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An elegant universe

Claudio Calosi[1]

Abstract David Lewis famously endorsed Unrestricted Composition. His defense of such a controversial principle builds on the alleged innocence of mereology. This innocence defense has come under different attacks in the last decades. In this paper I pursue another line of defense, that stems from some early remarks by van Inwagen. I argue that Unrestricted Composition leads to a better metaphysics. In particular I provide new arguments for the following claims: Unrestricted Composition entails extensionality of composition, functionality of location and four-dimensionalism in the metaphysics of persistence. Its endorsement yields an impressively coherent and powerful metaphysical picture. This picture shows a universe that might not be innocent but it is certainly elegant.

Keywords Unrestricted composition · Extensionality · Functionality · Four-dimensionalism

1 Introduction: metaphysics and innocence

David Lewis endorsed *Unrestricted Composition*[1]—and the full strength of classical mereology along with that- in a number of places, most notably in Lewis (1986, 1991). *Unrestricted Composition* is extremely controversial in that it entails a commitment

[1] At a first approximation the principle says that any non-empty collection of entities has a mereological fusion. The official formulation is the one in (9). Arguments in favor of *Unrestricted Composition* can be found in Rea (1998), Sider (2001) and Van Cleve (2008). Different critiques of the arguments are in Koslicki (2003), Simons (2006), Elder (2008).

✉ Claudio Calosi
claudio.calosi@unine.ch

[1] University of Neuchatel, Institute of Philosophy,
Espace Louis-Agassiz 1, 2000 Neuchatel, Switzerland

to all sorts of mereological fusions: on top of seas, birds and flowers there is an object made exactly of the left wing of that hummingbird over there, the stem of this daisy over here and three molecules of water from the Dead Sea. The number and variety, if not the metaphysical monstrosity, of such objects have been met with bewilderment.

Lewis' own response to such bewilderment is well known, and focuses on the *innocence* of mereology. The general idea builds upon the thesis known as *Composition as Identity*. It goes roughly as follows. Composition is very much like identity in many respects. The monstrous mereological fusions we talked about earlier do not involve any further ontological commitments than those you were already willing to make all along. You already accepted wings, stems and molecules of water. The commitment to their fusion is not a *further* commitment, for that fusion is in some relevant sense,[2] *identical* to those things considered collectively. Now, this is ontological innocence at its best. *A monstrous universe is an innocent universe*.

There are several passages in Lewis (1991) in which he spells out in more details what he means by this thesis. Here are some of the most vivid:

> [A fusion] is nothing over and above its parts, so to describe it you need only to describe its parts (Lewis 1991, p. 80);

> Given a prior commitment to cats, say, a commitment to cat-fusions is not a *further* commitment. The fusion is nothing over and above the cats that compose it. It just *is* them. They just *are* it. Take them together or take them separately, the cats are the same portion of Realty either way. Commit yourself to their existence altogether or one at a time, it's just the same commitment either way (Lewis 1991, p. 81, italics in the original);

> 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 (Lewis 1991, pp. 82–83).

This "innocence defense" of *Unrestricted Composition* -and classical mereology in general- has been widely criticized. This paper does not focus on this line of defense. It focuses on another line of argument, one that stems from a brief but uttermost important remark in Inwagen (1994). He writes (imagining to speak on behalf of a mereologicl nihilist, who does not believe in the existence of any composite object whatsoever):

> Tell me that if I accept Mereology I'll end up with a more satisfactory metaphysics, and I'll listen [...] But don't tell me that Mereology is innocent. If you tell me that, you're not better than the salesman who tells me that a new Acme furnace is free because the money it saves me will eventually equal its cost. "Innocent" is like "free" and "free" does not mean the same as "well worth it" (Inwagen 1994, p. 208).

[2] There is in the literature a stronger version of this thesis, known as *Composition is Identity*. This thesis maintains that a composite object is, strict and literally, just its parts. For a recent overview see Baxter and Cotnoir (2014).

These words contain a challenge. Here it is: leave the path of innocence and choose another path, a different path, a path that leads to a better metaphysics, a metaphysics that is well worth doing. In the rest of the paper I intend to pick up this challenge. I will argue that the endorsement of *Unrestricted Composition* leads to an impressively coherent, powerful, simple and elegant metaphysical picture. This picture includes extensionality (Sect. 3), functionality (Sect. 4) and four-dimensionalism (Sect. 5). These theses have been endorsed on independent grounds by Lewis himself. Thus the argument in this paper also shows how impressively coherent, powerful, simple and elegant his metaphysics is. Before entering the path let us stop to pick up some things for the road (Sect. 2).

2 Mereology

This section contains a brief overview of classical mereology and spells out more precisely the *Unrestricted Composition* principle, which will be the main focus of the paper. It is not meant to be exhaustive.[3] I will use parthood as primitive, which I shall write as $x \prec y$ for x is part of y. Define proper parthood, overlap and fusion via:

(1) *Proper Parthood* $x \prec\prec y =_{df} x \prec y \wedge x \neq y$

(A proper part of something is part of that thing which is distinct from it)[4]

(2) *Overlap* $O(x, y) =_{df} \exists z(z \prec x \wedge z \prec y)$

(Two things overlap iff they share a part)

(3) *Fusion* $F(z, \varphi(x)) =_{df} (\varphi(x) \rightarrow x \prec z) \wedge \forall y(y \prec z \rightarrow \exists x(\varphi(x) \wedge O(x, y))$

(z is the fusion of the φ-ers, i.e. those entities that satisfy the open formula $\varphi(x)$, iff each φ-er is part of z and each part of z overlaps some φ-er).[5]

Classical mereology is the formal theory of parthood relations comprising the universal closure of the following axioms:

(4) *Reflexivity* $x \prec x$

(Everything is part of itself)

(5) *Anti-symmetry* $x \prec y \wedge y \prec x \rightarrow x = y$

(Two distinct things cannot be parts of each other)

(6) *Transitivity* $x \prec y \wedge y \prec z \rightarrow x \prec z$

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[3] Interested readers can start from Simons (1987), Hovda (2009) or Varzi (2014). Lewis' most explicit formulation is in Lewis (1991).

