property *black-outlined square*. But carving this way involves overlapping regions which is something CAI advocates try to avoid. After all, CAI claims that wholes are (collectively) identical to their parts, so there is something dubious about counting the four smaller squares *and* the one larger one. To do so is to count the same thing twice. Thus, the considerations that motivated CAI in the first place also motivate a restriction that prevents double counting by banning carvings that feature overlap. This would restrict composition (though in an uninteresting way) by precluding the existence of any object composed of your hands and your whole body, for example. We can impose this restriction by mandating that we do not carve by properties for which the denotation of the associated predicates includes a subset of D whose members overlap.

[271] Yi (2014).

[272] I include the adjective 'black-outlined' because there are a great deal more square regions in Figure 4.3 than just the black-outlined ones. There might even be infinitely many square regions simpliciter in that region.

Again, we see that there are many options available in this space and I have only quickly gestured at a general strategy for implementing them. A more thorough treatment might well reveal a powerful new restricted theory of composition – such a theory would be particularly novel if it were to combine the two methods of restricting composition that I have discussed above in interesting ways. Unfortunately, my goals in this thesis direct my attention elsewhere, for now. It will have to suffice that I have demonstrated that super-CAI offers us a new set of tools for tackling the special composition question.

Now, let us go back to thinking about super-CAI. It is time to consider objections and alternatives.

CHAPTER 5:

OBJECTIONS

Super-CAI has now been outlined. The next step is to respond to objections that have been levelled at either CAI or supersubstantivalism, showing that super-CAI is immune to them all. A lot of this work has already been done, in previous chapters. I have already responded to many objections, including:

Against CAI

- Objections based on the Indiscernibility of Identicals (in 1.5.4 and 3.2.3).
- Sider's argument from Collapse (in 3.2.3)
- The Problematic Many-Manys objection (in 3.2.3).
- The allegation that CAI leads to mereological essentialism (in 1.5.1).
- The allegation that CAI leads to universalism (in 4.2).
- The allegation that CAI leads to mereological nihilism (in 4.3)
- The worry that '=' cannot be used to express many-one identities because it is syntactically one-one or many-many (in 3.2.2).
- Concerns that we cannot make semantic sense of many-one identity (in 3.1).
- The argument that identity is symmetric but composition is not, so CAI is false (in 3.1.3).

Against Supersubstantivalism

- The modal argument against supersubstantivalism (in 2.3.3)

- The allegation that supersubstantivalism is inconsistent with extended simples and gunky objects in pointy space (in 2.4).
- The worry that supersubstantivalism is at odds with common sense (in 2.4.1).

Yet there are more. I cannot possibly hope to address every single objection to CAI or supersubstantivalism that has ever been devised. Fortunately, some objections have extant replies about which I have nothing new to say. For example, objections to CAI based on strongly emergent properties[273] have been addressed by Bohn,[274] and, since I have nothing new to say on the matter, I leave that stone unturned. Or take the debate over material constitution, which asks about the relationship between a constituted material object (such as a statue) and its constituting matter (a lump of clay). Accounting for apparent modal differences between them has caused advocates of both CAI and supersubstantivalism to endorse counterpart theory.[275] This solution to the problems posed by material constitution is a form of a more general strategy called the *Abelardian strategy*, but there are notable objections to the Abelardian strategy that a detailed treatment of this issue would need to wrestle with.[276] All of that is a discussion worth having, but it would be vast. My only new contribution to that debate is to point out that if, as has been argued, the Abelardian strategy leads to supersubstantivalism,[277] and CAI requires that strategy to address the problems of material constitution, then we have *another* reason for combining supersubstantivalism with CAI.

Still, there is another significant objection we would do well to consider and about which I have a lot to say. I turn to it now.

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[273] See McDaniel (2008).

[274] Bohn (2012). See also Duncan and Miller (forthcoming) who offer the same response as Bohn (2012).

[275] For examples regarding CAI, see Bohn (2009a, p.viii), Wallace (2011b), and Bricker (2016). For an example regarding supersubstantivalism see Effingham (2009, p.40, n.4).

[276] Most notably, Fine (2003).

[277] Berto (2013). Though Berto thinks supersubstantivalism is "quite hard to swallow" (ibid. p.11) and sees it as a form of *reductio* for the Abelardian strategy. He appears convinced by the modal objection and the common-sense objection to supersubstantivalism, which I have addressed above.

5.1 Co-location and Interpenetration

Co-location occurs whenever *non-identical* objects have *identical* exact locations. If a ghost that is the exact same size and shape as you passes entirely through you, there comes a moment at which your exact locations completely overlap and yet you are not the ghost and it is not you. Those who think that constitution is not identity think that each statue is co-located with the lump of clay that constitutes it. This relation can be expressed formally:

Co-Location: $\exists x \exists y \exists r (x@r \ \& \ y@r \ \& \ \neg x = y)$

Similarly, interpenetration occurs whenever *disjoint* material objects have *overlapping* exact locations. When a ghost passes its hand through a wall, the ghost and the wall overlap, but the ghost and the wall have no parts in common. This can also be expressed formally:

Interpenetration: $\exists x \exists y \exists r \exists s (x@r \ \& \ y@s \ \& \ \neg x \circ y \ \& \ r \circ s)$

There is a substantial lineage of authors rejecting the possibility of co-location and interpenetration. For example, if we take material objects to be a kind, we can see Locke rejecting both in the following passage:

> For we never finding nor conceiving it possible, that two things of the same kind should exist at the same place at the same time, we rightly conclude that anything that exists anywhere at any time, excludes all of the same kind, and is there itself alone.[278]

[278] Locke (*An Essay Concerning Human Understanding*, Bk. 2, Ch. 27, §1).

Wiggins claims that "Locke gets this absolutely right",[279] and Quinton writes:

> This type of solidity may be called impenetrability and it is […] the property that every material thing possesses of excluding every other material thing from simultaneous occupancy of the region of space where it is to be found. The concept of logical solidity or impenetrability is implicitly defined by the principle that no two things can be in the same place at the same time unless one is part of the other.[280]

More recently, Markosian has argued:

> There are independent reasons for claiming that it's not possible for two physical objects to occupy the same place at the same time, and I am quite willing to make this claim. So I deny that the scenario described is possible.[281]

But not everyone rejects colocation and interpenetration. There are several compelling arguments for the possibility of interpenetrating material objects and, given the theory of material objects that I advocate, I need to say something about them.

Co-location and interpenetration are thought to provide problems for supersubstantivalism. It is easy to see the problem caused by co-location: supersubstantivalism claims that objects are identical with their exact locations so, given the transitivity of identity,

[279] Wiggins (1967, p.72).

[280] Quinton (1964, pp.341-42). Again, like Locke and Wiggins, Quinton is here only ruling out co-location and interpenetration for material objects. Since I have restricted the scope of this work to cover only material objects, this is equivalent to ruling out co-location and interpenetration simpliciter, in this context. The behaviour of immaterial objects (if there are any) is an issue for another day.

[281] Markosian (2014, p.74).

any two things with the same exact location must also be identical to each other. Co-location also violates the right-to-left direction of the Subregion Theory of Parthood.

Subregion Theory of Parthood: $\forall x \forall y((x \leq y) \leftrightarrow \exists r \exists s(x@r \,\&\, y@s \,\&\, r \leq s))$[282]

Since the subregion relation is reflexive, whenever two objects have the same exact location, the right-to-left direction of the Subregion Theory of Parthood says they are parts of each other. The antisymmetry axiom of parthood tells us that when two things are parts of each other, they are identical. Ergo, supersubstantivalism and the right-to-left direction of the Subregion Theory of Parthood (which is entailed by supersubstantivalism – see Chapter 3.2.1) both tell us that any two things with the same exact location are identical. We supersubstantivalists must therefore give reason to think that there are no co-located objects.

It has also been alleged that supersubstantivalism is inconsistent with interpenetration.[283] The argument goes like this. Assume a case of interpenetration: there is an object x and an object y exactly located at a region r and a region s (respectively) such that the regions r and s overlap, but the objects x and y do not overlap. Supersubstantivalism tells us that $x = r$ and $y = s$. But since we have identities, we can do substitution. Objects x and y can be substituted into statements about r and s. So, given the statement 'r overlaps s', we can substitute to get 'x overlaps y'. We now have a contradiction with the assumption that x and y interpenetrate.

Restricted supersubstantivalism can invalidate this argument. As we have seen in previous chapters, if we endorse a restricted supersubstantivalism, then we can claim that there is one mereology for spacetime regions, and another for material objects. I use subscript letters

[282] Where each instance of '$\leq$' is relativised to the same mereology (the region mereology, or the object mereology, or otherwise).

[283] Gilmore (2018).

on mereological operators to indicate this: 'r' for the region mereology and 'm' for the material object mereology. With this distinction in place, we see that the formal statement of interpenetration should look like this:

Interpenetration (restricted ss): $\exists x \exists y \exists r \exists s (x@r \ \& \ y@s \ \& \ \neg x \circ_m y \ \& \ r \circ_r s)$

But we cannot derive contradiction from an instance of this and supersubstantivalism. Assume a case of Interpenetration (restricted ss): there is an object x and an object y exactly located at a region r and a region s (respectively) such that the regions r and s overlap$_r$, but the objects x and y do not overlap$_m$. Supersubstantivalism tells us that $x = r$ and $y = s$. But since we have identities, we can do substitution. Objects x and y can be substituted into statements about r and s. So, given the statement 'r overlaps$_r$ s', we can substitute to get 'x overlaps$_r$ y'. But this is no contradiction with the claim that x and y do not overlap$_m$.

In fact, we can see a case of interpenetration with which supersubstantivalism appears to be consistent, in Figure 5.1, below.

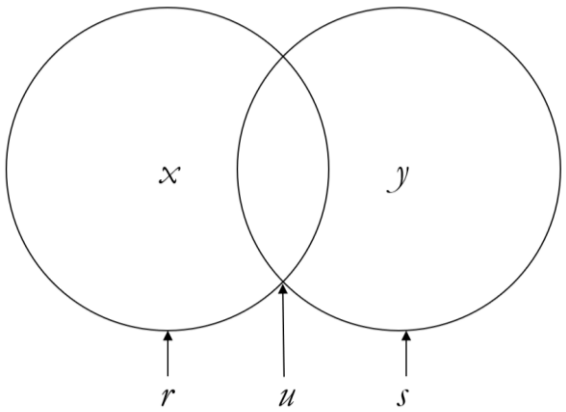

Figure 5.1

In Figure 5.1, we see two circular objects x and y, with exact locations r and s, respectively. r and s overlap$_r$ at u. But x and y are simples$_m$, so neither has a part$_m$ in common with the other, so x and y do not overlap$_m$. Nothing about restricted supersubstantivalism rules out this case. Unrestricted supersubstantivalism does rule it out because it says that there is an object identical with the region u. The right-to-left direction of the Subregion Theory of Parthood then guarantees that the object at u is part$_m$ of x and part$_m$ of y, so x and y overlap$_m$.

However, Figure 5.1 depicts only one way objects might interpenetrate. In fact, there are three ways objects might interpenetrate because interpenetration involves overlapping regions and there are three ways regions (or anything else, for that matter) can overlap. Take a look at Figure 5.2.

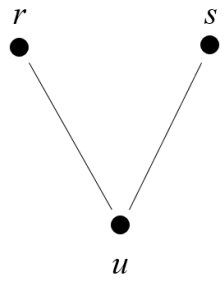

Figure 5.2

We have three regions. Two are composite (r and s) and one is atomic (u).[284] In this scenario, all three methods of overlap are taking place. Let us think of them as different *cases* of overlap. Case 1: r overlaps s because they both have u as a part. Case 2: r overlaps u because they both have u as a part (s overlaps u in this way too). Case 3: they each overlap themselves because overlap is reflexive. For the sake of clarity, we can represent these three cases spatially (although overlap is not inherently a spatial notion), as in Figure 5.3 (below).

[284] Of course, this model is ruled out by CAI because it says that composition is not unique, but we do not need this model to be possible; we just need it to illustrate the different ways things can overlap.

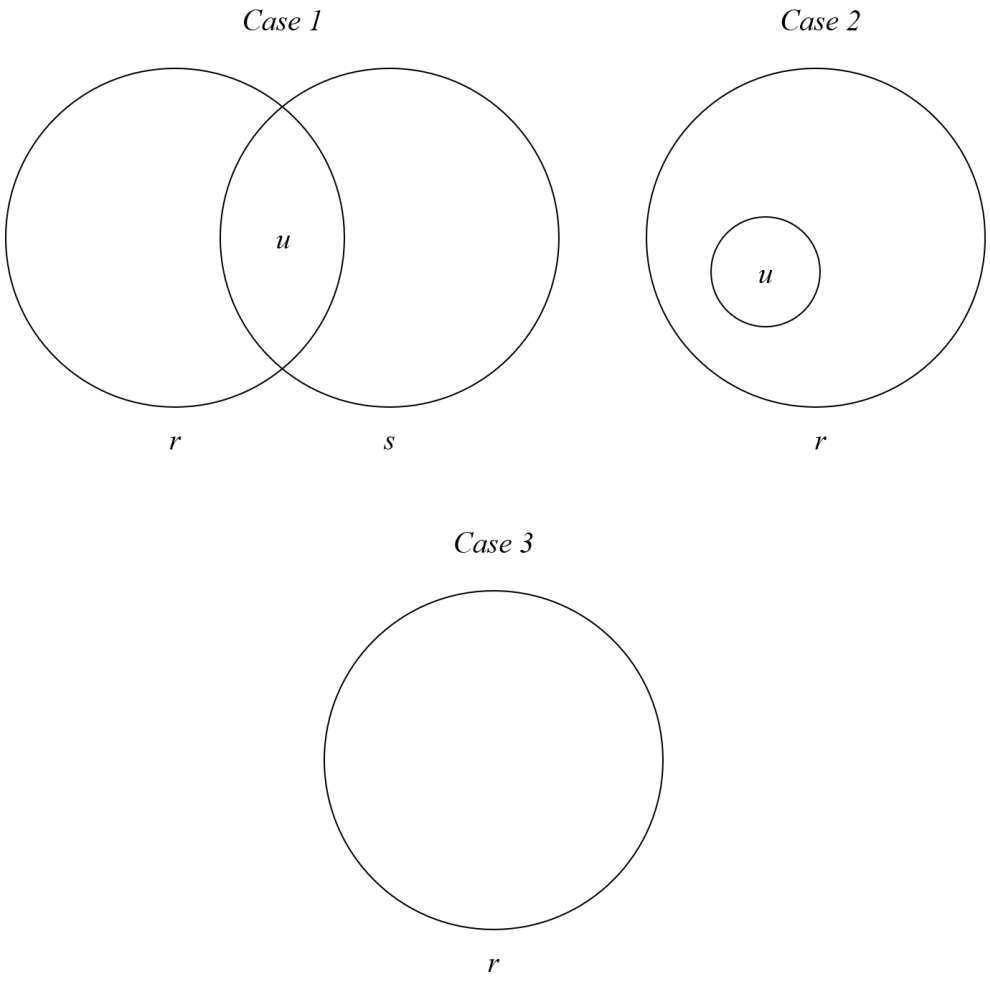

Figure 5.3

We have seen that supersubstantivalism is consistent with interpenetration involving Case 1 overlap (recall Figure 5.1). The two are consistent whenever no subregion of u is a material object. If we endorse any principle that guarantees some subregion of u is a material object, then supersubstantivalism will rule out this kind of interpenetration. One way that restricted supersubstantivalists might find themselves endorsing such a principle is by making commitments about which regions qualify as material objects. If, for example, we think that all and only the appropriately matter-filled regions are material objects, then we will think that u is a material object (if r or s is). But restricted supersubstantivalists do not *have* to endorse any of those views, so there is room for thinking that u is a mere region. Another way that restricted

supersubstantivalists might find themselves guaranteeing that some subregions of u are material objects is through the principle Arbitrary Partition:

Arbitrary Partition: $\forall x \forall r(x@_{>}r \rightarrow \exists y(y \leq_m x \wedge y@r))$

Arbitrary Partition says that every region pervaded by an object is the exact location of some object. If it is true, then u in Case 1 and Figure 5.1 is a material object (as is every subregion of u) and the left-to-right direction of the Subregion Theory of Parthood entails that this is not interpenetration after all. I think there are good reasons to reject Arbitrary Partition (discussed in Chapter 2), so I am inclined to think supersubstantivalism is consistent with *some* interpenetration. The important thing to notice about this case is that when interpenetration is a problem, it is because it contradicts the right-to-left direction of the Subregion Theory of Parthood. This is a theme in what follows.

Interpenetration involving Case 2 overlap is also ruled out by the right-to-left direction of the Subregion Theory of Parthood. Let us imagine how it would look. There is an object x, exactly located at region r and an object y exactly located at region u. r overlaps u in the way shown in Case 2. For this to count as interpenetration, x and y must be disjoint, but y is exactly located at a subregion of the exact location of x, so the right-to-left direction of the Subregion Theory of Parthood tells us that they are not disjoint. Hence, according to supersubstantivalism, which entails the right-to-left direction of the Subregion Theory of Parthood, this kind of interpenetration cannot occur.

Interpenetration involving Case 3 overlap is co-location. When two disjoint (and therefore non-identical) objects x and y are exactly located at the same region r, the exact location of x overlaps the exact location of y and vice versa. We have already seen that

supersubstantivalism is inconsistent with co-location, so we know that it is inconsistent with Case 3 interpenetration.[285]

The lesson to be learned from all of the above is that supersubstantivalism prohibits all the forms of co-location and interpenetration that violate the Subregion Theory of Parthood. Specifically, the right-to-left direction, which is entailed by supersubstantivalism. We have examined every way that things might overlap and found this to be the case. So the Subregion Theory of Parthood is where the action is.[286] Let us now consider some arguments for the possibility of co-located or interpenetrating objects that appear to threaten the Subregion Theory of Parthood. We will see that each scenario can be resisted.

5.1.1 Quantum Entanglement

I start with a dodge. It is not uncommon to understand the entanglement of quantum particles as co-location. If this is correct, then quantum entanglement may provide a counterexample to supersubstantivalism.[287] Unfortunately, I have no expertise in quantum physics and am cognisant of the frustration caused by philosophers without such expertise making judgements on these sorts of issues.[288] Instead, I simply note that alternative interpretations – consistent with supersubstantivalism – are available.[289] So the strength of this threat to supersubstantivalism depends on the strength of the relevant interpretations of the physics. This

[285] Note, though, that Case 3 interpenetration is not the only way for objects to co-locate. The problem of material constitution has led some people to claim that constituted objects (such as statues) share all their parts with the objects that constitute them (such as lumps of clay) but are not identical with them. See the start of this chapter for my brief discussion of the problem of material constitution.

[286] There is one view about co-location that threatens supersubstantivalism without threatening the Subregion Theory of Parthood: the view that material constitution involves mutual parthood (see Thomson (1983, 1998), Hawthorne (2006), Cotnoir (2010, 2013c)). Instead of rejecting the Subregion Theory of Parthood mutual parthood rejects the antisymmetry axiom (see Introduction). I do not examine this view here because I have assumed parthood is antisymmetric (see Introduction).

[287] Morganti (2011, p.194) makes this point.

[288] For a particularly vivid and compelling expression of this frustration, see McKenzie (2013).

[289] Most notably, Schaffer (2009, pp.140-144). Morganti (2011, p.194 n.18) also suggests a solution which, with work, could be made to fit with super-CAI.

is another area where I rely on the division of philosophical labour and where I acknowledge that those who wish to object to supersubstantivalism (and super-CAI, by extension) might (or might not!) find grist for the malady mill.

5.1.2 Ghosts

After that dodge, now a dismissal. Imagine there is a ghost and it passes through you. At some point, your exact location completely overlaps the ghost's exact location. Yet surely the two of you do not become identical in that moment, so super-substantivalism is false. There are several responses available but before considering them, we should get clear on what ghosts are thought to be like.

The philosophical conception of ghosts (in the Analytic tradition, at least) holds that they are minds without bodies; nothing more than a subject of phenomenal experience. Such entities are clearly descendants of Descartes' theory of mind,[290] and have since been thought possible by many, including P. F. Strawson,[291] J. L. Mackie,[292] and Philip Goff.[293] That sort of ghost will not do for our purposes because they are not located. Descartes famously claimed that minds are not spatially extended and lack location,[294] while others have pointed out good reasons to think that these ghosts are not located because any location they might have would be too arbitrary.[295] I will not consider philosophers' ghosts any further.

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[290] Descartes (*Meditations*). Though these ghosts may well have older ancestors than Cartesian minds; for instance, they might also descend from the medieval theologians' conception of angels, which are said to exist without bodies (see Aquinas, *Summa Theologica* 1.76.ad1). I do not address angels here, except in another footnote, below.

[291] Strawson (1959).

[292] Mackie (1982).

[293] Goff (2010).

[294] Descartes (*Meditations*, second and third meditations).

[295] See Smart (1971) and Janzen (2012). This objection ought to apply to medieval angels also. There has been disagreement over whether angels have locations: Boethius thought not, whereas Aquinas thought so (*Summa Theologica*, 1.52.1). Most (perhaps all) of the objections about ghosts that I discuss in this section can also be applied to angels. I leave that as an exercise for the reader.

The ghosts that threaten supersubstantivalism are located. Thus, they are not Analytic philosophers' ghosts. They are more like the ghosts of popular culture.[296] They are sometimes incorporeal and invisible and sometimes appear as puffs of smoke, whisps of wind, shimmers, or atmospheric disturbances. Schaffer dismisses them out of hand, calling them "an incoherent jumble of immaterial and material features."[297] I do not know whether the ghosts of popular culture are *metaphysically* impossible but they are surely physically impossible. They see with eyes while absorbing no light, they hear with ears without disturbing soundwaves, they exert forces on objects while being incorporeal and presumably having no mass. If it turns out that supersubstantivalists have to say that there are (at least actually) no ghostly entities of this kind, I do not see this as something to regret. However, if readers are still keen to entertain the possibility of ghosts, then I direct them to the discussion in Section 5.1.5. The claims I make there can be applied to ghosts also.

5.1.3 Recombination

Sider,[298] McDaniel,[299] and Saucedo[300] all offer a recombination argument for the possibility of interpenetration. The argument begins by observing some contingent, distinct states of affairs:

- Some object x pervades region r at time t_1
- Some object y disjoint from x pervades region r at time t_1

[296] Of course, ghosts (or things like them) appear in stories told in many cultures and there will be variations in the metaphysics of such ghosts across those cultures. This is not the place for an anthropological survey. I will have to assume that one of the two replies I have given above applies to potential ghostly counterexamples. They certainly apply to the kinds of ghosts I am familiar with.

[297] Schaffer (2009, p.140).

[298] Sider (2000, pp.585-586).

[299] McDaniel (2007a, p.241).

[300] Saucedo (2011).

Since they are contingent and distinct, we should be able to recombine them, resulting in x and y both pervading r at t_1, despite being disjoint (i.e. interpenetration). This is straightforwardly defused by supersubstantivalism. The supersubstantivalist gets to say that the two states of affairs are not distinct, since objects and their locations are identical. So recombination is not permitted and this argument is defeated.

5.1.4 Light Through Yonder Window

When light passes through your bedroom window on a sunny day, does each photon briefly interpenetrate with the window? Mellor has suggested they do because he rejects the view that the photons become part of the window – that would be very counter-intuitive![301] Nolan tells us, again, that we can bite the bullet on this case; he replies that "presumably it is not beyond the pale for a theorist to insist that the photon is briefly part of the window."[302] Williams agrees and gives us the details of how we might improve the bullet's taste, but first he considers an alternative explanation.[303] He starts with a distinction between the region the window *is located at* and the region the window *dominates*. A region r is dominated by an object x iff x causally excludes a wide enough range of objects from occupying r. The first response Williams offers uses this distinction to claim a gappy conception of the window, according to which, the region it occupies is gappy, but the region it dominates is not. That is why the photons may pass through the window. It is not interpenetration; the photons simply pass through the gaps and are not causally excluded from occupying the spaces in those gaps. Unfortunately, this solution has trouble with the relevant physics. Scientific explanations of why light passes through clear glass but not through opaque objects seem to have nothing to do with glass being gappy; roughly speaking, they say that glass is transparent because the energy of visible light is not

[301] Mellor (2008, p.68).
[302] Nolan (MS, p.20).
[303] Williams (2008).

enough to make electrons in the glass jump between different energy bands, so the light is not absorbed. Perhaps Williams' response can be interpreted in a way that maps onto this, but it is not immediately obvious how. There is another problem. Advocates of the gappy response need to tell us why some materials are transparent and others are not. It is implausible to suggest that glass is *more gappy* than all opaque materials – after all, the motivation for the gappy conception presumably comes from the simplistic conception that atoms are mostly empty space, but if this were true it would be true of atoms in opaque materials too.

Fortunately, Williams offers a second response, which does not rely on a gappy conception of ordinary objects. Instead, Williams tells us how to bite the bullet. He accepts that the photon *is* one of the parts of the window as it passes through, but claims it is "not a very interesting one".[304] To do this, Williams borrows the notion of 'working parts' from Mellor. According to Mellor, for any material objects x and y, x is a part of y, just in case x is contained within y and x contributes to y's *causal unity*.[305]

Mellor's view is that objects only have working parts. This means that Mellor has a novel theory of parthood. Call it the Working Theory of Parthood:

> Working Theory of Parthood: For any x and any y, x is part of y iff x is contained in y and contributes to y's causal unity.

I have shown (in Chapter 3.2) that super-CAI entails the Subregion Theory of Parthood. If both the Subregion Theory and the Working Theory of parthood are true, then it follows that for any x exactly located at r, any y exactly located at a subregion of r must be a working part of x.

[304] Ibid (p.97).

[305] I discuss causal unity briefly in Chapter 4.5.1. I understand it in the way Casati and Varzi (1999, p.14) describe it. An object x is causally unitary iff "operations performed on certain parts have systematic effects on other parts".

That seems like a strange result. After all, Mellor's complaint is precisely that the photon does *not* contribute to the window's causal unity. Given the Subregion Theory of Parthood, it is much more natural to do as Williams suggests – to say that objects have working parts *and* non-working parts – thereby accepting Mellor's distinction but rejecting his view that all parts are working parts. This permits us to say that the photon becomes part of the window as it passes through, but it does not become a *working* part of the window. Someone employing this sort of response can claim that our ordinary discourse and intuitions about the parts of material objects tend to track the more interesting parts (the working parts), even though objects often have more parts than just the interesting ones. That is why we have the (incorrect) impulse to say that the photon is not a part (simpliciter) of the window.

The working part response appears better than the gappy response, though I am inclined to psychologise the notion of a working part. That is, I claim that the distinction between working parts and non-working parts is not a distinction that carves reality at the joints – instead it tracks folk theorising, and that is why it explains the impulse to say that the photon is not part of the window. This response to the Light Through Yonder Window objection boils down to denying there is a problem (the photon really is a part of the window) but, at the same time, explaining why there appears to be one.

5.1.5 Sanford's Blocks

Sanford asks us to imagine two blocks of the same shape and size, travelling on paths that will intersect. The blocks reach the intersection at the same time and appear to pass through each other "without changing with respect to colour, texture, density, etc."[306] In such a case, Sanford argues:

[306] Sanford (1967, p.37).

> We want to say that we have the same two blocks with which we started. And we do not want to say that either block passed out of existence and was shortly thereafter re-created. Thus we want to say that each block moved along its path without any spatio-temporal discontinuity. And we can say this only if we admit that parts of one block simultaneously occupied the same space as parts of the other block.[307]

But the supersubstantivalists *can* say all the things we want to say, without saying any of the things we do not. We just need to embrace perdurantism or Pardurantism, as I have already said we should (Chapter 2.3.1). Let us think about what each theory of persistence would say about Sanford's blocks.

Given perdurantism, the two blocks are complex four-dimensional material objects that share a temporal part; the temporal part which occupies the region of the intersection of the paths. Saying this does not require any spatio-temporal discontinuity, it does not require saying anything went out of existence and was soon after re-created, and it does not require co-location or interpenetration. See Figure 5.4.

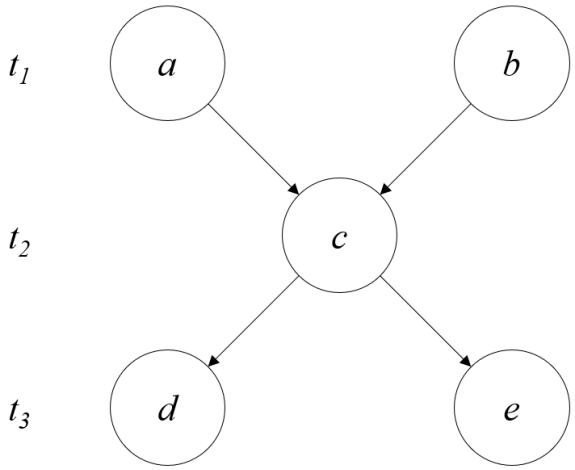

Figure 5.4

[307] Ibid.

According to the perdurantist reading, there are two perduring objects. One is composed of the temporal parts a, c, and e while the other is composed of the temporal parts b, c, and d. There is only one thing exactly located at the exact location of c and it is a temporal part of two different perduring objects. That these two objects share a temporal part is no stranger than the fact that my living room and kitchen share a wall.

Given Pardurantism, the two blocks are simple four-dimensional material objects that interpenetrate by overlapping at the spacetime region that corresponds to the intersection of their paths. This is depicted in Figure 5.5.

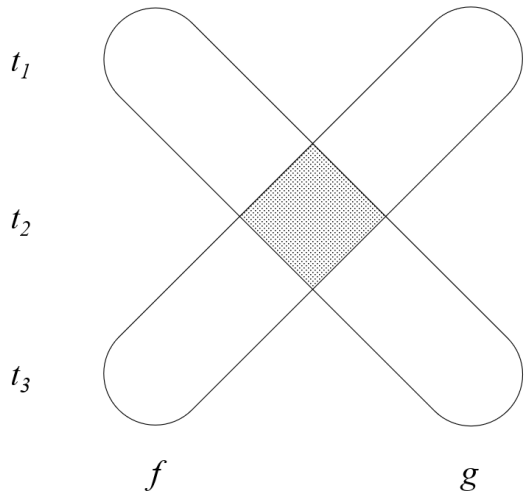

Figure 5.5

This is Case 1 overlap. The same kind of overlap as we saw in Figure 5.1, which is permitted by supersubstantivalism. So there is no problem here; Pardurantism is able to defuse the threat to supersubstantivalism posed by Sanford's blocks, with ease.

The above goes to show that, once we examine the theories of persistence that supersubstantivalists must commit to, Sanford's blocks pose no problem. But wait, there is more. We can modify the thought experiment in various ways.

Imagine the blocks come into existence at the same exact location in spacetime and are co-located until they cease to exist. Call this *permanent co-location*. When perduring or Parduring objects are permanently co-located, their four-dimensional exact locations overlap in the manner of Case 3 from Figure 5.2. We have already seen that supersubstantivalism cannot abide disjoint objects overlapping in this way. Not even Pardurantism can save us in this scenario.

When permanent co-location is alleged to occur between two objects that have all the same properties, it is easy to say that the two objects are identical. We have no reason to suppose there are really two objects at a region when there is, in principle, no way of discerning one from the other. But when permanent co-location is alleged to occur between two *discernible* objects, things become more difficult. There are many ways we might try to imagine permanently co-located objects differing. Some will invite no trouble, such as if we imagine they differ with respect to properties we are anti-realists about. For instance, a painting may be beautiful to me and not beautiful to you, but that does not give us reason to think there are two paintings co-located – one beautiful, the other not. Alternatively, if we imagine permanently co-located objects differing with respect to modal properties, then we raise the problem of material constitution, which I do not discuss here (see comments at the start of this chapter). But we could also imagine they differ with respect to physical properties. Gilmore complicates Sanford's thought experiment by making the blocks discernible in this way:[308]

> One might add that two incompatible properties are instantiated [by the blocks]—say, having mass of 2 kg, and having mass of 3 kg—where each of these properties is such that if it is instantiated by an entity x, then it is instantiated by anything that mereologically coincides with x. Presumably this is no less conceivable (or 'intuitively possible') than Sanford's original case.

[308] Gilmore (2018).

> But in this new version of the case, it is not open to Sanford's opponent to claim that the co-located objects are identical or mereologically coincident with each other.