[4] Lewis himself writes: "*proper parts*—parts not identical to the whole" (Lewis 1991, p. 2, italics in the original).

[5] I will return, albeit briefly, to this definition of fusion in Sect. 3 as well. Let me just note here that this is a notion of fusion that Lewis himself sometimes adopt: "The fusion of all cats is that large, scattered chunk of cat-stuff which is composed of all cats there are and nothing else. It has all cats as parts. There are other things that have all cats as parts. But the cat-fusion is the least such thing" (1991, p. 1). Note that, strictly speaking, (3) is a schema.

(A part of a part of something is a part of that thing)

(7) *Weak Supplementation* $x \prec\prec y \rightarrow \exists z(z \prec y \wedge \sim O(x, z))$

(If something is a proper part of another thing then there is a part of the latter that does not share any parts with the former)

(8) *Strong Supplementation* $\sim y \prec x \rightarrow \exists z(z \prec y \wedge \sim O(x, z))$

(If something fails to include something else as a part there is a part of the former that does not share any parts with the latter)

(9) *Unrestricted Composition* $\exists x(\varphi(x)) \rightarrow \exists z(F(z, \varphi(x))$

(Any non-empty set -or collection, or plurality- of things has a fusion[6])

This list is actually highly redundant but we will return to this later on. Classical mereology is extensional insofar as the following theorem[7] can be proven:

(10) *Extensionality* $\exists z(z \prec\prec x \vee z \prec\prec y) \rightarrow (x = y \leftrightarrow \forall z(z \prec\prec x \leftrightarrow z \prec\prec y))$

(Having the same proper parts is both necessary and sufficient for identity).

Extensionality dictates that mereological fusions are unique. It is a theorem of any mereological theory that includes (8) among its axioms.

As we already saw *Unrestricted Composition* is the most controversial of the axioms of classical mereology. It yields a quite plentiful and monstrous ontology. Or so its detractors fear. In the following I intend to show that a *monstrous universe might not be an innocent universe, but it is an elegant universe*.

3 Extensionality

Extensionality provides a powerful criterion of identity for composite objects. It is thus noteworthy that *Unrestricted Composition* favors—if not entails—it.[8] It is indeed a sign of its explanatory power when it comes to fundamental metaphysical questions of composition and identity. An argument in favor of the claim that *Unrestricted Composition entails*[9] *Extensionality* have been put forward in Varzi (2009). Varzi

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[6] As in the case of (3), this is a schema as well.

[7] A referee for this journal rightly notes that the left-to-right direction of the biconditional requires Leibniz's indiscernibility of identicals (LII) to be proven. Suppose now I endorse multilocation—which will be discussed thoroughly in Sect. 4, and I claim that one and the same object can have different properties at different locations. This would seem to undermine LII. I do not think friends of multilocation *have* to abandon LII. They could retain LII and then relativize property-instantiation to particular regions, for example the object's exact locations. I will not take side here, for it is not crucial for the purpose of the paper. I will rest content in laying down two different options. The first option consists of the following: (i) endorse LII, (ii) relativize property-instantiation to regions and (iii) phrase the extensionality theorem with (10)—as is done in Varzi (2014) for example. The second option consists of the following instead: (i) abandon LII and (ii) phrase the extensionality theorem using only the right-to-left direction of the biconditional in (10)—as is done in Varzi (2008) for example. That direction is the most interesting one in any case and it is this direction we will be interested on in what follows. Thanks to anonymous referee for this journal here.

[8] I will return to this later on in this section.

[9] As we will see, "*entails*" might be too strong a word. I will rest content to suggest that it (strongly) *favors Extensionality*.

is explicit in admitting that the arguments succeed as long as parthood is taken to obey *Transitivity* and *Weak Supplementation*. This section is mostly a defense of those arguments against an objection due to Rea (2010) and a discussion of yet another non-extensional universalist alternative, the so called mutual parthood approach. Rea is willing to concede both *Transitivity* and *Weak Supplementation*. I will simply assume them as well. We will see that there is yet another implicit assumption, namely *Anti-Symmetry*. This assumption has been recently questioned. Thus, the last part of this section will be devoted to a discussion in which *Anti-Symmetry* plays a crucial role.[10]

Varzi's argument is the following. Consider two distinct objects x and y. If one is part of the other it follows that they have different proper parts[11] and so their distinctness is reflected in their mereological structure—since proper parthood is irreflexive. If neither is part of the other *Unrestricted Composition* will yield that there is a fusion of x and y, say z, of which x is a proper part. By *Weak supplementation* there is a (proper) part—call it z_1—of z, which is disjoint from x and overlaps y.[12] Hence there exists a z_2 which is part of z_1 and y. There are two cases: either (i) $z_2 \prec\prec y$ or (ii) $z_2 = y$. In the first case the distinctness of x and y will be reflected in their mereological structure, for they would have different proper parts (for z_2 is disjoint from x). In the second case let z_3 be a proper part of y. Then by *Transitivity* z_3 is also a part of z_1 (for $z_3 \prec y(=z_2)$ and $z_2 \prec z_1$). But z_1 is disjoint from x. So z_3 cannot be a proper part of x, which is to say that x and y have different proper parts.

Here is how Varzi himself concludes[13]: "This shows that the non-identity of x and y is reflected in their different mereological composition. Extensionality now follows by generalization" (Varzi 2009, p. 600).[14]

Rea (2010) notes that: "Varzi's arguments […] rely on a tendentious assumption about parthood […]. The assumption is tendentious because is presupposed by standard extensional mereologies, known to be hostile to non-extensional mereologies […] A successful argument […] along the lines that Varzi has given would have to show that the universalist is committed to SD1* [the tendentious assumption in question], which he would be if, for example, it could be shown to follow from axioms or definitions that are partly constitutive of the meaning of the English word "part". But Varzi has done nothing like this" (Rea 2010, p. 491).

In the following I do exactly what Rea complains Varzi has not done, thus rescuing his arguments. The tendentious assumption Rea speaks of—the SD1* assumption—is that a part of something is either a proper part of that thing or identical to it:

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[10] Varzi considers yet another argument, which is due to Simons (1987, pp. 30–31). The *Unrestricted Composition Principle* entails that that two overlapping entities have a merelogical product, i.e. something which is composed by all and only those things that are part of both: $O(x, y) \rightarrow \exists z \forall w(w \prec z \leftrightarrow w \prec x \wedge w \prec y)$. This in turn entails the *Strong Supplementation*, and therefore, *Extensionality*.