If Gilmore's physically discernible blocks are *not* permanently co-located, then Pardurantists can say the same thing as I suggested they say about Figure 5.5; this is just the unproblematic kind of interpenetration that is consistent with supersubstantivalism. However, perdurantists cannot repeat the response I suggested for them. We cannot account for temporary co-incidence of physically discernible objects in terms of sharing a temporal part for the same reason that we cannot say my kitchen and my living room share a wall if my kitchen has only brick walls and my living room only concrete.

Notice, though, that temporary co-location is only a problem for perdurantism if each of the two temporarily co-located objects has a temporal part that is permanently co-located with a temporal part of the other. Without this feature, temporary co-location of perduring objects is more of the same unproblematic interpenetration we have accepted already.

So the apparent possibility of permanently co-located physically discernible objects is what threatens Pardurantism and perdurantism. So let us focus on just the intersection of the two paths of the physically discernible blocks and imagine that it is the exact location of a temporal part of each of the physically discernible blocks. Supposing that one is 2kg and the other is 3kg, how much mass is there at that exact location? If 2kg, then it looks as though this is not a case of co-location because one block has disappeared (only to reappear later). Mutatis mutandis if 3kg. But these verdicts are unacceptable because the choice over which block disappears and which remains would be too arbitrary and because these verdicts make it harder to say something we want to say: that neither block "passed out of existence and was shortly thereafter re-created".[309] If, however, there is 5kg at the intersection of the two paths, then what

[309] Sanford (1967, p.37).

stops us from claiming there is only one object at that region, and it has a mass of 5kg? That is exactly what supersubstantivalists should say. Indeed, it is very roughly what Schaffer has said about allegedly co-located bosons.[310] Of course, opponents of supersubstantivalism may insist that the region is not 5kg; it is 2kg *and* 3kg. In response to that, I wonder whether it is any worse to say that the intersection is host to *one* object which is *2kg and 3kg* than it is to say that it is host to *two* co-located objects one of which is 2kg and the other of which is 3kg? Since *being 2kg* is plausibly not the same property as *not being 3kg*, we cannot say that the one-object interpretation involves contradiction. Certainly, it is strange to imagine an object instantiating two different mass properties but both answers transgress against common-sense. How do we break this deadlock? How can we adjudicate on this impasse?

Without some way to settle the various questions raised in the paragraph above, we find ourselves at an impasse. The view that there is one object at the intersection looks plausible, but so does the view that there are two. We will have to resort to the weighing of theoretical virtues to determine which theory should be endorsed. I believe supersubstantivalism will fare well in any weighing contest (for all the reasons indicated in previous chapters) but I am nevertheless confident that I can offer independent traction on this issue.

In the following, final portion of this chapter, I offer an argument to the effect that whenever there are alleged to be many physically discernible objects with the same exact location, we have good reason to think there is actually only one object in that location. I start with the case of differences in mass, and then generalise the argument to all physical properties. This is an unusual argument for a work of metaphysics because it is, in principle, empirically falsifiable and it relies on the incorporation of physical fact. I have acknowledged above (in 5.5.1) that philosophers are prone to cause frustration when we make judgements on these sorts

[310] Schaffer (2009, p.140).

of issues, without the relevant expertise. I am hopeful I shall not cause too much frustration, but I apologise in advance for any hair my readers tear out on my behalf.

Mass warps spacetime. Along with the other elements of the stress-energy tensor, mass affects the curvature and metric structure of spacetime in ways described by the Einstein field equations. We can use these equations to prove that no two regions can differ with respect to mass and yet have the same curvature and metric properties. This in turn will serve to undermine any reasons we might have for thinking there are two objects at the intersection of the paths of the two blocks. Here is a proof. [311] It involves nothing more difficult than rearranging equations, but I will walk through it slowly. The Einstein Field Equation states:

$$G_{\mu v} + \Lambda g_{\mu v} = \kappa T_{\mu v}$$

The terms we need to pay most attention to are '$G_{\mu v}$' which is the Einstein tensor and describes the curvature of spacetime, '$g_{\mu v}$' which is the metric tensor and describes the metric properties of spacetime (including topological (connectedness) and geometrical (distances and angles) properties), and '$T_{\mu v}$' which is the stress-energy tensor and describes the density and flux of mass, energy, momentum, and pressure. The other terms are 'Λ' which is the cosmological constant, and 'κ' which is the Einstein gravitational constant.

Let us take two arbitrary regions, expressed with subscript '1' and subscript '2', and show that assuming they have the same metric but different masses leads to contradiction. First, the Einstein field equations for the two regions can be stated:

$$G_{\mu v1} + \Lambda g_{\mu v1} = \kappa T_{\mu v1} \text{ and } G_{\mu v2} + \Lambda g_{\mu v2} = \kappa T_{\mu v2}$$

[311] Thanks to Calum Patterson for much help with this.

These can be rearranged to make the metric tensors the subjects:[312]

$$g_{\mu\nu1} = \frac{\kappa T_{\mu\nu1} - G_{\mu\nu1}}{\Lambda} \text{ and } g_{\mu\nu2} = \frac{\kappa T_{\mu\nu2} - G_{\mu\nu2}}{\Lambda}$$

Now assume the two metric tensors are equal. Since the regions are identical, this must be true:

$$g_{\mu\nu1} = g_{\mu\nu2}$$

This means we can equate the two regions:

$$\frac{\kappa T_{\mu\nu1} - G_{\mu\nu1}}{\Lambda} = \frac{\kappa T_{\mu\nu2} - G_{\mu\nu2}}{\Lambda}$$

Multiply both sides by Λ:

$$\kappa T_{\mu\nu1} - G_{\mu\nu1} = \kappa T_{\mu\nu2} - G_{\mu\nu2}$$

This can be rearranged:

[312] This requires assuming that $\Lambda \neq 0$, but the same conclusion can be proved if $\Lambda = 0$, as follows. Start by observing that if $\Lambda = 0$ then $\Lambda g_{\mu\nu} = 0$. This gives us: $G_{\mu\nu} = \kappa T_{\mu\nu}$, which can be rearranged to $\frac{G_{\mu\nu}}{T_{\mu\nu}} = \kappa$ (Assuming $T_{\mu\nu}$ is not 0, which it is not, because we are assuming two co-located objects with mass). This means $\frac{G_{\mu\nu}}{T_{\mu\nu}}$ for our two regions is equal to κ, therefore $\frac{G_{\mu\nu1}}{T_{\mu\nu1}} = \frac{G_{\mu\nu2}}{T_{\mu\nu2}}$. As with the proof in which $\Lambda \neq 0$, assuming the metrics are equal gives us $G_{\mu\nu1} = G_{\mu\nu2}$, which means $T_{\mu\nu1} = T_{\mu\nu2}$ Which, as we see below, is inconsistent with different masses.

$$\kappa T_{\mu v1} - \kappa T_{\mu v2} = G_{\mu v1} - G_{\mu v2}$$

Since $G_{\mu v}$ is a function of the metric and we have assumed the metrics are equal, we also assume $G_{\mu v1} = G_{\mu v2}$.[313] Therefore:

$$\kappa T_{\mu v1} = \kappa T_{\mu v2}$$

Since κ is a constant, they cancel out and leave us with the statement we will soon contradict:

$$T_{\mu v1} = T_{\mu v2}$$

The stress-energy tensor $T_{\mu v}$ can be expressed as a 4x4 2D matrix. For $T_{\mu v1}$ to be equal to $T_{\mu v2}$, all their elements must be equal, so we can get a contradiction if just one of the elements are not equal. The energy density is denoted by the term 'T_{00}' and is proportional to mass. Since we have assumed that the two regions have different masses, $T_{001} \neq T_{002}$ and, therefore, $T_{\mu v1} \neq T_{\mu v2}$.[314] We now have a contradiction, so one of our assumptions is false. The two metrics are not equal. But no region can have different metric properties from itself. Therefore, if two objects of different masses ever came to occupy the same exact location, that location could not be a region that has the same metric properties as each of the two objects prior to

[313] Given the concise form of the equations that we are dealing with, this looks like an additional assumption. In reality, the Einstein tensor is a function of the metric, but a full statement of the function is too long to warrant inclusion here. We only need to assume the metrics are identical to get identical Einstein tensors. It might help to notice that whenever some variable y is a function of some other variable x (say, for instance $y = x^2$), we cannot keep the value of x the same and expect to get a different value for y.

[314] If we are being careful, we should note that T_{001} could be equal to T_{002} if, for instance, the 2kg mass were moving at an appreciable fraction of the speed of light such that its energy density increases to that of a 3kg mass. However, this still gives us the result that $T_{\mu v1} \neq T_{\mu v2}$ because it would mean that the momentum vectors in $T_{\mu v1}$ and $T_{\mu v2}$ do not match.

their colocation. It might be a region with the metric properties of a 2kg mass, or a 3kg mass, or even a 5kg mass, but it cannot be a region with the metric properties of a 2kg mass *and* the metric properties of a 3kg mass (or some other combination of different masses). It is physically impossible.

What is more, this proof generalises to cover far more properties than just mass. It applies to any of the variables that make up the stress-energy tensor. No one spacetime region can have the metric properties of two different objects, if those objects differ with respect to mass, energy, momentum, rotation, or pressure, since all would change the metric.

In fact, it proves *even more* than that. Let us consider some other properties of objects. I can think of no way of changing the microphysical properties – like spin or charge – of an object without affecting its mass or energy or momentum or a combination thereof. It also seems that changing macrophysical properties involves change in the stress-energy tensor. Take colour as an example: any change of colour involves changing materials which affect energy and mass. This is because a lot of what we see as colour relates to electron energy levels which would affect the metric. So this argument appears to generalise to all physical properties.[315]

To see why this matters, think about Sanford's blocks again. We have two material objects – the blocks – each travelling along its own path. At each point along its respective path, each block has a temporal part with an exact location. That exact location is a spacetime region with certain metric properties that determine the way the block warps spacetime. Until

[315] I do not wish to get side-tracked trying to define 'physical property'; I use the phrase merely to contrast it with properties on which this argument clearly has no traction, such as modal or aesthetic properties. This means it cannot be used to object to constitution cases (where the purported difference between allegedly co-located objects is in their modal or aesthetic properties). Instead, this argument is a rebuttal to arguments like Gilmore's; arguments which suppose it possible that physically discernible objects can have the same exact location. This rules out Sanford's blocks. And, if we assume that ghosts have some physical properties, it rules out the possibility that they be co-located with any part of anything they might wish to pass through.

(and after but not while) they meet at the intersection of their paths, one block warps spacetime in a 2kg way, while the other block warps spacetime in a 3kg way. But how is the region where they are alleged to co-locate warped? The proof above demonstrates that it cannot be warped in both a 2kg way *and* a 3kg way. That is physically impossible. Nor can any region be warped in a green way *and* a red way, nor a positive charge way *and* a negative charge way, and so on, and so on, for any combination of different values of the same physical property. But if no spacetime region can instantiate two different values of *any* physical property, what reason could we have for thinking that there is a region at which two physically discernible objects are co-located? There can be no property by which we can discern them.

Back to the blocks. We have already seen that it would be too arbitrary for the intersection of their paths to have the metric properties of just one of the blocks; if the intersection was warped in a 2kg way, it would raise questions about where the 3kg block went, and why the two blocks behaved differently (one seeming to disappear, while the other sticks around). Given what we have just proved, it seems that the intersection of the two paths would surely be a region that has the metric properties of a region with the *total* stress-energy tensor of the two blocks.[316] It is more curved than the exact location of either block, when they are not (allegedly) co-located. So the region of spacetime where the two blocks meet is warped in a 5kg way, not in a 2kg way, not a 3kg way, and not in a 2kg way *and* a 3kg way. I suggest we interpret this as a region occupied by one 5kg material object.

The upshot of all the above is a dilemma for anyone who wishes to say that material objects may co-locate. Either the alleged co-located objects are physically indiscernible and so four-dimensionalists have no reason to say there is more than one of them at that location. Or the material objects are physically discernible but, since the spacetime region at which they are allegedly co-located cannot instantiate multiple different values for any physical properties,

[316] As it is in cases where bosons are alleged to co-locate.

there are no grounds for saying that anything at that region is discernible from something else at that region, and so we again have no reason to say there are two objects there. Given this dilemma, I conclude that we have reason to think that it is physically impossible for material objects to co-locate.

This is another instance of an argument that only regards nomological/physical possibility. I have already said that I think the case for super-CAI is abductive, and there are surely worlds at which the best explanations are not true. For that reason, I am open to contingent answers to all sorts of metaphysical questions. Now, let us take stock.

5.1.6 Summary

We have seen that cases of co-location and interpenetration do pose threats to supersubstantivalism whenever they threaten the Subregion Theory of Parthood. Some cases of interpenetration do not, and so those cases are consistent with supersubstantivalism. We looked at a handful of purported examples of problematic co-location and interpenetration, but it was only after modifying Sandford's thought experiment involving co-located blocks that we found any trouble worth worrying about. Supersubstantivalists will say that there is only one block at the intersection of the two blocks' paths, while opponents of supersubstantivalism might say there are two blocks there. When the blocks at the intersection are indiscernible, it is easy to suppose there is only one object there, and we can employ perdurantism or Pardurantism to ensure we can say all the things we want to say. However, when the blocks are discernible because they have some difference in their physical properties (e.g. mass), the argument from the Einstein field equations shows that we still have good reason to say there is only one object and no co-location occurs. I hope that readers will find this new argument compelling but, if they do not, we can always fall back on the standard practise of weighting theoretical virtues.

CHAPTER 6:

ALTERNATIVE VERSIONS OF COMPOSITION AS IDENTITY

In this chapter, I compare super-CAI with several of the literature's most prominent, alternative versions of CAI and supersubstantivalism. I argue that super-CAI fares better than each of them.

6.1 Baxter's CAI

Baxter was among the first to argue that composition is identity and his version of CAI remains the most radical to date.[317] It is radical in several respects; most notably, it claims that parthood is also (a kind of) identity, and that objects can be discernible from themselves (hence a more complicated story must be told about the Indiscernibility of Identicals). Furthermore, as Turner has noted, Baxter's view "involves novel philosophical concepts and uses familiar ones in unfamiliar ways [and so] even the most liberal-minded philosophers can be forgiven if it gives them a bit of vertigo."[318] Perhaps all of this explains why Baxter's version of CAI is so often cited in the literature but so rarely engaged with in detail. Reaching a full enough understanding of his theory will be done here in stages. Ultimately, I argue that although the strangeness of Baxter's view is cause for some concern, it is not grounds for rejecting it. Most interestingly, I argue that his view shares some significant similarities with my own, and can be thought of as a combination of CAI and location as *constitution* (which is a version of supersubstantivalism I briefly mentioned in Chapter 2). Since my own view is a combination of CAI and location as

[317] I follow others in taking (Baxter, 1988b) to be the canonical statement of his view, though I draw from other sources (Baxter 1988a, 1999, 2018, and Turner 2014) for detail.

[318] Turner (2014, p.225).

identity, this makes for an interesting parallel. Despite this parallel, however, I argue that Baxter's view has a problem that warrants its rejection. Super-CAI is to be preferred.

6.1.1. Baxter on Carving

In 1.2, I introduced the carving conception of metaphysical structure and argued that all versions of CAI should endorse it. Baxter's version is no exception and he offers some more helpful analogies, to motivate the carving conception:

> Consider the express check-out line in a grocery store. It says 'six items or less'. You have a six-pack of orange juice. You might well wonder if you have one item or six items. But you would never hesitate to go into the line for fear of having seven items: six cans of orange juice plus one six pack. […] There are either six or one. In counting we either count the whole as one, or each part as one. If we count the whole then we do not count the parts. If we count the parts then we do not count the whole.
>
> Which we do count depends on the situation.[319]

In this way, subsequent versions of CAI have followed Baxter. But there is one major difference between Baxter's view and others; he claims that existence is count-relative. Objects only exist in the counts they are counted in. This claim is the root of all the unusual features of Baxter's view, and I make a lot of fuss about it in what follows.

Given count-relative existence, Baxter seeks to answer the question "What becomes of the parts in the count in which only the whole exists?"[320] He points out that it is natural to think that the parts exist in that count because the various subregions of the whole (which, on other counts, contain parts) are surely still distinguishable from the whole. For instance, the left half

[319] Baxter (1988b, p.200).
[320] Ibid (p.202).

of an object can always be distinguished from the whole. If existence is count-relative, as Baxter says it is, then what is the left half of the whole? It cannot be a part, since the parts do not exist in the same count as the whole. In response to this line of thinking, Baxter introduces his theory of aspects.[321]

6.1.2. Baxter's Theory of Aspects

Consider the following situations:

- Insofar as Tess loves the work she does, she does not want to retire. Yet, insofar as Tess is weary, she does want to retire.
- Insofar as he is a father, Jason thinks too much about philosophy. But insofar as he is a philosopher, Jason does not think too much about philosophy.

Situations like these show us that, when we consider only certain aspects of objects (rather than objects without qualification) they can have contradictory properties. Thus, Baxter argues, objects may differ from themselves by having aspects that differ from each other.

Aspects are not individuals, but individuals have aspects. We refer to aspects with expressions that combine (i) a term for an individual or an aspect (since aspects may have aspects), (ii) the locution 'insofar as', and (iii) a property / open sentence. For example, 'Tess insofar as she is weary' refers to an aspect of Tess. 'The book insofar as it is red' refers to an aspect of the book. But Baxter does not think aspects are mere ways of talking about objects; he claims they are metaphysically deep, mind-independent entities (though not individuals!), which are ontologically dependent on and numerically identical to the objects of which they are aspects.

[321] The term 'aspect' is used in Baxter (1999 and 2018) and Turner (2014). However, in the most thorough statement of his view on composition (Baxter 1988b), Baxter uses the term 'image' instead. The two terms are used to express ultimately the same idea.

At this point, alarm bells should be sounding. In Chapter 1.2 I argued that CAI is inconsistent with the layered world conception of metaphysical structure because nothing can be more fundamental than itself. Yet, Baxter claims that aspects are *dependent on and numerically identical to* the objects of which they are aspects, which appears to contradict the claim that nothing is more fundamental than itself as follows. For any x and any y such that x is an aspect of y:

(1) Nothing can be more fundamental than itself (Assumption)

(2) x is dependent on y (from Baxter's theory of aspects)

(3) x is numerically identical to y (from Baxter's theory of aspects)

(4) x is dependent on x (substitution of identicals, from 2 and 3)

(5) Contradiction (from 1 and 4)

Baxter does not address this argument explicitly, but we can anticipate his response. He would say that aspects cannot be substituted this way. He writes:

> [The Indiscernibility of Identicals] is closely related to the principle that co-referential terms are substitutable *salva veritate*. However, the principle concerns singular reference. It concerns the substitution of expressions that refer to single individuals. There needs to be an argument that it generalises to reference to aspects.[322]

He reasons that aspects are not individuals and we have no good reason to think that substitution principles apply to anything but individuals. So substitution is not warranted. So the move from (2) and (3) to (4) is not permitted. Still, something seems off. To recover the argument against

[322] Baxter (2018, p.908).

Baxter, we might say that the principle in line (1) ought to be modified from 'nothing can be more fundamental than itself' to 'nothing can be more fundamental than anything it is numerically identical to' (call this '(1*)'). This would allow us to move directly from (1*), (2), and (3) to contradiction. But why should we think that (1*) is true? Those of us who are used to thinking of numerical identity in terms of qualitative sameness (no doubt, due to prolonged exposure to the Indiscernibility of Identicals) are likely to think (1*) is eminently plausible; after all, (1*) is really just a prohibition on numerically identical things differing with respect to their fundamentality. We can anticipate Baxter's response again. Baxter does not define identity in terms of qualitative sameness or difference. Instead, he takes numerical identity as a primitive in his theory and glosses it with the idea that, for any x and any y, x and y are numerically identical iff x and y are one individual. He claims that "it is the connection with cardinality that is essential to numerical identity, not some connection with qualitative sameness."[323] Given this novel conceptualisation of numerical identity, the Indiscernibility of Identicals must be reformulated. According to Baxter, therefore, the Indiscernibility of Identicals applies only to individuals, and not their aspects: "Identicals considered unqualifiedly are indiscernible. But identicals considered qualifiedly may be discernible."[324] We begin to see how truly unusual this theory is.

The upshot of all this is a new category of entity: aspects. Aspects are objects insofar as they are some specified way (e.g. weary, a philosopher, round, red, travelling at the speed of light, etc). Objects are numerically identical to their aspects, yet aspects are dependent on and discernible from the objects of which they are aspects. Aspects are also discernible from each other. The ideology of aspects permits Baxter to say that existence is count-relative because it gives him an answer to the question of what happens to the parts on the count in

[323] Ibid (p.907).
[324] Baxter (1988b, p.206).

which only the whole exists. The question is raised by the fact that it seems that we can discern portions of the whole (such as its left half) from the whole, on that count, so it seems *prima facie* incorrect to say that the parts do not exist there. Aspects to the rescue. The theory of aspects permits us to say that, on the count in which the whole exists, the parts do not exist, but the whole has aspects which correspond to the parts in other counts. For each part, there is an aspect which is the whole insofar as it occupies some location r, which is the exact location of the part on the count in which the parts exist. To illustrate, imagine a six-pack of orange juice, again. Imagine that it is exactly located at region r, and that one of the cartons that compose it is located at region r' such that r' is a proper subregion of r. The carton does not exist on the count in which the whole six-pack exists, but the whole six-pack has an aspect – the six-pack insofar as it is located at r' – which does exist on that count. That aspect is discernible from the whole, but numerically identical to and dependent on it.

6.1.3. Baxter's Cross-Count Identity

We need one final detail, to finish getting Baxter's view on the table. That final detail is his notion of *cross-count* identity. I have said that wholes have aspects that correspond to their parts. Aspects correspond to parts by being cross-count identical with them. In fact, Baxter says each part is cross-count identical to an aspect of the whole (i.e. the whole insofar as it is located at the exact location of the part). Cross-count identity is not numerical identity. Nonetheless, it is transitive, symmetric, and reflexive. Also, since all aspects of the same individual are numerically identical, Baxter needs to do something to block the inference that any one aspect of an individual corresponds to each and every part (distributively). To block that inference, he stipulates that cross-count identity obeys something resembling the indiscernibility of identicals:

> Let me [stipulate] that in my mapping, [the aspect of the whole] must exactly resemble [the part], in every way that does not entail that [whole] and [part] exist in the same count, or are identical with the same things. Thus each part exactly resembles the whole insofar as it occupies the part's location.[325]

Things may only be numerically identical with each other if they are the same individual (or aspects thereof) in the same count, and things may only be cross-count identical with each other if they are qualitatively indiscernible and in different counts. Both identity relations are transitive, but mixtures of them are not; the following inference is not valid:

(1) x is numerically identical to y

(2) y is cross-count identical to z

(3) Therefore, x is (cross-count or numerically or otherwise) identical to z

If inferences like this were permitted, then we could say:

(1*) Carton_1 is cross-count identical to the six-pack insofar as it occupies region r'.

(2*) The six-pack insofar as it occupies region r' is numerically identical to the six-pack

(3*) Therefore, the carton is (cross-count or numerically or otherwise) identical to the six-pack

But (3*) is clearly false. We now have all the components of Baxter's view. Let us put them together.

[325] Ibid (p.208).

6.1.4. Baxter's Theory of Composition

We now have all the tools we need, to understand Baxter's analysis of composition. Baxter states that:

> What are many things can be thought to be distinguishably one. We talk about things 'in concert', or 'collectively', or 'unanimously', or 'all together', or 'as a whole'. But I will not pursue this here except to point out the following. The [aspect which corresponds to] the parts *collectively* is the whole considered unqualifiedly.

This statement leaves a lot open for interpretation, but I think the best interpretation is clear. On some count, we have a whole. On another count, we have the parts which compose the whole. From this, Baxter commits to the following identities:

(1) The parts, considered collectively, are cross-count identical to an aspect of the whole.
(2) That aspect of the whole is numerically identical to the whole.
(3) Hence, the parts, considered collectively, are cross-count identical to the whole.

Since cross-count identity requires indiscernibility, this means that the parts are collectively indiscernible from the whole. We have now arrived at something that is recognisably a version of CAI. But the story does not end there.

Turner has pointed out that, on Baxter's view, spacetime regions do not have count-relative existence.[326] It follows that, on Baxter's view, objects are not identical to their locations. One has count-relative existence, the other does not. So objects are not identical with their locations and Baxter's CAI is inconsistent with my super-CAI. Furthermore, it looks as

[326] Turner (2014, p.235). This is because the whole-in-so-far-as-it-occupies-region-r is cross count identical to the part exactly located at r.

though Baxter ought to say the same about matter: part and whole share matter, so the existence of matter is not count-relative.[327] Denying this would undermine the claim that the parts are each identical to an aspect of the whole, since being made of different matter is surely sufficient for being a different individual. Denying this would also lead to something like the view that every region that hosts a complex object hosts interpenetrating matter. A strange view, indeed. The upshot of all this is that, on Baxter's view, objects are identical to neither their matter nor their locations. So, what are the relations between objects, their matter, and their locations?

We can get halfway to an answer by considering the debate about material constitution (briefly discussed in Chapter 4). It can be thought of as a debate between those who think that objects are identical to their matter (one-thingers) and those who think objects are constituted by, but not identical to, their matter (multi-thingers). Since Baxter cannot claim that objects are identical with their matter, he should be understood as claiming that objects are constituted by their matter (and constitution is not identity).

The rest of the answer requires knowing the best way to interpret Baxter's view on the relation between matter and location. Unfortunately, I see no textual evidence in Baxter's writing for any position on the relation between matter and location. I submit, therefore, that Baxter's CAI is consistent with relationism, substantivalism, and supersubstantivalism. In Chapter 2, I discussed those three views and came out strongly in favour of supersubstantivalism. For all the same reasons, I think Baxter's view is best paired with supersubstantivalism. The combination of Baxter's CAI and supersubstantivalism would claim that matter is identical to spacetime regions and constitutes material objects. This is an interesting variation on my own view. But it does not matter which theory about the relation

[327] This assumes a view of matter as a kind of substratum. If, instead, we think of matter as something like the finest partition on reality – so that your matter is just the smallest parts that compose you – then matter and object can be cross-count identical.

between matter and spacetime we pair with Baxter's CAI; I argue that Baxter's CAI is false regardless.

6.1.5. Against Baxter's CAI

My objection to Baxter's view is an objection to his claim that existence is count relative. Let us kick things off with the following principle, which I regard as capturing an important feature of identity:

> Piggyback: For any x, when one commits to the existence of x, one thereby also commits to the existence of all things identical with x.

This is true whether we think of identity in terms of individuals (as Baxter does) or indiscernibility (as is traditional). In support of this principle, I point out that one of the greatest benefits of a view like CAI is its ontological parsimony. CAI theories get to claim that once you have the parts, you get the whole free of charge *because they are identical*. Just as when you are committed to the existence of George Orwell, it is no extra commitment to say that Eric Blair exists.

Piggyback causes problems for Baxter's view. Call the count in which some whole x exists C_1. Call the count in which its parts (on some decomposition) exist C_2. There is something in C_1 (i.e. an aspect of x) that is cross-count identical to something in C_2 (i.e. the parts of x). So, when we count by C_1, Piggyback entails that we also commit to the existence of something identical to the whole in C_2. Ergo, existence is not count relative.

Here is a reply. Piggyback only guarantees that when we commit to the *count relative* existence of something in C_1 we also commit to the *count relative* existence of something in C_2, but that does not entail that there is some notion of count-independent existence.

Fair enough. But now notice that, if something exists in *every* count, then its existence is not count relative. The point can be made by analogy: if all events occur simultaneously from every frame of reference, then there is no frame relative simultaneity. Rejecting the notion that simultaneity is frame relative does not require making sense of a notion of simultaneity outside of any frame of reference; it would suffice to show that all frames agree. So it goes with existence. If some ontological commitment is agreed upon by every count, then whatever is committed to in all those counts does not have count relative existence. But, this means that if Baxter wants to say that in every count there is something (not necessarily an individual!) that is (either cross-count or numerically) identical to x (this might be aspects of x or all x's parts considered collectively), he must give up the count relative existence of x. So, does he want to say that? I think he must. To see why, recall Baxter's earlier example.

You are approaching the checkout of a grocery store, with a six pack of cans of orange juice in your basket. Baxter is right to say that we might count this as one object or six objects but not seven. To count it as seven would be double counting, which there are good metaontological reasons to prohibit. But double counts are not the only counts we should disallow. Seven is not the only wrong answer to questions about how many items you have when taking your six pack to the checkout: zero would also be incorrect. Any count which fails to count the six pack (in any way, as one or six etc) *undercounts*. The metaontological considerations that weigh against double counting also weigh against undercounting: we should not do either, as our inventory of the world would be inaccurate either way. In Varzi's words, our counts must not involve *redundancy* but they must also be *complete*.[328]

So here is a dilemma for Baxter. Either he permits counts in which nothing identical with the six pack exists, and he therefore permits undercounting. Or all counts agree that

[328] Varzi (2000).

something/s identical with the six-pack exist/s and therefore its existence is not count-relative. Either option results in disaster.

Baxter cannot avoid this argument by claiming that (contra the dilemma's second horn) there are counts in which something identical with the six pack exists but the six pack does not exist, because that is to deny Piggyback.

Nor can he avoid this argument by restricting Piggyback the same way he restricted the substitutivity of identicals. He argued that substitution is only licenced for individuals, not for aspects. He justified this restriction on the grounds that substitution derives its plausibility from the Indiscernibility of Identicals, which he similarly restricts. But Piggyback does not derive its plausibility from the Indiscernibility of Identicals; instead, it derives its plausibility from our notions of ontological innocence, which we have no reason to restrict.

Finally, it would be hopeless to respond that Piggyback applies to numerical identity but not cross-count identity. The ontological innocence of committing to things that are identical to that which you have already committed is so central to identity that we should object to any theory which claims there is a kind of identity that does not feature it. For any relation R, if R does not conform to Piggyback, then R is not any form of identity. Furthermore, the ontological innocence of CAI is one of its most appealing advantages. Claiming that Piggyback applies to numerical identity but not cross-count identity would completely undermine that most central motivation to endorse CAI in the first place.

I believe that the above argument is enough to show we should not endorse Baxter's CAI. However, let us suppose that some compelling response can be developed. I argue that, even if such a response were possible, we should favour super-CAI over Baxter's CAI, given the balance of theoretical virtues.

The chief virtue of Baxter's CAI is its explanatory power. By committing to aspects and counts, Baxter can offer analyses of diverse phenomena such as composition, constitution,

and property instantiation.[329] But for all that explanatory power, his theory has some very significant costs. A new, *sui generis* entity (aspects) increases its ontological cost. There is also an ontological cost to claiming that objects are not identical to their matter. Baxter's notion of cross-count identity comes with extra ideological cost. On top of all that, revisionary theories are regarded with more suspicion than non-revisionary theories (all other things being equal), and Baxter's CAI restricts and revises the way we think about indiscernibility and identity quite dramatically. Finally, the view is also not as elegant or unifying as super-CAI. For all those reasons, I claim that super-CAI fares better on balance of theoretical virtues.

The lesson to be learned from this encounter with Baxter's CAI is not just that super-CAI is a preferable theory. We should also learn that existence is not count-relative.

6.2 Cotnoir's CAI

Cotnoir's version of CAI generalises the one-one and many-many identities of classical and plural logic to include a many-one identity. I did the same, in Chapter 3.1. To express this generalised identity, he uses the symbol '≈'.

On Cotnoir's account, what makes an identity statement true is that it relates some portion of reality to itself. That is to say, the symbol we use to express the identity ('≈') is flanked on either side by terms that denote the same portion of reality. Thus, when we have some parts xx which compose some whole y, Cotnoir's CAI claims that '$xx \approx y$' is true because 'xx' and 'y' denote the same portion of reality. 'The bricks' and 'the house' denote the same portion, under different descriptions. I also echoed these sentiments in 3.1. But it is hard to feel that a solution to the semantic puzzle (1.4.2) can be truly satisfactory without telling us what sameness of portion of reality amounts to. Most authors who use the ideology of portions of reality leave this stone unturned. On my view, they are regions of spacetime, but I

[329] I have not explored constitution or property instantiation here but see Baxter (1988b) for discussion.

am not the first to be curious about how others treat them. Lando notes that "the notion of portion of reality is never really clarified,"[330] while Hawley writes:

> To appreciate the force of the claim that composition is a kind of identity, we must therefore understand what it is for objects to be the same portion of reality as one another.[331]

Thankfully (and unusually) Cotnoir does attempt to explain. Cotnoir offers *partitions of sets of objects* to get traction on sameness of portion of reality. For him, partitions model ways of counting entities in some portion of reality. If two partitions are partitions of the same set, then they model two counts of the same portion of reality. Here is how they work. Start with a set of objects A (they might be atoms, they might be composite objects, and they might even be spacetime points). Some other set P is a partition of A, if it is a non-empty set of sets that (i) covers all of A (i.e. $\cup P = A$) and (ii) all its members are pairwise disjoint (i.e. $p_i \cap p_j = \emptyset$ for any p_i and p_j in P such that $i \neq j$).