[11] This argument assumes the definition of proper parthood given in (1). As we shall see in a moment this is strictly related to *Anti-Symmetry*.

[12] This follows by the definition of fusion. The fusion of x and y overlaps all and only those things that overlap either x or y. Thus if z_1 is disjoint from x it has to overlap y.

[13] Adapted to the present context.

[14] A referee for this journal correctly notes that this establishes only the right-to-left direction of (10). The left-to-right direction is a simple application of LII. See footnote 7 for a somewhat long discussion of different options regarding the extensionality theorem and LII.

(11) $x \prec y \leftrightarrow x \prec\prec y \vee x = y$

The right-to-left direction is almost trivial to prove. There are two cases, either (i) $x \prec\prec y$ or (ii) $x = y$. In the first case $x \prec y$ follows by definition of proper parthood, in the second by *Reflexivity* of parthood. Let's then move to the left-to-right direction. Assume it doesn't hold. Hence we would have $x \prec y$, whereas both (i) $x \prec\prec y$ and (ii) $x = y$ would be false. But they cannot be both false. Suppose (ii) is false, i.e. suppose $x \neq y$. Together with $x \prec y$ this will yield that $x \prec\prec y$, that is, (i) is true. On the other hand suppose (i) is false. By definition of proper parthood either (iii) $\sim x \prec y$ or (iv) $x = y$. Since (iii) is ruled out by our assumptions we are left with $x = y$, that is, (ii) is true. Hence both (i) $x \prec\prec y$ and (ii) $x = y$ cannot be false and (11) is established.

What are the assumptions that have gone into my argument? They are basically two: I have used *Reflexivity* and the definition of proper parthood.[15] *Reflexivity* is redundant for it can be derived from *Unrestricted Composition*. Consider a single φ-er, say x. *Unrestricted Composition* will yield that there is a fusion z of that φ-er. Now, if x is a single φ-er it follows that $z = x$. Since $x \prec z$ by definition of fusion we can simply substitute to get $x \prec x$. *Reflexivity* follows by generalization.

This leaves the definition of proper parthood. Forget for a minute that the definition I provided is widely recognized as standard.[16] Cotnoir (2010) suggests an alternative one:

(12) *Proper Parthood** $x \prec\prec^* y =_{df} x \prec y \wedge \sim y \prec x$

Could Rea appeal to this definition? Not by itself. This is because, given *Anti-Symmetry*, the two definitions are equivalent:

(13) $x \prec\prec y \leftrightarrow x \prec\prec^* y$

I will argue for the left-to-right direction. An entirely similar argument establishes the right-to-left. Given the two definitions all we need to prove is that we cannot have both $x \neq y$ and $y \prec x$, which is fairly easy to show. Assume $x \neq y$. If we had $y \prec x$ it would follow by *Anti-symmetry* that $x = y$, since we already have $x \prec y$. Hence we would get a contradiction.

Anti-symmetry is not easily dismissed. Given the definition of proper parthood in (1), it just follows from *Transitivity* and *Weak Supplementation*. Suppose it does not. We would have all of the following: (i) $x \prec y$, (ii) $y \prec x$ and (iii) $x \neq y$. By (i), (iii) and definition of proper parthood we get (iv) $x \prec\prec y$ and from *Weak Supplementation* (v) $\exists z(z \prec\prec y \wedge \sim O(x, z))$. By (ii), the first conjunct of (v) and *Transitivity* we get (vi) $z \prec x$ and therefore (vii) $O(x, z)$, against the second conjunct of (v).

And so, the only way to resist Varzi's arguments is to endorse proper parthood* and drop *Anti-Symmetry*. Now, Rea has not suggested anything like this but Cotnoir (2014) does so explicitly. He labels his approach *mutual parthood approach* and argues convincingly that it is the only viable alternative for non-extensional universalists. In light of the foregoing Cotnoir seems to be right. Several strategies are available for

[15] Which is in turn related to *Anti-Symmetry* as we will see in a moment.

[16] And, as we saw, endorsed by Lewis himself.

defenders of extensionality at this point. The first one is to argue in favor of the claim that proper parthood rather than proper parthood* captures our "real" pre-theoretical mereological notion. I am skeptical such an argument can be given, as Cotnoir himself recognizes.[17] Another option would be to argue in favor of *Anti-Symmetry*. It is worth noting that even foes of extensionality, such as Gilmore (Forthcoming),write that even if *Anti-Symmetry* is not nearly "as obvious as *Reflexivity* and *Transitivity*", it is "fairly plausible" (Gilmore, Forthcoming, p. 4). Finally an argument against the mutual parthood approach can be given. If that is indeed the only viable universalist alternative that does not entail extensionality, an argument against such a view would be tantamount to an argument in favor of the claim defended in this section, namely that universalism favors extensionalism. It is to such argument(s) that I now turn to.

The gist of the mutual parthood approach is that it admits cases in which two distinct things are mutual parts of each other and yet they have the same proper parts, thus providing a counterexample to extensionality. The most famous case in the literature is arguably that of statue s and the lump l it is made (or composed[18]) of. They are allegedly distinct for they have different persisting conditions (e.g. can survive the loss of a single part) or different modal properties (e.g. can survive squishing). Now, if this argument is found compelling it should warrant similar arguments. Consider $s - 1$, a statue minus a single atom and $l - 1$, a lump minus the very same atom. By the same argument they should be mutual parts. So should $s - 2$ and $l - 2$. And so should $s - 3$ and $l - 3$ and so on. Either we are given a clear cut case in which $s - n$ and $l - n$ are not distinct mutual parts or we are pressured to go "all the way down".[19] And any n seems arbitrary. Let us then consider just two cases. In the first one we have two mereological atoms and in the second one we have a single atom.[20]

Consider the first one first. *Unrestricted Composition* entails there is a fusion of the two atoms in question. The mutual parthood approach actually should countenance two such fusions, the lump or quantity of matter composing the two atoms, and the thing that is composed by that quantity of matter. If there are no such two fusions the mutual parthood theorist owes us an account why in certain cases where composition occurs we have two things and in certain cases when composition occurs we do not have them. But note that at this level of mereological complexity every anti-extensionalist considerations, such as the ones I mentioned before, lose its force and grip. How can the "composite thing" lose any of its two parts?[21]

Maybe there is some sort of reply here that can be given on behalf of the mutual part theorist. Consider a case of two extended simples. They could compose a statue. Maybe that statue could not survive squishing whereas the matter composing the statue can.