Partitions correspond to the different ways of carving portions of reality into objects, and this captures the Fregean idea that the same external phenomenon can be counted in different ways: the copse is just the five trees counted differently, and the set of the copse is a partition on the set of the trees. Each partition of some set of objects is a different way of counting those objects.

I have a concern about this. To express that concern, I'll need to unpack our tree/copse example a little more. Note that the set A that contains the trees is $\{tree_1, tree_2, tree_3, tree_4, tree_5\}$. This means that the set P that contains just the copse cannot be $\{copse\}$, since $\{\{copse\}\}$ is not a partition on A because the union of $\{\{copse\}\}$ is $\{copse\}$,

[330] Lando (2017, p.205).
[331] Hawley (2013, p.326).

which is not the same set as $\{tree_1, tree_2, tree_3, tree_4, tree_5\}$. So if the set P containing the copse is to be a partition on A with only one element, then it has to be $\{\{tree_1, tree_2, tree_3, tree_4, tree_5\}\}$. This is not a problem. It might look like we are smuggling CAI in when nobody is looking, but remember: this is being offered as a way to model CAI's talk about portions of reality. It does not have to be neutral with respect to CAI.

The thing to notice is that partitioning does not let you translate some set like $\{tree_1, tree_2, tree_3, tree_4, tree_5\}$ into some set like $\{copse\}$. Instead, it lets you count the five elements of a set as one element (or two, or three, or four, or five), which is analogous to the counts of CAI. Here is another partition: $\{\{tree_1, tree_3, tree_5\}, \{tree_2, tree_4\}\}$. This partition lets us count the five elements of A as two elements, so it lets us make two composite objects out of the five trees – call them treeodd and treeeven.

However, for any set A and any partition P on that set, we can never end up with more things in P than there were in A. This means we must always start with the most fine-grained of the decompositions we want to consider (i.e. the set of the smallest parts we want to consider) and apply partitions to that.[332] Further, if we ever want an exhaustive list of what objects count as the same portion of reality (for any given portion of reality, no matter how big or small), we must start with whatever set is the set of smallest parts – i.e. the atoms. This is the source of my concern.

I worry that Cotnoir's model motivates some kind of ontological priority for the smaller parts involved in composition. We start with the smallest parts and we generate the bigger objects by partitioning the set of the smallest parts. But versions of CAI that relativise cardinality ascriptions are motivated by the view that there is nothing special about any particular decomposition of a whole; the count on which there are lots of atoms is just one

[332] This does not have to be the finest grained set available; just the finest grained set relevant to whatever your purposes are when you are carving things up.

count, and it is no more privileged than the count on which there are lots of molecules (but fewer molecules than atoms), or the count on which there is only one thing. Once we give any kind of privilege to any particular decomposition (e.g. the smallest parts), we do damage to the notion that they are all equally appropriate ways of carving up the world.[333]

I can think of three ways that Cotnoir might respond to this. Each response has promise, but they also all motivate more investigation into what portions of reality are.

First response. Cotnoir could supplement his view with a way to model *de*composition as identity. He would not be able to use partitioning for this, for reasons mentioned above but, if he was able to, then doing so would permit him to say there is no privileged level of (de)composition because you can always go up or down from any level. This would make a strong response, and it is an option, but Cotnoir has not done it, and absent any story about how that can be done, his view is clearly a bottom-up picture. If we want to understand talk of portions of reality in a way that preserves CAI's view that there is nothing special about any particular decomposition of a whole, then we need to say more.

Second response. Of course, Cotnoir offered partitioning as a *model*, not an *analysis*. This means Cotnoir is not aiming to tell us what portions of reality are – he is just aiming to give us an insight into how they behave, based on some other phenomenon. The model helps us by showing that portions of reality are not totally mysterious, because we can get some idea of how they work by looking at partitions of sets. We might think of partitioning as an analogy that helps us understand portions and hence, as with any analogy, there are going to be features

[333] This is also the reason I object to Loss's (2019) version of CAI which he calls *atomic composition as identity*. Loss weakens plural comprehension so that the plural quantifiers only range over atoms. This has the effect that composite objects can only be decomposed into pluralities of atomic parts. Loss is motivated by the objections from Collapse and Problematic Many-Manys to make this restriction. In previous chapters, I have shown that those objections can be overcome without action as drastic as Loss's. I think atomic composition as identity throws the baby out with the bathwater: it has dramatically reduced expressive power *and* it gives up the driving intuition that there is nothing special about any particular way of counting the world. When drawing up our inventory of the world, we should be able to count by atoms, molecules, trees, or copses.

they do not have in common. Cotnoir is free to say that the requirement to start with the smallest parts and perform functions on that is one feature that the partitions and portions do not share. Nevertheless, this response cries out for more information. Given the central role played by talk of portions of reality, it sure would be nice to have a thorough understanding of what they are and how they behave. A model is nice, but if we can have an analysis, that would be better. I have given an analysis, so my view is to be favoured.

Third Response. There are still things Cotnoir could say. He might respond by pointing out (as Hawley has), that nothing in his theory requires him to quantify over portions of reality. In fact, for Cotnoir, portions of reality are identical with ordinary objects and his formalisation of CAI does not make use of the notion of portions of reality at all, despite the fact that his semantics of that formalisation – his ordinary language expression of CAI – does.

Evaluating this reply requires us to confront a difficult meta-metaphysical question. I will not spend much time on it, since it represents a sizable diversion from the topic at hand. I will gesture at its outline and then dodge it almost entirely. The question is this: When we construct a metaphysical theory and express it in both logic and ordinary language, which expression is an expression of the theory, and which is merely a helpful analogy?

I am reminded of a joke. A physics professor is teaching a class about gravity and has the following exchange with a student:[334]

PROFESSOR: "Spacetime is like a rubber sheet. Massive objects distort the sheet, and—"

STUDENT: "Wait. They distort it because they're pulled down by… what?"

[334] Munroe (2011).

PROFESSOR: Sighs. “Spacetime is like this set of equations for which any analogy must be an approximation.”

STUDENT: “BOOOOORING.”

The joke relies on the view that, in physics at least, formalisations are the proper way to express theories and ordinary language expressions end up being analogies that can only approximate the theory. This appears to be a widely held view in philosophy of science. But this view is not shared by all metaphysicians about theories in metaphysics; many metaphysicians put an emphasis on data from ordinary language or avoid formalisation altogether.

Thankfully, I do not need to make a decision about this question here. Instead, I can use the question to pose a dilemma for Cotnoir. Here it is. Either the formal expression is the best expression of CAI (and the ordinary language expression is an aid for understanding), or the ordinary language expression is the best expression of CAI (and the formal expression is an aid for understanding).[335] If the former, then we should be worried that the formalism motivates a kind of priority for the smallest parts, and that worry will motivate further inquiry. If the latter, then there is no significant concern for Cotnoir, but we should take his talk about portions of reality seriously (particularly given that every CAI theory relies on them) and notice that we still do not understand what they really are. Saying that they are identical with ordinary objects is a start, but is it enough? Hawley has pointed to various ways we might interpret this claim,[336] and we could reasonably ask for more explanation on this matter.

Cotnoir offers us a smart solution to an alleged problem with CAI, but portions of reality still seem mysterious. If we decide we want to take the ordinary language expressions

[335] On some views, it might be said that both are essential and neither is better than the other. If those views are correct, then Cotnoir’s version of CAI falls on both horns of the dilemma I am posing.

[336] Hawley (2013).

of the view seriously, we might explore ways to augment views like Cotnoir's that unpack talk of portions a little more.

In summary, I claim that super-CAI is to be favoured because it does not privilege any particular way of carving and it does not leave anything mysterious about portions of reality talk.

6.3 Wallace's CAI

The two distinguishing features of Wallace's CAI are that it does not commit to the carving conception of metaphysical structure and it is *five-dimensional*.[337] Both features are reasons to reject the view. I explain more about this below, but it will be useful to begin by unpacking the view in more detail.

Wallace offers solutions to several of the new puzzles for CAI, mentioned in Chapter 1.5. Recall that The Logical Puzzle asks us to make sense of an identity relation that takes singular terms on one side and plural terms on the other. To solve this puzzle, Wallace introduces two new logical tools. First, she stipulates a hybrid identity predicate that can be flanked by a mix of singular and plural terms. The symbol for this is '$=_h$'. Second, she introduces a concatenation function which allows us to list members of pluralities in such a way that any predicate applied to them is applied to them *collectively*. The symbol she uses for this is a comma. For example, take some objects x_1, x_2, and x_3. It is conventional to denote this plurality with a plural term such as 'xx' or 'the xs'. Wallace reads those conventional formalizations as distributive and asks us to denote the plurality with the term 'x_1, x_2, x_3' if we wish to refer to it collectively. In Chapter 3, I did something similar. I was inspired by Hovda to declare that all plural terms are to be read as collective and I offered translations for

[337] Wallace (2011a, 2011b, 2014).

distributive predication.[338] As I said at the time, I believe all versions of CAI can benefit from doing something like this.

Using these two new logical tools, we can express the claim that some object y is collectively identical with its parts x_1, x_2, and x_3 as follows: $y =_h x_1, x_2, x_3$. The Logical Puzzle is solved.

Wallace's approach to The Indiscernibility Puzzle is to divide and conquer. This puzzle asks CAI theorists to explain why parts and wholes often appear to have some different properties. The law of the indiscernibility of identicals states that things with different properties are not identical, so objections to CAI can be formed out of putative cases where an object has properties not possessed by its parts (collectively) or vice versa. Wallace considers such objections based on temporal properties (such as when the parts of an object exist before the whole is built out of them), cardinality properties (such as when the parts are many and the whole is one), and modal properties (such as when the parts can survive scattering, but the whole cannot). She offers a different response in each case.

In response to indiscernibility arguments framed in terms of temporal properties, Wallace performs the standard move of utilising four-dimensionalism for a solution. I do this too. See Chapter 1.4.4 for discussion.

In response to indiscernibility arguments framed in terms of cardinality properties, Wallace does not follow the many other CAI theories that relativise cardinality ascriptions to ways of carving or counting. Nevertheless, she does embrace complex answers to 'how many' questions. She says that the correct answer to questions like "how many things are there in front of me?" or "how many things are there in the universe?" will not be just one number. If I have two coins in my pocket (and if composition is unrestricted), then the answer to the

[338] Hovda (2014).

question “how many things are there in my pocket?” will be something like “one, and two, and the two are identical to the one.”

Wallace’s method for arriving at those numbers is to count variables on either side of the identity operator in CAI’s logical expressions of many-one identities. The following formula uses the symbol ‘P’ to stand for the property *is in my pocket* and tells us that x, y, and z are all in my pocket, and that x and y are (collectively) identical to z (but neither x nor y are individually identical to z and they are not identical to each other):

$$\exists x\, \exists y\, \exists z\, (Px \,\&\, Py \,\&\, Pz \,\&\, x \neq_h y \,\&\, y \neq_h z \,\&\, x \neq_h z \,\&\, z =_h x, y)$$

To arrive at Wallace’s answer to the “how many” question, we count the variables flanking the identity operator (the final conjunct). On its left-hand side, there is one variable: z. On its right-hand side, there are two variables: x and y. This means that the answer to the question is that *there is one thing and two things and the one is identical to the two*. This is a solution to indiscernibility arguments based on cardinality because we do not have some parts that are many and some whole that is one, thereby warranting an indiscernibility argument; instead we have some portion of reality (my pocket) that contains something(s) that are many and one, and the many is identical to the one.

All versions of CAI have to make sense of several different cardinality ascriptions being true of the same portion of reality, at the same time. The other versions of CAI that I have examined have all made sense of this by relativising cardinality ascriptions to ways of carving up the world. One benefit of the relativisation strategy is that we can dismiss the objection that we believe in contradictions: “there are exactly three objects over there *and* there is exactly one object over there” appears to be a contradictory statement, but we can say that there are three objects on one way of carving and one on another. No single way of carving has three objects

and one object, so contradiction is averted. Wallace has not done this. Instead, she accepts these seemingly contradictory statements and must insist that they are not in fact contradictory. According to her version of CAI, several different cardinality facts can be true of the same portion of reality at the same time, without qualification. This is strange. It strikes me as stranger than the Fregean idea that there are different, equally good, ways of carving / counting the world, but perhaps it does not strike everyone this way. I see this strangeness as a weak, defeasible reason to prefer other versions of CAI. A much bigger problem is that, the same strategy is much less plausible when it comes to problems like Collapse or Problematic Many-Manys, which have motivated others (including myself) to relativise *is one of* predications (see Chapters 3 and 5). The following model displayed in Figure 6.1 is instructive.

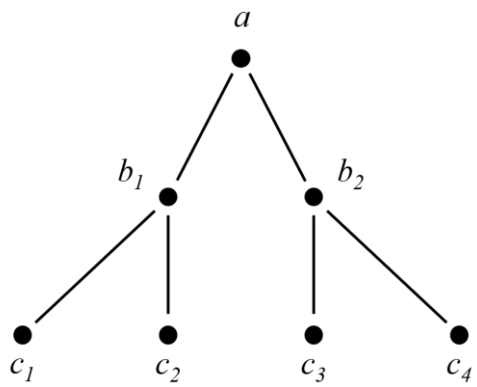

Figure 6.1

In Wallace's notation, $a =_h b_1, b_2$ and $a =_h c_1, c_2, c_3, c_4$. By substitution of identicals, therefore, $b_1, b_2 =_h c_1, c_2, c_3, c_4$. Yet $b_1 \prec b_1, b_2$ and $b_1 \nprec c_1, c_2, c_3, c_4$ so, by the indiscernibility of identicals, $b_1, b_2 \neq_h c_1, c_2, c_3, c_4$. Contradiction.

The collective/distributive distinction will not help here because the terms in question are all plural terms that indicate collective predication (as per Wallace's notation) and b_1 really is one of b_1, b_2 collectively but not one of c_1, c_2, c_3, c_4 collectively. The predicate 'is one of'

always assumes a collective reading because it treats the relevant plurality as a collection and picks out something in that collection. A distributive reading of '$b_1 \prec b_1, b_2$' would claim that $b_1 \prec b_1$ & $b_1 \prec b_2$, which is obviously not the intended meaning. There are four canonical responses to this problem: we can (1) relativise the *is one of* operator to ways of carving;[339] (2) restrict plural comprehension so that there are "fewer pluralities than one usually expects";[340] (3) restrict the substitutivity of identicals;[341] or (4) restrict or reject the indiscernibility of identicals.[342] Officially, I have taken option (3), but I have also explored a promising way to take option (1) (see Chapter 3). Wallace has not said anything about this matter.

The problem here is that cardinality objections and objections based on *is one of* are similar enough that we should expect similar solutions to them both (hence, even when I opted for strategy (3), I justified it by saying that *is one of* should be thought of as relative to properties). This is because cardinality properties and *is one of* properties both regard counting and are part of a family called 'set-like' properties.[343] But we find we cannot use Wallace's solution to the cardinality objections in *is one of* objections. Consider the following identity statement again:

$$\exists x\, \exists y\, \exists z\, (Px \,\&\, Py \,\&\, Pz \,\&\, x \neq_h y \,\&\, y \neq_h z \,\&\, x \neq_h z \,\&\, z =_h x, y)$$

Wallace counts the variables in identity statements like these to determine the cardinality facts true of portions of reality. But there are no meta-linguistic facts about these identity statements that can be pointed to as the way to determine what is one of what. Or, at least, I can see none. So, my complaint against Wallace's view is not just that she does not tell us how to answer the

[339] Cotnoir (2013a) Bohn (2014, forthcoming), and Bricker (2016).
[340] Sider (2014) and Loss (forthcoming).
[341] Hovda (2014).
[342] Baxter (1988a, 1988b, 2018).
[343] Sider (2007).

problems like Collapse; my complaint is that since there are no meta-linguistic facts about identity statements (like the above) from which we can derive the facts about what is one of what, Wallace *requires* us to treat the *is one of* facts in a different manner than we treat the cardinality facts, despite both pertaining to set-like properties (to which we should expect a unified approach).