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[17] See Cotnoir (2014, p. 8). He claims that the difference is "merely terminological".

[18] I will be somewhat sloppy and use them interchangeably, thus ignoring the more technical sense of "composition", as defined, for example in Inwagen (1990).

[19] See for example Fine (2003).

[20] I consider two "atomistic" cases for the sake of simplicity. I believe the arguments can be given even if there are only gunky objects. Even if electrons turn out to be gunky the same considerations would still apply. Furthermore I doubt that any mutual parthood theorist would want her approach to rule out atomism.

[21] A referee of this journal suggested that in such cases we simply do not have any adequate intuitions about the persistence conditions of fusions.

It is suspicious at best to rest the case for mutual parthood on such exotic examples. In any event, this line of reply is not available in all such cases, say, e.g. in the case of two electrons.

Wouldn't then the anti-extensionalist be far better off to claim that composition does not occur? We would still need an account of when composition does occur but the mutual parthood theorist should not be blamed for it. It is well-known that the Special Composition[22] question is not easy to answer.

Let us then pass to the case of a single mereological atom.[23] The mutual parthood theorist is pressured to say that there are two distinct entities even in this case, the quantity of matter that composes the mereological atom and the mereological atom itself, and that they are mutual parts,[24] if she accepts something like the $s - n$, $l - n$ argument above. But the anti-extensionalist is on very thin ice in this case. What is the quantity of matter—distinct from the atom—she is talking about? Should we understand it along the way of a particular *stuff ontology*? Is she positing an hybrid ontology of stuff on the one hand and things on the other? Is any mutual parthood theorist willing to go this way or this far?

Never mind that. Consider a single electron, or a single lepton for that matters.[25] There seems to be no convincing anti-extensionalist consideration that can be brought to bear at this level. No argument mentioning the possibility of losing a part, no argument mentioning the possibility of surviving deformations seem to have any bite. I would go as far as claiming that this a reason to accept *Anti-Symmetry* after all. There are no two mutual parts here, there is a single thing. If this is the case then the arguments in this section are vindicated. Yet I am willing to concede that more needs to be said. That is to say that I myself recognize these arguments are not knock down arguments against the mutual parthood theorist. But they raise serious problems and challenges. UC and *Extensionality* seem to come together in any viable *metaphysical* picture. Given UC, we better take *Extensionality* on board. And with this we can move to the next section.

4 Functionality

Can material objects be exactly located at more than one spacetime region? *Functionality* theories of location[26] claim they cannot[27] whereas *Multilocation* theories of location claim they can. In what follows I will argue that *Extensionality*, and thus *Unrestricted Composition*, given the results of §3, favors *Functionality*.[28] Let us enrich our

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[22] The question—posed in Inwagen (1990)—about the necessary and sufficient conditions that have to be met for any-non empty plurality to have a mereological fusion.

[23] I take atom to be an entity without proper parts.

[24] She could maybe argue that mutual parthood enters the picture only when we deal with mereologically complex entities. But we need an argument for this last claim, and there are none in the literature, as far as I know. Furthermore my previous argument would still apply.

[25] Cotnoir (2014), the forerunner of the mutual parthood approach, uses examples from physics himself.

[26] See for example Casati and Varzi (1999) a n d Parsons (2007).

[27] In what follows I will downplay this modal element.

[28] For another argument see Calosi (2014).

vocabulary with another two-place predicate, exact location. I shall write $ExL(x, R)$ for a *material object* x is exactly located at *spacetime region* R, and I will understand this relation in such a way that if an object x is exactly located at region R it has the same shape, size, volume as that region. In other words the object and the region share all of their relevant geometrical properties.[29] Using the mereological notions of Sect. 2 we can define *Weak location* via[30]:

(14) *Weak Location* $WL(x, R) =_{df} \exists R_1(Ex\ L(x, R_1) \wedge O(R, R_1))$

(An object is weakly located at each region which is not completly free of it)

I will assume without any further argument[31] that the exact location relation obeys the following axioms:

(15) *Exactness* $WL(x, R_1) \rightarrow \exists\, R_2(Ex\ L(x, R_2))$

(If something is located somewhere it has an exact location)

(16) *Expansivity* $x \prec y \wedge Ex\ L(x, R) \rightarrow \exists\, R_1(Ex\ L(y, R_1) \wedge R \prec R_1))$

(A composite object is located where its parts are)

Now, the major focus of this section is the principle of *Functionality*:

(17) *Functionality* $Ex\,L(x, R_1) \wedge Ex\ L(x, R_2) \rightarrow R_1 = R_2$

(Every object has a unique location)

Functionality entails that there is no multilocation. The argument from *Unrestricted Composition* to *Functionality* is: (i) *Unrestricted Composition* favors *Extensionality*—via the argument in §3—; (ii) *Extensionality* favors *Functionality*[32]; (iii) Hence *Unrestricted Composition* provides an argument against multilocation.[33]

Consider two distinct objects x and y such that x is multilocated at distinct and disjoint regions R_1, R_2, whereas y is exactly singly located at yet another region R_3.[34] *Unrestricted Composition* entails there is something that is the fusion of the things exactly located at R_1 and R_3. One of the exact locations of such a thing, call it z_1, i s presumably $R_1 \cup R_3$.[35] On the other hand *Unrestricted Composition* entails also that

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[29] I'm in good company. Here's a list of some other philosophers who understand the relation in the same way: Casati and Varzi (1999), Hudson (2001), Gilmore (2006), Sattig (2006), Hawthorne (2008), and Donnelly (2010).

[30] For an authoritative and extensive overview of the relation between mereology and location see Gilmore (2013).