The decision to treat one kind of counting fact (i.e. those pertaining to *is one of*) as relative while treating another kind of counting fact (i.e. those pertaining to cardinality) as non-relative, without underlying philosophical motivations for this difference, appears *ad hoc*. All of the above should be enough to reject Wallace's view, but there is more. We need to talk about five-dimensionalism.

In response to indiscernibility arguments framed in terms of modal properties, Wallace introduces her theory of modal parts. On this view, ordinary material objects are five-dimensional; extended in space, time, *and across possible worlds*. They are extended in space by virtue of having spatial parts; extended in time by virtue of having temporal parts; and extended in modal space by virtue of having modal parts. We should think of objects as "trans-spatio-temporal-world sums of spatial, temporal, and world (or modal) parts."[344] Wallace defines modal parts as follows. For any x and any y, x is a modal part of y iff (i) x exists at some world w, (ii) x is part of y at w, and (iii) x overlaps everything that is part of y at w.[345] Wallace also endorses the use of counterpart relations to determine which are the modal parts of five-dimensional ordinary objects.[346] She writes that this is "to take the 'part' in 'counterpart' seriously."[347]

[344] Wallace (2011b, p.824).
[345] Wallace (2014, p.117).
[346] Wallace (2011b, p.824 and 2014, p.118).
[347] Wallace (2011b, p.824).

Given the above, Wallace's solution to modal indiscernibility arguments against CAI is analogous to the solution to temporal indiscernibility arguments against CAI, from Chapter 1.5.4. So, like in that case, let us imagine a stool. Instead of imagining it across time, we will now imagine it across worlds.

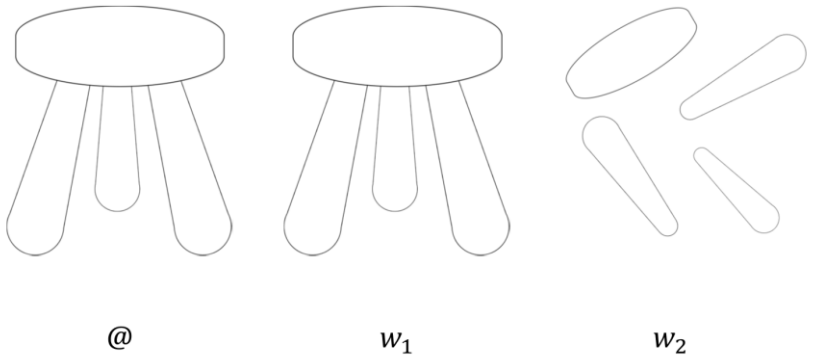

Figure 6.2

At the actual world, @, there is a stool made of three legs and a top (each of which is atomic). Call it $stool_{@}$. At world w_1, there is a stool also made of three legs and a top. Call it $stool_1$. But at world w_2, three legs and a top exist, but there is no stool. The modal indiscernibility objection claims that w_2 represents a possibility that $stool_{@}$ does not survive but its parts do. Therefore, since $stool_{@}$ has a different modal profile from its parts, it is not identical to its parts.

All Wallace has to say is that there is some five-dimensional object that is the fusion of (and collectively identical to) $stool_{@}$ and $stool_1$, but which has nothing at w_2 as a part. Call that object $stool$. When you gaze upon $stool_{@}$ and say that its parts could survive scattering but it could not, Wallace takes you to mean that the parts of $stool_{@}$ (the top and each leg) are each five dimensional objects which have modal parts in some world where $stool$ does not have a modal part. In our diagram above, that world is w_2. Nothing about that prevents $stool_{@}$

from being identical with its parts, or the five dimensional object $stool$ from being identical with its parts (which, on one decomposition are $stool_{@}$ and $stool_{1}$, and on another decomposition are the top at @, each leg at @, the top at w_1, and each leg at w_1). Five-dimensionalism rejects trans-world identities, so we should not infer that just because the actual top is part of stool, that the top at w_2 is also part of stool. It is not. Problem solved.

Given this view, composition occurs in several different ways:

- At each world, each four-dimensional object is composed of many temporal parts.
- Each of those temporal parts might be composed of some number of parts (and those parts are either spatial, if the temporal part is instantaneous or achronal, or temporal if not).
- At each world, each four-dimensional object is a single modal part. Many modal parts together, across worlds, compose five-dimensional objects.

According to Wallace, all three forms of composition are identity.

I do not think we should endorse five-dimensionalism. Five-dimensional CAI has some benefits and some drawbacks. As far as benefits go, in addition to all the usual benefits of CAI, five-dimensional CAI has the benefit of providing a solution to the modal indiscernibility arguments and the problem of material constitution (see Chapter 4). We have seen how it solves the former, and it solves the latter by claiming that the statue and the clay are not co-located because they have different modal parts – instead, they simply overlap, which is unproblematic.

However, these benefits are quickly undermined. Wallace's five-dimensional CAI uses counterpart theory in addition to modal parts, and counterpart theory can already be deployed to neutralise modal indiscernibility arguments against CAI (as discussed in Chapter 1.4.4) and the problem of material constitution (as gestured at in Chapter 4.2), so the fact that five-dimensional CAI can do the same job with extra commitments is underwhelming. In fact, it

can be read as unduly unparsimonious, if the existence of modal parts cannot be supported by some other, independent argument.

This response can be resisted. Wallace could reject counterpart theory and instead rely on universal composition (for which she has also expressed support) to guarantee that the relevant five-dimensional objects exist. In fact, there is precedent: as Wallace has noted, Lewis thought that five-dimensional fusions were a consequence of universalism (though five-dimensional objects did no heavy lifting in his theories). In fact, she need not even endorse universalism, as long as she permits enough composition to occur between objects at different worlds. As it stands, with the inclusion of counterpart relations in her theory, Wallace's view can be thought of as a modal analogue of *exdurantism*, which claims that there are counterpart relations between the temporal parts of four-dimensional objects. But by rejecting counterpart theory and endorsing some principle of transworld composition (perhaps unrestricted), she can develop a modal analogue to *perdurantism*, that will do all the work she wants it to without being subject to the objection I have levelled above.

However, even if the amendments I have suggested are adopted, five-dimensionalism offers no special advantage over super-CAI because the problems that modal parts solve are already solvable for super-CAI (or, indeed, any other version of CAI) with the use of counterpart theory. Every advantage five-dimensional CAI has, super-CAI also has. But, as has been shown in previous chapters, super-CAI has the additional advantages of offering traction on several different, difficult problems relating to the nature of location. Wallace's view also struggles with indiscernibility arguments from *is one of*, which point to the need for revision or supplementation. Given all this, super-CAI is to be favoured over Wallace's five-dimensional version of CAI.

6.4 Bohn's CAI

Bohn has also offered notable defences of CAI.[348] We have encountered his view several times already in this work, so discussion here will be brief. Some significant similarities between his view and my own are worth noting. For instance, the identity relation Bohn has in mind for CAI is a "broadened or generalized notion of identity"[349] – generalised from the one-one identity of classical logic and the many-many identity of plural logic, it will happily relate any combination of plural or singular terms. Though we have seen that this is a common feature of CAI theories. Bohn has also advocated relativising the *is one of* operator to ways of counting, as a way to capture the relativity of cardinality ascriptions that also defuses the threat of Collapse. This was a strategy I developed in Chapter 3.

Nevertheless, there are some disagreements between our theories. Some are small and may be eliminable, such as over his claim that composition is not symmetric. He calls the expression '$yCxx$' "mereological nonsense",[350] whereas I have already argued that it is perfectly acceptable (see Chapter 3). Others might not turn out to be disagreements at all. For instance, Bohn has said that carving should be relativised to *concepts*, about which he has said the following:[351]

> Now, of course, the nature of the concepts to which the set-like properties are relative needs further discussion, in fact it is one of the areas that a proponent of CAI (as I have construed things) needs to dig into. I cannot do so here but will henceforth simply treat such concepts as objective and mind-independent Fregean abstract functions that we can grasp through thought and language. They take real things, or portions of reality as input, and give truth-values as output.

[348] Bohn (2009a, 2014, forthcoming).
[349] Bohn (2009a, p.4).
[350] Bohn (2014, n.4).
[351] Bohn (forthcoming).

I have said that properties can play this role, and it remains an open question whether Bohn would accept that view. There is, however, one significant disagreement between us: he has claimed that CAI entails universalism.[352] I have already argued against that claim (see Chapter 4). But I did note, at the time, that there is an optional commitment that CAI theorists can endorse which does entail universalism. Ultimately, I sat on the fence about that commitment. I think it is interesting and worthwhile to imagine what CAI (and indeed super-CAI) could look like if it endorsed a restricted view of composition, which Bohn rejects, but I am sympathetic to Bohn's use of CAI to erode the distinction between one and many in a way that makes universalism much more plausible.

In many ways, then, my own view of CAI is in step with Bohn's and takes further some ideas at which he has gestured. There are areas where it might turn out that we disagree, but those details are unsettled. More needs to be said, by both him and me, to determine whether Bohn's view counts as a genuine alternative to my own. That can wait for another day.

Of course, the biggest difference between my version of CAI and each one discussed above is that I endorse supersubstantivalism also. The addition of supersubstantivalism to CAI brings a great many advantages that have been recorded in the previous chapters (and will be summarised in the final chapter, Chapter 8) and which do a great deal to recommend the combined view. Now let us turn to consider alternative interpretations of supersubstantivalism.

[352] Ibid.

CHAPTER 7:

ALTERNATIVE VERSIONS OF SUPERSUBSTANTIVALISM

I am far from the first to advocate for supersubstantivalism. The earliest use of the term appears to be by Sklar, in 1974,[353] but the view far predates that.[354] In the rest of this chapter, I explore other versions of supersubstantivalism and argue that my own version fares best among them. I ignore eliminativist versions and those that claim location is constitution because they do not cohere as neatly or elegantly with CAI and I am committed to finding the best version of supersubstantivalism to pair with CAI.

Some supporters of supersubstantivalism have advocated the view without unpacking it in much detail. Those authors cannot really be said to have their own version of supersubtantivalism and so I have no quarrel with them on the matter at hand. This is true of Lewis,[355] Sider,[356] Morganti,[357] and others. Take Sider, as an example. Sider has said that if we do not advocate relationism, we should advocate supersubstantivalism,[358] but his exegesis of supersubstantivalism does not go much beyond the claims that spacetime exists and each material object is identical with some region of it. All advocates of supersubstantivalism agree on that much.[359] As far as I can tell, there are only two matters on which I disagree with Sider: the existence of spacetime points and the ontological priority of parts and wholes. He builds spacetime points into his theory, whereas I remain neutral about them, and he claims that the spacetime points ground the existence of the whole manifold, whereas I think such points (if

[353] Sklar (1974, p.214). Skow (2005, p.54, n.1) believes that "Sklar coined this term".

[354] Dumsday (2016) attributes it to Spinoza. It has also been attributed to Newton and Descartes (Skow 2005, Chapter 3).

[355] Lewis (1986). Lewis does not explicitly endorse supersubstantivalism but does, as Skow (2005, p.55, n.2) says, "flirt with" it.

[356] Sider (2001, p.110-114).

[357] Morganti (2011).

[358] Sider (2001, p.110-114).

[359] Recall that I am using the term 'supersubstantivalism' to refer only to the identity version of the view.

there are any) are (collectively) identical to the whole manifold. Those disagreements alone do not warrant a further discussion than that which can be found in earlier chapters. In this chapter, I outline and argue against three versions of supersubstantivalism that differ more significantly from my own.[360]

7.1 Cartesian Supersubstantivalism

Although Descartes has been traditionally viewed as a relationist, Skow makes a good case for viewing him as a supersubstantivalist. Skow's case is based on the following claims made by Descartes:[361]

(1) Being spatially extended is the only essential property of material objects.

(2) Necessarily, every extended thing is a material body.

(3) Being spatially extended is the only essential property of space.

Skow points out that (1)-(3) entail supersubstantivalism if we add the following plausible claim, which Descartes may well have believed:

(4) Distinct kinds of things cannot share all of their essential properties.[362]

Support for this interpretation lies in Descartes' *Principles of Philosophy*, where he can be found to have written such statements as:

[360] I also disagree significantly with Schaffer's (2009) version of supersubstantivalism but argued at length against that in Chapter 2 so will not do so again here.

[361] Skow (2005, p.60).

[362] Ibid (p.61).

> A substance may indeed be known through any attribute at all; but each substance has one principal property which constitutes its nature and essence, and to which all its other properties are referred. Thus extension in length, breadth, and depth constitutes the nature of corporeal substance.[363]

And "[i]t is easy for us to recognise that the extension constituting the nature of a body is exactly the same as that constituting the nature of a space."[364] Relationists deny the reality of space, and so are best thought of as eliminativists about it. Descartes, however, identifies material objects with space and vice versa. For Descartes, space really exists and it is the same substance as material objects. That sure sounds like supersubstantivalism, to me. Perhaps the reason it sounds like relationism, to some, is that supersubstantivalism looks remarkably similar to relationism when combined with the claim that all regions are objects. The combination of (2) and (3) commits Descartes to that claim, which I (following Schaffer) have called 'unrestricted supersubstantivalism'. I examined the argument that unrestricted supersubstantivalism collapses into relationism, in Chapter 2. There, I found that it is true in a limited sense (i.e. unrestricted supersubstantivalism collapses into relationist views that posit a plenum, which are only a subset of relationist views). So those who call Descartes a relationist are right, as are we who call him a supersubstantivalist.

There are good reasons to prefer super-CAI over Cartesian supersubstantivalism. Notice that Cartesian supersubstantivalism is inconsistent with the existence of spacetime points (since space is essentially extended) and is necessarily an unrestricted view. Super-CAI, on the other hand, is compatible with the existence of spacetime points (although I have stayed neutral on their existence) which are required for Minkowski spacetime and super-CAI is compatible with restricted versions of supersubstantivalism, in favour of which there are strong

[363] Descartes (*Principles of Philosophy*, 1:53).
[364] Ibid (2:11).

arguments (see Chapter 2). For those reasons, we should favour super-CAI over Cartesian supersubstantivalism.

7.2 Dumsday's Supersubstantivalism

Dumsday gives us the outline of a new version of supersubstantlivalism, which he calls *non-mereological pluralistic supersubstantivalism*.[365] We have met the modifiers 'non-mereological' and 'pluralistic' already. The term 'pluralistic' alludes to the claim that the parts of spacetime are ontologically prior to the whole manifold. This is in contrast with the priority *monist* view, which claims that the whole spacetime manifold is ontologically prior to its parts.[366] We have seen that my view, super-CAI, claims neither; it claims that the whole spacetime manifold is (collectively) identical to its parts and so neither is ontologically prior to the other. Dumsday's view is not the first explicitly pluralistic incarnation of supersubstantivalism,[367] and I have already discussed the reasons to think parts and wholes are identical, rather than one having priority over the other, (see Chapter 1), so I will not focus on this element of Dumsday's view. Instead, my quarrel is with the *non-mereological* component of non-mereological pluralistic supersubstantivalism. According to Dumsday, objects do not stand in any parthood relations to the whole spacetime manifold. Before turning to the fine details of this view, however, we need broad strokes. Its broadest strokes can be captured by six claims. In Dumsday's own words, they are as follows:[368]

(1) Individual material objects are real substances.

(2) The larger spacetime manifold is a real substance.

(3) Individual material objects are not parts of the larger spacetime manifold.

[365] Dumsday (2016).
[366] See Schaffer (2010b).
[367] See Sider (2006, p.393).
[368] Dumsday (2016, p187).

(4) Individual material objects can (in principle) exist independently of the larger space-time manifold and vice versa.

(5) Individual material objects are members of the same underlying natural kind as the larger spacetime manifold, and are thus distinguished from that larger manifold by the possession of one or another sort of accidental (contingent) property.

(6) Individual material objects relate to the larger spacetime manifold in at least one of three ways: by embedding, containment, or co-location.