[31] Gilmore (2013) rightly notes that *Exactness* follows by definition (16). Hence, it should not be considered an *assumption* after all.

[32] For a different, yet similar, argument see Calosi (2014).

[33] I shall give another argument for this very conclusion at the end of Sect. 5.

[34] I will also assume throughout the argument that nothing else besides x and y is exactly located at the relevant regions.

[35] I'm using the set-theoretic notion of union for spacetime regions for the sake of familiarity. This does not mean that a further primitive set-theoretical notion is needed, for the argument could be cast using the notion of mereological fusion instead. See Uzquiano (2011, p. 201).

there is something that is the fusion of the things exactly located at R_1, R_2 and R_3. One of the exact locations of such a thing, call it z_2, is presumably $R_1 \cup R_2 \cup R_3$.[36]

Now, let us consider all the mereological relations between z_2 and z_1. Suppose first that z_2 is not part of z_1. Then *Strong Supplementation* entails that there is a part of z_2 which is disjoint from z_1. But this is not the case, insofar as each part of z_2, namely x, y and their (proper) parts, overlap at least a part of z_1, namely x and y.

Suppose then that z_2 is part of z_1. Then, given the definition of proper parthood in (1) and the argument in favor of (12), it is either (i) a proper part of it, or (ii) identical to it. If it is a proper part of it *Weak Supplementation* entails there is a part of z_1 that is disjoint from z_2. But the very same argument above shows this is not the case. It remains to show that z_1 and z_2 are not identical. Several considerations in favor of this last claim can and should be brought to bear. Here is one such consideration. $R_1 \cup R_3$ and $R_1 \cup R_2 \cup R_3$ have different geometrical properties. Given the intuitive gloss we gave for exact location, namely that if an object is exactly located at a region it shares the very same geometrical properties of that region, how can one and the same object which has not undergone any change be exactly located at regions with different geometrical properties? Perhaps, relativization of properties to regions, along the lines suggested in footnote 7, could help. Whatever the merits of these considerations they all go beyond mereological considerations. I myself do not find this particularly problematic, but it would be better to have considerations regarding the mereological structure of objects to drive the point home, given that extensionality provides a *mereological* criterion of identity.[37] A strong mereological argument can be given, if one is willing to widen the scope of mereological considerations from the sole mereological structure of objects to its relation to the mereological structure of their exact locations. Barker and Dowe (2003) famously argue that multilocation is paradoxical. Different responses to their arguments have been given in the literature but most of them depend crucially upon substantive and controversial metaphysical theses. McDaniel (2003) for examples contends that there are two kinds of shape properties and goes on to argue that this undermines Barker and Dowe's original claim. Recently Calosi and Costa (2014) have proposed another argument that does away with such controversial considerations. They claim that friends of multilocation can resist Barker and Dowe's argument if only they are willing to accept a location principle to the point that things located at *proper subregions* of the exact location of a certain thing are *proper parts* of that very thing. They label it *Region Dissection Principle*:

(18) *Region Dissection Principle* $(ExL(x, R_1) \wedge \exists y(ExL(y, R_2) \wedge R_2 \prec\prec R_1) \rightarrow y \prec\prec x$

[36] A referee for this journal suggested the following: the fusion of x and y is exactly located at $R_1 \cup R_2 \cup R_3$ and there is nothing exactly located at $R_1 \cup R_3$. This is a nice suggestion, yet it does not provide a (complete) solution to the problems discussed in the argument in the main text. For it entails that there is no material object, nor any part of any material object that has the same size, area, volume of $R_1 \cup R_3$. But in fact we want to say that there is. Consider the case in which x is singly located at R_1 and y singly located at R_3. In this case we would readily admit that their fusion is located at $R_1 \cup R_3$. Hence this fusion has the same size, are, volume of that region. In the multilocation case just focus on x at one of its exact locations, namely R_1 and the case is entirely analogous.

[37] Thanks to an anonymous referee here.

Despite the fact that the*Region Dissection Principle* prohibits some instances of multilocation that have been explored in the literature, most notably in Kleinschmidt (2011), it immediately rescues multilocation from threats of paradoxes. This seems a fair price.[38] But that principle also provides the strong mereological argument we were after. Here it is.

$R_1 \cup R_3$ is a proper subregion of $R_1 \cup R_2 \cup R_3$. Hence *Region Dissection* entails that the thing that is exactly located at $R_1 \cup R_3$ is a *proper part* of the thing that is exactly located at $R_1 \cup R_2 \cup R_3$. As we know from §3 in any extensional mereology proper parthood and proper parthood* are equivalent.[39] It then follows, whatever definition of proper parthood is endorsed, that the things exactly located at $R_1 \cup R_3$ and $R_1 \cup R_2 \cup R_3$ respectively are *distinct*. This is exactly what we were looking for. Now, the relations that have been considered exhaust the possible mereological relations between z_1 and z_2.[40] They show that the hypothesis of multilocation is in serious tension, if not altogether inconsistent, with *Extensionality*. Since *Unrestricted Composition* favors *Extensionality* it also provides an argument against multilocation, as promised.

Let me sup up briefly the overall dialectic of the argument. *Unrestricted Composition* entails there is something which is the fusion of what is exactly located at $R_1 \cup R_2 \cup R_3$, and something which is the fusion of what is exactly located at $R_1 \cup R_3$. Purely (extensional) mereological considerations suggest it is the very same thing. On the other hand considerations regarding (multi)location, in particular considerations regarding the relation between the mereological structure of objects and the mereological structure of their exact locations, suggest they are distinct things. Hence mereological extensionalism favors *Functionality*, i.e. the denial of multilocation. If so, insofar as *Unrestricted Composition* favors *Extensionality*, it also favors *Functionality* as well.

5 Persistence

A prominent example of a metaphysical theory that entails multilocation comes from the metaphysics of persistence.[41] There are two main alternatives here, three and four- dimensionalism. Recently Gilmore (2006, pp. 204–205) has suggested a very elegant formulation of those theses in locational terms. Let us enrich our language with yet another primitive notion, namely that of absolute precedence, which I shall write as $x \subset\subset y$, f o r x absolutely precedes y. Define:

(19) *Achronality* $Achr(R) =_{df} \forall p_1 \in R \forall p_2 \in R \sim (p_1 \subset\subset p_2) \wedge \sim (p_2 \subset\subset p_1)$

[38] Not to mention that independent arguments in favor of the *Region Dissection Principle* can be given. See for example Calosi (2014).

[39] Given Anti-Symmetry.

[40] We just need to change the roles of z_1 and z_2 in the arguments.

[41] The arguments in this section presuppose some sort of eternalism, i.e. the view that all the tenses are ontologically on a par. It is beyond the scope of this paper to argue in favor of this claim. Lewis gives an (admittedly weak) argument in favor of this claim in Lewis (1986, p. 204).

(A region is a acrhonal, i.e. temporally unextended, iff given any two points of that region, neither of them absolutely precedes the other)

(20) *Path* $Path(x) =_{df} \cup_{R_i} \quad ExL(x, R_i)$

(The path of an object is the union of its exact locations).

Lewis (1986, p. 202) writes that a persisting object is an object that exists at two different instants, no matter how it does so. This can be elegantly captured via:

(21) *Persisting* $Pers(x) =_{df} \sim Achr(Path(x))$

(A persisting object is one whose path is not achronal)

Gilmore goes on to define three-dimensional objects as objects that are exactly located at temporally unextended regions, whereas four-dimensional objects are exactly singly located at temporal extended ones, namely their Path:

(22) *3D-object* $3D(x) =_{df} Pers(x) \wedge \forall R(Ex\ L(x, R) \rightarrow Achr(R))$

(23) *4D-object* $4D(x) =_{df} Pers(x) \wedge ExL(x, Path(x)) \wedge \forall R(ExL(x, R) \rightarrow R = Path(x))$

Three and four-dimensionalism are the universal claims according to which all persisting objects are 3D or 4D-objects respectively. Two different arguments from *Unrestricted Composition* to four-dimensionalism thus defined can be put forward.

The first is an indirect one and goes as follows: (i) *Unrestricted Composition* suggests that there is no multilocation—via the argument in Sect. 4; (ii) If three-dimensionalism is true, then there is multilocation; (iii) Hence *Unresticted Composition* is at odds with three-dimensionalism; (iv) *Unrestricted Composition* is not at odds with four-dimensionalism; (v) Hence *Unrestricted Composition* favors four-dimensionalism.

We just need to give an argument for premises (ii) and (iv). Here's the argument for premise (ii). Suppose that a 3D-object is not multilocated. Then it is exactly located at a single region.[42] This region is achronal by definition of a 3D-object. Moroever, since it is the only exact location of the object, we would have that it is identical to the object's path. Hence its path would be achronal too, and the object in question would not be a persisting object, against our initial assumption.[43] The argument for

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[42] It follows from *Exactness* that it has at least one exact location. Note that the argument assumes that material objects are at least weakly located somewhere.

[43] A referee for this journal has noted that this argument relies on a (not so implicit) assumption, namely that the relation between a material object and (space)time is that of *location*. This is correct. Now, if this is relatively uncontroversial in the case of space–modulo, for example, supersubstantivalism—it is controversial in the case of time. Giordani and Costa (2013) discuss a very interesting alternative option. They call it "*temporal trascendentism*". According to temporal trascendentism "events are *properly located* [...] at times whereas objects are *derivatively present* at times by being participants of events" (Giordani and Costa, 2014: 213, italics mine). In other words, objects *are not located* in time, events are. Objects strictly speaking *transcend* the temporal dimension. Addressing payoffs and limits of trascendentist persistence goes beyond the scope of this paper. I will simply note that, on the one hand, it seems to offer a way to resist the argument in the main text. On the other hand it should be considered what is the relation of material objects to *spacetime*, rather than time *simpliciter*. If this relation is indeed location that argument still applies. Thanks to an anonymous referee for this journal for having drawn my attention to this point.

premise (iv) is even more straightforward, for uniqueness of exact location, in line with *Functionality*, is built into the definition of a 4D object.[44]

The second argument is more direct. Consider two distinct non persisting objects x and y exactly located at two distinct regions R_1 and R_2 respectively, such that there is at least a point $p_1 \in R_1$ and a point $p_2 \in R_2$ for which $p_1 \subset\subset p_2$ holds. *Unrestricted Composition* entails that there is a fusion of x and y, call it z. B y *Exactness* z has an exact location, and by *Functionality*, this location is unique. Call such a location R. Since both x and y are part of z it follows by *Expansivity* that both R_1 and R_2 have to be part of R.[45] This means that $R_1 \cup R_2 \prec R$, which already rules out the possibility of z being a 3D-object since, whatever region R may be, is not achronal.

A strong case can nonetheless be mounted for the following claim: $R = R_1 \cup R_2 = Path(z)$. If so z would indeed qualify as a 4D-object. I already argued that $R_1 \cup R_2 \prec R$. Once again, by the argument in favor of (12), this leaves us with two cases: either (i) $R_1 \cup R_2 \prec\prec R$ or (ii) $R_1 = R_2$. Consider the first case. By *Weak Supplementation* there will be a region R_3 which is part of R but disjoint from $R_1 \cup R_2$. And yet no part of z would be even weakly located at R_3, for every weak location of every part of z overlaps either R_1 or R_2. S o R_3 is completely free of z and thus should not be part of its exact location. This leaves us with $R = R_1 \cup R_2$.[46] Given *Functionality* this is the unique exact location of z, so that we also have $R = Path(z)$. This delivers everything we wanted. R is not achronal, so that $Path(x)$ is not achronal, thus guaranteeing that z is a persisting object. And we just saw that is uniquely exactly located at its path. So z qualifies as a 4D-object. It may be objected that this falls short of establishing that *all* persisting objects are 4D objects. This is true. But it shows that, given *Unrestricted Composition*, there are plenty of 4D objects out there. Not only. If the argument falls short of proving that *all* persisting objects are 4D it nonetheless proves *that there are persisting objects which are not 3D objects*. Hence, as long as three-dimensonalism is phrased as a universal claim, as it is usually done, three- dimensionalism is inconsistent with *Unrestricted Composition*.[47] All in all, I contend

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44 It could be argued that what the definition forbids is that a 4D object is exactly located at its path and one of its proper subregions, but it allows a 4D object to have more than one path. Suppose $Path_1$ and $Path_2$ are two such distinct regions. Can a 4D object be exactly located at both $Path_1$ *and* $Path_2$? Suppose it is the case. Since the path of an object is defined as the union of its exact locations $Path(x)$ would be in this case $Path(x) = Path_1 \cup Path_2$. Now, as I mentioned already, the definition of a 4D object does not allow for it to be exactly located at its path and one of its proper subregions. But both $Path_1$ and $Path_1$ are proper subregions of $Path(x) = Path_1 \cup Path_2$. Hence the 4D object is exactly located neither at $Path_1$ nor $Path_1$, against our assumption. This *reductio* argument shows that uniqueness of location is indeed inbuilt into the definition of a 4D object. Thanks to an anonymous referee here.