All substantivalists (whether super or not) agree with (1) and (2). What makes a substantivalism *super* is the belief that (1) and (2) allude to the same substance. Hence, the first conjunct of (5) is what makes Dumsday's view a *super*substantivalist one. Spacetime and material objects are the same underlying substance. This sometimes manifests in Dumsday's writing as the claim that there is a "type-identity" between material objects and spacetime.[369] It is not clear what Dumsday means by this. Typically, when a type-identity is alleged, it is claimed that for any type x of some domain D_1, there is a type y of a domain D_2 such that $x = y$. For instance, the (now defunct) theory that there is a type-identity between mental states and brain states claimed that for any mental state kind x (e.g. pain) in the domain of all mental states D_1, there is some brain state kind y (e.g. c-fibres firing) in the domain of all brain states D_2, such that $x = y$. In the context of supersubstantivalism, this type-identity schema translates into the claim that, for any kind of material object x in the domain of all objects, there is a kind of spacetime y in the domain of all spacetimes (or should that be the domain of all spacetime regions?), such that $x = y$. But this is clearly *not* what Dumsday means, since he also says that material objects are "irreducible to and numerically distinct from that larger spacetime manifold and any of its

[369] Ibid (pp.186, 187, 193).

parts."[370] In fact, the non-identity of material objects and spacetime is crucial to Dumsday's theory since, if an object is identical to a region of spacetime, then it is a part (albeit an improper part) of that region of spacetime, and if that region of spacetime is part of the whole manifold, then the substitutivity of identicals implies that the object is part of the whole manifold. So, although Dumsday and other supersubstantivalists (including myself) agree on the first conjunct of (5), we do so in incompatible ways, and greater clarity is required on what Dumsday means by it, if non-mereological pluralistic supersubstantivalism is to be a tenable theory. I assume that Dumsday means nothing more than that spacetime and material objects are the same type of thing (i.e. the same substance), but that no material object is identical to any region of spacetime. This is a departure from the standard conception of supersubstantivalism (which says that material objects are literally identical to their exact locations in spacetime) but it is still supersubstantivalist in spirit because it claims that spacetime and material objects are fundamentally the same kind of thing. The same substance.

The second conjunct of (5) is best read as a commitment to something like a restricted version of supersubstantivalism; Dumsday is saying that spacetime and objects are the same underlying natural kind (hence, they have all the same non-accidental properties) and we discern material objects from spacetime by the accidental properties they have. Properties like mass and charge and spin. I explored this idea, and offered other candidate properties for discerning host regions (which are objects) from mere regions (which are not), in Chapter 2. It is another thing on which Dumsday and I agree.

More agreement can be found in (4). I have discussed essentialism and supersubstantivalism already, in Chapter 4. There, I told the standard story about how counterpart relations allow us to say that spacetime and material objects are identical but different counterparts are picked out when we consider spacetime qua spacetime rather than

[370] Ibid (p.183, abstract).

spacetime qua material objects. This allows us to say that (in principle) material objects can have material object counterparts in worlds where the larger spacetime manifold does not have spacetime counterparts. This validates (4).

That leaves (3) and (6). (3) says that non-mereological pluralistic supersubstantivalism rejects the notion that there are parthood relations between spacetime and material objects. (6) says what relations there are between them, instead: embedding, containment, or colocation. Dumsday admits that he has "left a great deal undone" by (among other things) saying very little about what those three relations amount to.[371] Still, he does offer a couple of guiding similes:

- Containment is like different coloured balloons floating inside a larger balloon (the smaller are contained in the larger and all are the same kind of thing but with different properies, such as colour).
- Embedding is like an ice cube floating through water (made of the same stuff but competing for space and displacing the water it moves through).

The project of making non-mereological pluralistic supersubstantivalism tenable requires telling us more about these relations. I am sceptical that such details can be filled in plausibly,[372] but let us suppose they can. Why should we bother? What benefit does this theory offer? Dumsday argues that it avoids four objections to supersubstantivalism:[373]

[371] Ibid (p.198).

[372] The only one of these relations that does not require a lot more explication is co-location. But, notice that given claim (5), Dumsday is suggesting the co-location of objects *of the same kind*. This contradicts the popular Lockean proviso that "anything that exists anywhere at any time, excludes all of the same kind, and is there itself alone" (Locke, *An Essay Concerning Human Understanding*, Bk. 2, Ch. 27, §1).

[373] Dumsday includes a fifth argument which he observes "might be seen less as an objection and more as an argument for changing the dominant background substance ontology that supersubstantivalists have heretofore been working with" (Dumsday 2016, p.193). I find the point compelling but, since I do not

(i) The common sense objection

(ii) The movement objection

(iii) The diachronic property-unification objection

(iv) The essentialism objection

I have already argued that super-CAI (and, indeed, other forms of supersubstantivalism) is unthreatened by (i) and (iv) (see Chapter 4). I will now explain what the other objections are and why they do not threaten super-CAI. The upshot is that Dumsday's view gains no advantage from them.

The movement objection expresses a worry about how motion is conceptualised by supersubstantivalists. Dumsday says:

> We normally think of the motion of an electron (for instance) as involving a single, unified material object progressing through or across a background spatial manifold. On supersubstantivalism, what we have instead is a collection of properties (negative charge, half-integral spin, etc.) being possessed by one spacetime region or point followed by another followed by another, etc., such that the set of properties is successively possessed by an ordered series of regions/points.[374]

He likens this to the way screens represent movement; instead of an object genuinely moving, a series of adjacent pixels light up, one after another. Instead of one object moving through

engage with questions of background substance ontology in the present work, I shall say no more about it. Suffice it to say that it does not give reason to think that supersubstantivalism or super-CAI is false and it does not undermine any of the motivations for it that I have discussed in previous chapters, though it does undermine a motivation offered by Morganti (2011).

[374] Dumsday (2016, p.189).

space, movement is accounted for by a series of numerically distinct objects (temporal parts of the four-dimensional whole) no single one of which moves at all. This is supposed to be a problem for supersubstantivalism because it is "arguably, deeply counter-intuitive".[375] Dumsday seems to think this is not genuine movement.

The movement objection is just a specific case of an older, more general objection to perdurantism and it is only applicable to supersubstantivalism by virtue of supersubstantivalism's commitment to perdurantism. The older argument comes from Mellor who argued that perdurantism does not allow for genuine change because it attempts to account for any given object's change over time by replacing it with many numerically distinct objects that have different properties and none of which undergo change.[376] Movement is one, specific way that things can change, so Dumsday's movement objection is just a reformulation of Mellor's objection. The same replies can be given to both. My preferred response is to agree with Hawley who describes Mellor's genuine change objection as "bad but tempting".[377] She points out that the argument begs the question against perdurantism, saying:

> Any theory of persistence must account for ripening bananas, decaying books, and ageing people. But we cannot simply make the theoretical assumption that what we see around us are enduring objects with different properties at different times, rather than perduring objects, whose different temporal parts have different properties at different times. Endurance theorists are not entitled to stipulate that perduring objects do not change – instead, they must provide an argument to the effect that the endurance account of change is the best one.[378]

[375] Ibid.
[376] Mellor (1998, Chapter 8). See also Simons (2000).
[377] Hawley (2001, p.12).
[378] Ibid.

This applies to Dumsday's movement objection too. To Dumsday's credit, he does notice that many will not be phased by his movement objection. He observes that "most supersubstantivalists" are perdurantists and, as such, "will likely be unconcerned" by it.[379] Nevertheless, Dumsday includes this objection because he holds a set of views very uncommon to this literature. He advocates supersubstantivalism but wants to combine it with three-dimensionalism and endurantism by rejecting the unification of space and time. You may recall that I pointed out, in Chapter 2, that supersubstantivalism only entails perdurantism if we take Newtonian conceptions of space (as enduring and separate from time) off the table. To justify taking them off the table, I pointed to the overwhelming scientific and philosophical near-consensus that Newtonian conceptions of space do not cohere with modern science and are thus untenable. I concluded from that, that we might as well treat supersubstantivalism as entailing the falsity of three-dimensionalism. Dumsday acknowledges this near-consensus but "clings" to a Newtonian conception of space, nonetheless. In an endnote, he reveals the following:

> I realize that the current supersubstantivalist literature is formulated almost entirely in terms of spacetime rather than in terms of space alone, and I am cognizant of the powerful arguments in favour of such a link between space and time (especially those arising from standard interpretations of relativity). Nevertheless, part of me is inclined to cling to a presentist ontology of time with a 'from my cold dead hands!' stubbornness. […] I will also note that non-mereological pluralistic supersubstantivalism as developed in what follows is liable to be permissible to endurantists if read as a theory of the relationship between matter and space. However, endurantists probably cannot be on board with it when read as a theory of the relationship between matter and *spacetime*.[380]

[379] Dumsday (2016, p.200 n.7). For example, Morganti (2011, p.193) explicitly states that supersubstantivalists should be four-dimensionalists who conceptualise motion in the way to which Dumsday objects.

[380] Dumsday (2016, pp.199-200, n.7).

This is why, in discussions of the movement objection, he repeatedly refers to genuine movement with expressions like "progressing through or across a background *spatial* manifold".[381] Pluralistic non-mereological supersubstantivalism can either be endurantist and expressed in terms of space or it can be perdurantist (or Pardurantist) and expressed in terms of spacetime. Those of us who accept the abovementioned overwhelming scientific and philosophical near-consensus on the unification of space and time will find the former far too unpalatable, but it is Dumsday's preferred version. On those grounds, I claim that Dumsday's preferred version of pluralistic non-mereological supersubstantivalism can be rejected. I suspect that all who might disagree with me on that will have stepped off the bus I am driving a long time ago. In spite of all that, we should note that the broad strokes of Dumsday's view (as expressed in claims (1)-(6), above) are compatible with perdurantism (or Pardurantism) and spacetime, so we cannot yet reject non-mereological pluralistic supersubstantivalism. Instead, we should merely conclude that the movement objection provides no advantage to non-mereological pluralistic supersubstantivalism and no threat to its alternatives.

Similar things can be said about the diachronic property-unification objection. According to perdurantism, persistence involves the fusion of numerically distinct objects (temporal parts) at different times into one temporally extended object. Consider a perduring piece of chalk. At t_1, the chalk has temporal part. At t_2, it has a temporal part. The temporal part at t_1 is extremely similar to the temporal part at t_2; the two have almost all the same properties, such as shape, size, mass, colour, and so on. Dumsday wonders how supersubstantivalism can explain why it should be that a region at t_1 instantiates almost all the same properties as an adjacent region at t_2. Something is needed, to explain the regularity with

[381] That quotation is from (ibid. p.189, emphasis my own), but more examples of reference to a spatial (rather than spacetime) manifold can be found throughout.

which unified collections of properties appear over time at adjacent regions. Just like the previous objection, this objection is extremely similar to an argument against the metaphysics of perdurantism. In this case, I am talking about Thomson's famous *ex nihilo* objection to perdurantism. Thomson argues as follows:

> I said this seems to me a crazy metaphysic. It seems to me that its full craziness only comes out when we take the spatial analogy seriously. The metaphysic yields that if I have had exactly one bit of chalk in my hand for the last hour, then there is something in my hand which is white, roughly cylindrical in shape, and dusty, something which also has a weight, something which is chalk, which was not in my hand three minutes ago, and indeed, such that no part of it was in my hand three minutes ago. As I hold the bit of chalk in my hand, new stuff, new chalk keeps constantly coming into existence ex nihilo. That strikes me as obviously false.[382]

This can be read as a request for an explanation of why there should be a piece of chalk at t_2, after there was a numerically distinct piece of chalk at t_1. Since the two temporal chalk parts are distinct, the existence of the latter appears (to Thomson, anyway) to come from nothing. An explanation of where it in fact comes from would defuse this concern. This clearly parallels Dumsday's request for explanation of why similar sets of properties are instantiated at numerically distinct regions.

There are many responses to Thomson's objection, in the literature. Many of those responses can be marshalled against Dumsday's objection. For example, we might suppose, with Sider, that "current temporal parts are caused to exist by previous temporal parts"[383] or, with Williams, that "[subsequent temporal parts of perduring objects] are clearly created from

[382] Thomson (1983, p.213).
[383] Sider (2001, p.217).

something, namely the powers-based causal actions of the predecessor object stages."[384] Those philosophers, and others, have provided candidate explanations of why we see the same collection of properties appear at adjacent regions of spacetime. Super-CAI (and supersubstantivalism more generally) only adds to those explanations that the temporal parts in question are each identical with a region of spacetime and collectively identical to a whole, perduring, four-dimensional object.

Even if the above were not true – if there were no available responses to Dumsday's diachronic property-unification objection – Dumsday's version of supersubstantivalism gains no advantage. This is because the diachronic property-unification objection applies to any and all perdurance theories. So, either Dumsday's theory is perdurantist, in which case the diachronic property-unification objection confers no advantage to it over other perdurantist supersubstantivalisms, or it is not. If it is not, then there are a variety of views it might be instead. It might be a traditional three-dimensionalist endurantist view which means it rejects the unification of space and time (recall Dumsday's concession that "endurantists probably cannot be on board with [non-mereological pluralistic supersubstantivalism] when read as a theory of the relationship between matter and *spacetime*."[385]) and it is at a significant disadvantage – i.e. its lack of coherence with our best science. Or it might be a Pardurantist view, which would permit it to escape the diachronic property-unification objection but in a manner completely available to advocates of super-CAI. Super-CAI is consistent with Pardurantism (see Chapter 2). For any theory of persistence one might choose to pair with Dumsday's view, one of these three responses can be given, *mutatis mutandis*.[386] Hence, no

[384] Williams (2019, p.214).

[385] Dumsday (2016, pp.199-200, n.7)

[386] For instance, the diachronic property-unification objection applies to all *exdurantist* theories too, so one of the three lines of response above (i.e. the first one) also applies to exdurantist versions of Dumsday's view. I will not attempt to demonstrate the same for every extant theory of persistence. I leave the more obscure theories to the reader.

matter what theory of persistence one holds, the diachronic property-unification objection is no help to Dumsday.

Given all of the above, it can be concluded that none of the arguments Dumsday considers gain any traction on alternatives to his view (including super-CAI and other forms of supersubstantivalism), so they provide his view with no advantage. Yet Dumsday's view comes with significant costs. For instance, it is far less ideologically parsimonious than its rivals. A great benefit of supersubstantivalism is that it requires no primitive occupation or containment relations to express the relationship between material objects and space or spacetime. Super-CAI usually does this job with identity (as do other versions of supersubstantivalism), which is no extra commitment. However, non-mereological pluralistic supersubstantivalism not only requires a new relation to explain the relationship between material objects and space or spacetime, it also wants to use a peculiar new relation with most of its details hitherto unarticulated. For this cost, it provides no benefit. For that reason, it should be rejected.

7.3 Nolan's Supersubstantivalism

Nolan does not claim his version of supersubstantivalism is true. Instead, he aims to give us a theory with interesting features, which serves as a counterexample to some standard claims about supersubstantivalism. It is, of course, common and worthwhile to trek up uncharted philosophical peaks without pitching one's tent there; doing so can provide a vantage point from which to spot new regions of the philosophical landscape or produce better maps of the old. But, for ease of exposition, I will speak as if he believes his version to be true.

The early portions of Nolan's paper are dedicated to establishing a modified version of Tarski's geometry of space.[387] Those details are not needed for the present discussion. In fact,

[387] Tarski (1927).

Nolan is happy to admit that "a lot of the technical detail […] is not really important for what is to follow."[388] So I will make only the following brief comment about those details. Nolan sets his theory in a gunky spacetime composed of extended spherical regions, not points. He does this to highlight the fact that supersubstantivalism is consistent with Pardurantism, but he could have imagined his theory taking place in a variety of different spacetimes – pointy or not. I have already acknowledged that supersubstantivalism is consistent with Pardurantism and that I am neutral on the question of whether there are point-sized regions, so no more needs to be said about that. Once we extricate Nolan's theory about the relationship between objects and spacetime from the spacetime he sets it in, we see that it has some striking similarities with my own.

Recall that I treat parthood and subregionhood as the same relation and I have said that there are two mereologies at play in the world. (1) The region mereology, which relates all regions of spacetime to each other and obeys CEM, and (2) the material object mereology, which relates only host regions and the rules of which are discussed in 3.1.

Nolan disagrees. Instead, he treats parthood as different from and derivative of subregionhood. For him, the subregion relation is primitive and nonmereological. He defines parthood in terms of it, as follows:

Nolan's Parthood: $x \leq y =_{df}$ both are material objects and x is a subregion of y.