45 A referee for this journal rightly notes that *Functionality* here is redundant. The argument would go through even without R being the only one of z's exact locations.

46 Which is actually what we expected all along. This is because with *Functionality* at hands we could (should?) require exact location to obey the following *Additivity* axiom:

$ExL(x, R_1) \wedge ExL(y, R_2) \rightarrow ExL(S(z, \varphi(w)), R_1 \cup R_2)$, where

$\varphi(w) = w = x \vee w = y$. This formulation assumes *Unrestricted Composition* in that it assumes that there always exists a fusion of x and y. T h e *Additivity* axiom is problematic in the context of multilocation. See Sattig (2006)and Calosi and Costa (2014).

47 A referee for this journal suggested the following. Many three-dimensionalists see themselves –at least when they do not talk about multi-location- to advocate a more commonsensical view of the world. And

that we can safely conclude that *Unrestricted Composition* favors a metaphysics of persistence over another.[48]

Before moving on to the concluding section let me add just one more argument. Given the results of this section there is an independent argument from *Unrestricted Composition* to *Functionality*. It is a simple one indeed: (i) *Unrestricted Composition* favors *Four-dimensionalism*; (ii) *Four-dimensionalism* favors *Functionality*; (iii) Hence *Unrestricted Composition* favors *Functionality*.

We have gone a long way. Let me conclude then.

6 Conclusion: metaphysics and beauty

Unrestricted Composition delivers a plentiful and monstrous ontology. Is this lushness innocent, as Lewis believed? I decided not to answer that question. I decided to take the path less traveled and I attempted to do something else instead. I tried to answer a challenge, originally voiced by van Inwagen against Lewis. That challenge was to show that the endorsement of *Unrestricted Composition* leads to a better metaphysics.

I thus argued that *Unrestricted Composition* favors (i) extensionality of composition, (ii) functionality of location and (iii) four-dimensionalism as a metaphysics of persistence. If the arguments I presented are on the right track, they speak volume of its ability to deliver an organic, general, simple and powerful metaphysical picture. For its explanatory power can be used to solve various metaphysical problems. The following is an impressive—and yet not exhaustive—list. It can be used to solve the problem of material constitution, to deliver an answer to the Special Composition question, to pro- vide an identity criterion for composite objects, to shed new light on difficult problems about extension in time and identity through change. Are these simplicity, generality, overall cohesiveness and explanatory power unparalleled and unmatched? There are probably some other contenders. Mereological nihilism or mereological essentialism may come to mind. They all seem radical theses but so does *Unrestricted Composition*. Yet mereological nihilism does not seem to be able by itself to answer questions of functionality of location and persistence. Nor does mereological essentialism, which seems compatible for example with both metaphysics of persistence.

Now, it is well known that theoretical virtues such as simplicity, coherence and unifying power play a fundamental role in theory choice. They surely do within the

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Footnote 47 continued
on this view there is plenty of four-dimensional *entities* that extend through time. I agree. But it seems that these temporally extended entities are *not material objects* but *rather events*, on the commonsensical picture the three-dimensionalist is advocating. So the argument in the main text—if correct—still stands, for it establishes that *Unrestricted Composition* entails the existence of a four-dimensional *material object*. Thanks to an anonymous referee here.

[48] Which is good news, for there are other influential arguments from *Unrestricted Composition* to four-dimensionalism, the most celebrated of which is probably the argument from vagueness in Sider (2001). For a critique of this last argument see Koslicki (2003) and Simons (2006). It should be noted however that the arguments presented here and Sider's argument are entirely different. Sider's argument—if found compelling—is actually much stronger for it entails that a 4D object divides into temporal parts. Nothing of this sort is entailed by the arguments I presented. It is actually a distinct possibility to have 4D-objects according to the definition I gave that do not divide into temporal parts. This is something advocated already in Parsons (2000). Thanks to an anonymous referee for having pushed this point.

sciences. As of lately also aesthetic merits are being considered a theoretical virtue. It is also widely accepted that it *should* be so. What I am claiming boils down to this: endorsement of *Unrestricted Composition* seems—if the arguments of this paper are compelling- to fare pretty well on all these respects. All things considered this line of defense should be considered thoroughly, especially when other lines of defense, such as the innocence of mereology defense that builds on theses such as composition is identity, are, admittedly, fairly controversial.

The unifying and explanatory power of *Unrestricted Composition* is remarkable. These are significant payoffs. What about the costs then? The costs seem to be the acceptance of (allegedly) *monstrous* objects and a *multiplication* of (such) objects. It is beyond the scope of the paper to advocate that we *should* trade off explanatory power and multiplication of (monstrous) entities. But I will offer two considerations. The first one is from Williamson (2013). He writes: "Multiplying entities is sometimes a necessity for the sake of theoretical plausibility, because the alternative is massive loss of simplicity, elegance, and economy in principles" (Williamson 2013, p . 9) . T h e second one is even more pressing in the present context for it is from Lewis himself. In answering some objections to his modal realism he distinguishes between *qualita- tive* and *quantitative* parsimony and argues that modal realism is only quantitatively unparsimonious. It is better to have Lewis himself speak: "Distinguish two kinds of parsimony, however: qualitative and quantitative. A doctrine is qualitative parsimonious if it keeps down the number of fundamentally different kinds of entity: if it posits sets alone, rather than sets and unreduced numbers, or particles alone rather than particles and fields, or bodies alone or spirits alone rather than bodies and spirits. A doctrine is quantitatively parsimonious if it keeps down the number of instances of the kinds it posits; if it posits 10^{29} electrons rather than 10^{37}, or spirits only for people rather than spirits for all animals. I subscribe to the general view that qualitatively parsimony is good in a philosophical or empirical hypothesis; but I recognize no presumption whatever in favor of quantitatively parsimony" (Lewis 1973, p. 87). This line of argument applies to the doctrine of *Unrestricted Composition* as well. That doctrine is only quantitatively unparsimonious.