This means that Nolan's parthood relation is coextensive with the parthood relation I have reserved for the material object mereology, expressed by the predicate '$\leq_m$' which can only be flanked by terms denoting host regions. Nolan and I also agree that it is best to assume

[388] Nolan (2014, p.97).

regions obey CEM[389] – though this assumption is eliminable from both theories. This means that Nolan's subregion relation is coextensive with the parthood relation I apply to the region mereology, expressed by the predicate '$\leq_r$' which can be flanked by any region whatsoever. By virtue of our theories containing these coextensive predicates, our theories have similar expressive power. Nolan notes that his view is consistent with extended simples, Pardurantism, and restricted composition – I have noted the same about my own view. Nolan could also have noted that his view, like mine, is consistent with gunky objects in pointy space and other widespread failures of harmony (though that would require a different spacetime setting for his view).[390] These are good virtues to have. I am pleased to share them. However, his claim that subregionhood is nonmereological is worth investigating. It is a difference between Nolan's supersubstantivalism and my own, and I think it is a good reason to favour my view over his.

A bad objection to Nolan's view goes as follows. Since he says subregionhood obeys CEM, it cannot help but be mereological. It must be parthood. This objection claims that although Nolan is free to stipulate whatever he likes, in his theory, we are similarly free to object that some stipulations are confused or made in error. By stipulating that subregionhood obeys CEM but is not parthood, he has made one such confused error. To say otherwise is to misunderstand parthood.

Nolan's replies are convincing. He points out that there are all sorts of sets of ordered pairs that we can pick out, which satisfy the axioms of CEM, "including ones which relate you to me – it does not follow that you are literally a part of me and/or vice versa."[391] On top of that, he points out that spacetime regions are often thought of as *sets* of points. If they are sets, then the subregion relation is the subset relation, not parthood. Of course, Lewis has advocated

[389] Ibid (p.94).

[390] Though, the similarities should not be overstated. Nolan's view does not come with all the same benefits as my own because he does not endorse composition as identity. I say a little more about this, below.

[391] Ibid (p.109).

the idea that subsethood is parthood,[392] but Lewis does not appear to have said that anyone who disagrees with it does not understand parthood. To say so would be implausible. Hence, it does seem the mere fact that a relation obeys CEM is not good enough grounds to say that it *must* be parthood.

I agree with Nolan on the above, but his example reveals some important nuance. Supersubstantivalists cannot endorse the conception of regions as sets of points because supersubstantivalists claim that material objects are identical with spacetime regions. If regions are sets, then this would have the consequence that material objects are sets, which they are not.[393] The lesson to be learned from this is that the metaphysics of supersubstantivalism places restrictions on what subregionhood can be. For one thing, whatever it is had better be something that can structure material objects.

There is more. Paying proper attention to the metaphysics of restricted supersubstantivalism reveals a new line of objection to Nolan's view. Let us consider the question "what is the metaphysical difference between a mere region and a host region?". The answer depends on the criteria we endorse for restricting which regions are objects. For the sake of argument, assume that the best criteria for this purpose relate to physical properties like charge, mass, and spin: regions that have such properties are material objects, whereas regions that do not are not.[394] Speaking metaphorically, then, we might say that "all god has to do" to turn a mere region into an object is to add some of those physical properties. Yet it is surely false to claim that adding charge, mass, or spin can turn something non-mereological into something mereological. The addition of those particular physical properties to a region simply

[392] Lewis (1991).

[393] However, see Maddy (1990) for the view that sets are material objects. On that view, it might be possible to resist my current point, though it does nothing to resist the next.

[394] Nolan (2014, p.95) himself expresses sympathy for this view.

has little or nothing to do with whether that region's underlying metaphysical structure is mereological. Why should it? Consider an analogy.

Haikus are poems structured in a particular way; they must be composed of three lines which are in turn usually composed of five, seven, and then five syllables (in that order). Nolan's claim that adding charge, mass, or spin to a region can turn it from something non-mereological into something mereological is analogous to the obviously false claim that adding metaphor, alliteration, or irony to a poem can turn it from something that is not a haiku into a haiku. In both cases, the features being added are just not relevant to the structural change being alleged. The differences (between mere and host regions) are not enough to make a difference (between mereological and non-mereological entites). For that reason, I am convinced that we should reject Nolan's claim that mere regions are non-mereological and host regions are mereological.

That being said, I suspect this dispute may be merely verbal. Although I say parthood is subregionhood and both are mereological, while Nolan says the two are different relations and only parthood is mereological, it should be possible to translate claims made by one view into the language used by the other without a change in truth value. Whenever I say some mere region r is a part_r of some other mere region s, Nolan will say that r is a subregion of s. Whenever I say that some material object x is a part_m of some material object y, Nolan will say x is part of y. And the same holds in reverse. So what does it matter that we use different terminology?

It does not matter as much as substantive metaphysical disagreements and, ultimately, there is clearly more that unites our two views than divides them. But I am not convinced it does not matter at all. For one thing, I think it is important that, as Markosian has said, "mereology carves ontology". Mereology is a tool for describing structure and, as such, the observation that there are multiple mereological structures helps us to unify a family of related

phenomena. In this work, I have focused on the relationship between material objects and spacetime regions. In doing so, I have disambiguated a mereology for material objects from a mereology for regions. But we need not stop there. I think it plausible that there is a distinct mereology for events (we might say that my birth is part_e of my life, for instance), or for social groups (so that I am part_g of the philosophy department), and that the parthood relation on those entities is also the subregion relation.[395] By labelling all of these structures 'mereologies', governed by different relations that are all parthood relations, we unify them in a way that makes salient their similarities and therefore makes salient the power of mereological tools to describe huge swathes of phenomena.

Of course, 'mereology' need not be the term we use to unify this family of relations; Nolan could invent a new term to do the same job,[396] but the benefit of employing well entrenched terminology is that we all know what it means – it connotes the similarities between the relations. While the danger of Nolan's terminology is that it creates a distinction without a significant difference; we agree that parthood and subregionhood behave in the same way, so saying that one is mereological while the other is not runs the risk of implying a greater difference between them than there is, in fact. I understand that this taxonomical argument is an outlier in a work predominantly devoted to metaphysics, but I do not think it is trivial. The ability of supersubstantivalism to unify locational facts with facts about parthood relations on both material objects and spacetime regions (and perhaps more!) is a benefit to be flaunted, and the language we use can help us do so.

Obviously, however, the biggest difference between my view and Nolan's is that I have added a commitment to composition as identity. Testaments to the benefits of this addition are

[395] I suspect Nolan would agree with some of this. Nolan (2011b) has defended the view that objects are identical with events. Although his view is not compatible with supersubstantivalism (since it posits co-located events), something in the neighbourhood certainly is.

[396] Equally, one might object that I have left out mereologies which govern parts of non-located objects. I hint at a route of reply to this at the end of the next chapter.

found scattered throughout this work and summarised in the next and final chapter of this work: the conclusion. Let us turn to that now.

CHAPTER 8:

CONCLUSION

8.1 The Strength of Super-CAI

Let me start with a remark about where super-CAI fits in the literature. In Chapter 1, I said that super-CAI is not a version of what some call *weak* CAI because it does not claim that composition is merely analogous to identity. But I did not say whether super-CAI is a version of *moderate* CAI or *strong* CAI. For good reason. Taxonomies of CAI are ten a penny, and there is limited agreement across them about what counts as moderate or strong.[397]

According to some, the difference between moderate and strong CAI is whether the view conforms to the Indiscernibility of Identicals, appropriately generalised to include many-one cases of identity.[398] Views are strong if they do conform and moderate if they do not. In Chapter 3, I showed that super-CAI does conform to the Indiscernibility of Identicals. Hence, on those taxonomies, super-CAI is a version of strong CAI.

According to others, the difference between moderate and strong CAI is whether the identity posited between the many parts (taken together) and the whole is *numerical* identity.[399] Views are strong if it is and moderate if not. Unfortunately, the literature contains several confusions about this.

First, many CAI theories relativise numerical ascriptions to ways of counting. The portion of reality is one when counted as a copse, but many when counted as trees. So identity of number is precisely the wrong way to be thinking of identity, according to those versions of

[397] See Sider (2007, 2014), Wallace (2011a), Cotnoir (2014), Bricker (2016).

[398] See Bricker (2016) and Wallace (2011a) – though Wallace uses the terms ‘strong’ and ‘stronger’ instead of ‘strong’ and ‘moderate’.

[399] See Cotnoir (2014), Calosi (2016a).

CAI. Hence it seems odd that Bohn's version of CAI (which includes this relativisation) is typically counted among the strong, by those who endorse this way of taxonomising views.

Second, I have argued that composition is many-one identity and that many-one identity is an instance of a more general identity relation that also has the one-one identity of classical logic and the many-many identity of plural logic as instances. This claim is common among advocates of CAI, but it is treated differently in different places. Let us take the treatment of Cotnoir and Bohn's views as representative of this confusion.

Cotnoir and Bohn say exactly the same as I have above: composition is many-one identity and many-one identity is an instance of a more general identity relation. According to Cotnoir, "Composition, then, is MANY-ONE cross-count identity given by ≈",[400] where '≈' is the symbol he uses for the general identity relation. While, Bohn says:[401]

> [T]he supposedly revisionary notion of identity and distinctness need not be so much a revisionary notion of identity as it can be a broadened or generalized notion of identity. It will not violate any classical laws of identity, but rather employ those very same principles more broadly.

Bohn then defines composition as the many-one form of that generalised identity. So Cotnoir and Bohn agree. The difference between them (on this matter) is that Bohn uses '=' to express general identity and calls his view strong, while Cotnoir uses '≈' to express general identity and calls his view moderate. Those are not substantive differences. Yet their views are only sometimes categorised together.[402] Other times, Bohn is taken to endorse strong CAI, while Cotnoir is taken to endorse moderate.[403] For example, Calosi writes:

[400] Cotnoir (2013a, p.306).
[401] Bohn (2009a, p.4). Similar remarks are made in Bohn (forthcoming).
[402] See Carrara and Lando (2017).
[403] See Cotnoir (2014) and Calosi (2016a).

> Cotnoir then goes on to develop a proposal according to which composition is not numerical identity, i.e., the = relation, but rather generalized identity, which he writes as ≈, and takes it to be a genuine form of identity in that it allows substitutivity of identicals.
>
> […] Maybe this is the road to take to try to vindicate at least the pre-analytical intuition that composition is identity, that is, trade the familiar notion of identity for some other cognate relation. I cannot do justice to such a claim here. I will rest content to point out that the equivalence argument should be considered seriously by those who actually want to stick to the familiar notion of identity.[404]

And Calosi "simply assume[s]"[405] Bohn is among those that "actually want to stick to the familiar notion".

Either the many-one instance of a generalised identity relation can count as the familiar notion, or it cannot. If it can, then Cotnoir and Bohn (and I) endorse strong CAI. If it cannot, then they (we) endorse moderate CAI.

Furthermore, to anyone who wishes to deny that (many-one instances of) generalised identity can count as 'familiar' or numerical identity, I ask: why? If it is simply that only one-one identity can count in this way, then *no* version of CAI is strong, and the taxonomy is useless. Greater clarity is needed on this issue. For now, I conclude that my view is a version of strong CAI because it obeys the Indiscernibility of Identicals and I see no reason to think that there is some stronger notion of identity than the one I mean when I use '='.

There is, however, a sense in which super-CAI might be considered weaker than some of its rivals. That is in terms of its modal strength. It is common to claim that if CAI is true, it

[404] Calosi (2016a, pp.229-230).
[405] Ibid. (p.220, n.5).

is necessarily true.[406] Yet, although I have claimed super-CAI is true, I have not claimed that it is so necessarily. I have also explained why. It is because my arguments for super-CAI rely on abductive inferences, and it seems plausible that there might be degenerate worlds where the most virtuous theories are not true. Further, my arguments have at times relied on facts about actual spacetime, such as appeals to Special and General Relativity which are surely not true necessarily. I claim, therefore, that composition, exact location, and identity are *actually* extensionally equivalent. Of course, if you believe that answers to the general composition question must be necessarily true if they are actually true (perhaps because you think that *necessary* extensional equivalence is required to settle the general composition question, or perhaps because you think of mereological principles as logical truths, rather than laws of nature[407]), then fine. Take this work as an argument that super-CAI is necessarily true. After all, the arguments that it is actually true are compelling. Perhaps more compelling than any argument to the effect that it is possibly false.

8.2 The Benefits of Super-CAI

We should be enticed by the prospect of any theory which claims to unify various relations by showing that they are one and the same. Successful unifications of this kind can offer great reductions in ideological commitment, without sacrificing expressive or explanatory power. And when one of the relations being unified is identity, great reductions in ontological commitment follow too. Since we want our theories to be simple and powerful in these ways, we should explore opportunities for such unification wherever we find them. In this work, I have sought to unify three different relations: identity, composition, and exact location. I claim they are all the same relation.

[406] See Cameron (2007, p.101, n.11), Sider (2007), McDaniel (2008, p.131), Bohn (2014, p.162, n.38).
[407] See Nolan (2011a) for more discussion of this and related issues.

But the benefits of super-CAI are not *just* ideological and ontological parsimony. Super-CAI also explains many features of composition, parthood, and location. For instance, it explains:

- Why two distinct objects cannot have the same exact location.
- Why your parts do not compete with you for space.
- Why your parts do not compete with you for causal efficacy and effects caused by composite objects need not be causally overdetermined.
- Why your parts follow you around, wherever you go. That is, why your location and the locations of your parts cannot be freely recombined.
- Why material objects must have locations.
- Why material objects have the particular locations they do.
- Why colocation and (some forms of) interpenetration are (at least physically) impossible.
- The nature of portions of reality.
- The nature of the relation between material objects and spacetime – i.e. occupation.
- The nature of the relation between material objects and their parts – i.e. composition.

By giving all these explanations, super-CAI captures all that is special about parthood. This is a big deal. As Sider says:

> 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.[408]

We could resist the criticism Sider levels in the second half of this passage, by pointing out that his "logically conservative route" less ontologically and ideologically conservative than super-CAI. We could then fall back on the standard questions about trade-offs between different kinds of theoretical conservativism. But we do not need to. Super-CAI fares better than CAI and it fares better than supersubstantivalism in this regard because it *does* imply everything that is distinctive about parthood, as we have seen.

Furthermore, since super-CAI explains the nature of composition, it represents an answer to van Inwagen's *general composition question*. So, we see there is a great deal of explanatory benefit to super-CAI.

But the explanatory benefits of super-CAI are not the only things that speak in its favour. It should be noted that combining composition as identity and supersubstantivalism has not been a mere exercise in slamming two theories together and seeing what falls out. On the contrary, there are good independent motivations for combining the two views. We have seen that they solve problems in the same ways and share the same commitments (such as counterpart theory and four-dimensionalist theories of persistence). We have also seen that their methods for restricting composition (explored in Chapter 4) line up very neatly. I have even hinted that the combination can be motivated by an argument that claims the Abelardian strategy leads to supersubstantivalism and is relied upon by CAI.

All of the above strikes me as a powerful case for the view I have advocated in this work.

[408] Sider (2007, p.79).

8.3 What Next?

Finally, I want to touch on potential applications that fell beyond the scope of discussion in previous chapters.

Mereology is a tool for describing structure and, since entities of different ontological categories are structured in different ways, different mereologies can describe them.[409] In this work, I have focussed on two such mereologies: the mereology for regions (simpliciter), and the mereology for host regions (which are material objects). In Chapter 7, I briefly indicated that I think these are not the only ontological categories that can be described with their own mereologies. A theory according to which events are identical with pluralities of objects and are exactly located at (and identical with) the spacetime regions where they occur would be easily expressible in super-CAI's terms. Similarly, for social groups. Mereological theories of those ontological categories exist already and could be built upon with insights from super-CAI.[410]

Furthermore, although I have restricted my attention to material objects located in spacetime, I am not *entirely* convinced super-CAI must be restricted in this way. What if, following Simons,[411] we were to treat location as a formal concept applicable to structures of all kinds? We might say that entities can have locations in formal structures without being located in spacetime. By employing something like his view, we could try to make sense of the claim that even abstract entities are identical with their exact locations. Super-CAI thus has the potential to be a perfectly general theory of composition, identity, and location across all ontological categories.

[409] This point is well made by Markosian (2014, 2015).

[410] For events as objects, see Goodman (1951), Quine (1970), Steen (2005) and Nolan (2011b). For a mereological theory of social groups, see Hansson Wahlberg (2014) and Hawley (2017).

[411] Simons (2004a).

All this gesturing is in service of the following point. I have shown that super-CAI is a powerful and compelling theory, but the full extent of its power is well beyond the scope of this work. Super-CAI explains an awful lot about material objects and regions of spacetime – about composition and location – but this is surely not all the theory has to offer.

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