This much for multiplication and parsimony. What about monstrosity? Shouldn't it be recognized that the (alleged) monstrosity of some inhabitants is at least well balanced, if not outright outweighed, by the elegance and beauty of the entire universe that the *Unrestricted Composition* principle delivers? I mentioned it already. *A monstrous universe is* (ironically you might think) *an elegant universe*.

Is that it then? Should we abandon the path of innocence and take the path of beauty and (explanatory) strength instead? I'm afraid I do not have an answer. But didn't the poet once say:

> "Beauty is truth, truth beauty, -that is all
> Ye know on earth, and all ye need to know"?[49]

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[49] Keats, *Ode to a Grecian Urn*, verses 49–50.

References

Barker, S., & Dowe, P. (2003). Paradoxes of multi-location. *Analysis*, *63*(2), 106–114.

Baxter, B., & Cotnoir, A. (Eds.). (2014). *Composition as identity*. Oxford: Oxford University Press.

Calosi, C. (2014). Extensionality, mulilocation, persistence. *Dialectica*, *68*(1), 121–139.

Calosi, C., & Costa, D. (2014). Multilocation. Fusions and confusions, *Philosophia*. doi:10.1007/s11406-014-9566-2.

Casati, R., & Varzi, A. C. (1999). *Parts and places*. Cambridge, MA: MIT Press.

Cotnoir, A. (2010). Anti-symmetry and non-extensional mereology. *The Philosophical Quarterly*, *60*, 396–405.

Cotnoir, A. (2014). Does universalism entail extensionalism? *Noûs*. doi:10.1111/nous.12063.

Donnelly, M. (2010). Parthood and multi-location. *Oxford Studies in Metaphysics*, *5*, 203–243.

Elder, C. (2008). Against universal mereological composition. *Dialectica*, *62*(4), 433–454.

Fine, K. (2003). The non-identity of a material thing and its matter. *Mind*, *112*, 195–234.

Gilmore, C. (2006). Where in the relativistic world are we? *Philosophical Perspectives Metaphysics*, *20*, 199–236.

Gilmore, C. (2013). Location and mereology. At: http://plato.stanford.edu/entries/location-mereology/

Gilmore, C. (Forthcoming). Quasi-supplementation, plenitudinous coincidentalism, and gunk. *Substance: New Essays*, Philosophia Verlag.

Giordani, A., & Costa, D. (2013). From times to worlds and back again: A trascendentist theory of persistence. *Thought*, *2*, 210–220.

Hawthorne, J. (2008). Three-dimensionalism vs four-dimensionalism. In T. Sider, J. Hawthorne, & D. Zimmerman (Eds.), *Contemporary debates in metaphysics* (pp. 263–282). Oxford: Oxford University Press.

Hovda, P. (2009). What is classical mereology. *Journal of Philosophical Logic*, *38*(1), 55–82.

Hudson, H. (2001). *A materialist metaphysics of the human person*. Ithaca: Cornell University Press.

Kleinschmidt, S. (2011). Multilocation and mereology. *Philosophical Perspectives*, *25*(1), 253–276.

Koslicki, K. (2003). The crooked path from vagueness to four-dimensionalism. *Philosophical Studies*, *114*, 107–134.

Lewis, D. (1973). *Counterfactuals*. Oxford: Blackwell.

Lewis, D. (1986). *The plurality of worlds*. Oxford: Blackwell.

Lewis, D. (1991). *Parts of classes*. Oxford: Blackwell.

McDaniel, K. (2003). No paradox of multi-location. *Analysis*, *63*(4), 309–311.

Parsons, J. (2000). Must a four-dimensionalist believe in temporal parts. *The Monist*, *83*(3), 399–418.

Parsons, J. (2007). Theories of location. *Oxford Studies in Metaphysics*, *3*, 201–232.

Rea, M. (1998). In defense of mereological universalism. *Philosophy and Phenomenological Research*, *58*, 347–360.

Rea, M. (2010). Universalism and extensionalism. A reply to Varzi. *Analysis*, *70*, 490–496.

Sattig, T. (2006). *The language and reality of time*. Oxford: Clarendon Press.

Sider, T. (2001). *Four-dimensionalism: An ontology of persistence and time*. New York: Oxford University Press.

Simons, P. (1987). *Parts. A study in ontology*. Oxford: Clarendon.

Simons, P. (2006). Real wholes, real parts. Mereology without algebra. *The Journal of Philosophy*, *103*(12), 597–613.

Uzquiano, G. (2011). Mereological Harmony, In K. Bennet, & D. Zimmerman (Eds.), *Oxford studies in metaphysics* (Vol. 6, pp. 199–224).

Van Cleve, J. (2008). The moon and the sixpence: A defense of mereological universalism. In T. Sider, J. Hawthorne, & D. Zimmerman (Eds.), *Contemporary debates in metaphysics* (pp. 321–340). Oxford: Blackwell.

Van Inwagen, P. (1990). *Material beings*. Ithaca: Cornell University Press.

Van Inwagen, P. (1994). Composition as Identity. In J. E. Tomberlin (Ed.), *Philosophical perspectives* (Vol.8, pp. 207–220). Logic and language. Atascadero: Ridgeview.

Varzi, A. (2008). The Extensionality of parthood and composition. *The Philosophical Quarterly*, *58*, 108–133.

Varzi, A. (2009). Universalism entails extensionalism. *Analysis*, *69*, 599–604.

Varzi, A. (2014). Mereology, At: http://plato.stanford.edu/entries/mereology/.

Williamson, T. (2013). *Modal logic as metaphysics*. Oxford: Oxford University Press.