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Composition as Identity and the Innocence of Mereology

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Abstract
According to the thesis known as 'Composition as Identity' ('CAI'), every entity is identical to the parts it fuses. Many authors in the literature acknowledge that, in spite of its controversial character, one attractive virtue of CAI is its apparent ability to give a straightforward account of the innocence of mereology. In this paper I will present a simple argument according to which CAI entails that *no* composite entity can be said to be ontologically innocent in the relevant sense. After having shown that said argument is independent from the problems surrounding the infamous 'Collapse Principle', I will conclude that CAI-theorists should endorse a suitably 'restricted' version of CAI. In the final part of the paper I will then argue that the best restricted version of CAI is the theory according to which every composite entity is identical to the plurality of its atomic parts.

1 | INTRODUCTION

The thesis known in the literature as 'Composition as Identity' (henceforth 'CAI'), taken in its most radical form, claims that every entity is, quite literally, *identical* to the parts it fuses.[1] The idea that *one* entity may be identical to *many* entities (taken together) is very controversial even among those who accept that, in some sense, 'the many and the one are the same portion of Reality' (Lewis 1991: 87).[2]

[1]For an introduction to CAI see Wallace (2011a, 2011b) and Cotnoir (2014).

[2]For a recent defence of the idea that an entity may consistently be 'one' and 'many' see Payton (2019: 9-10) and Loss (2019: 17-19).

At the same time, many philosophers acknowledge that CAI seems to have at least one very attractive feature. In fact, the idea that a composite entity is, in some sense, 'nothing over and above' the parts it fuses (and that, for this reason, shouldn't count as an additional ontological commitment over the entities of which it is composed) is defended by several authors in the literature.[3] Plausible as this idea may sound, however, it is far from obvious how exactly a new *entity* shouldn't count as a new *ontological commitment* in its own right.[4] According to many authors, if true, CAI would provide a clear and straightforward account of the 'ontological innocence' of mereology:

> Perhaps the major motivation for CAI is that it implies the 'ontological innocence' of classical mereology. Insofar as one accepts the existence of the Eiffel Tower and [some] electron in the President's nose, since the whole made up of them is *identical* to them, one accepts the existence of the object composed of them. (Cotnoir 2014: 7)

> […] on the one hand, surely a composite whole is numerically distinct from each of the things that compose it […]. Thus, on the face of it, the ontology of someone who endorses mereological fusions appears to be richer than the ontology of someone who does not; it countenances the fusions *and* it countenances the individual things that compose them, each of which is something else. On the other hand, the thought that a fusion is numerically identical to the things that compose it *taken together*—that the 'are' of composition is really the 'is' of identity in plural form—would vindicate the intuition that such double countenancing is ultimately redundant, hence the innocence thesis. (Varzi 2014: 49)

> But why think that mereology is ontologically innocent? If composition is identity, then ontological innocence is secured. Suppose that you are committed to the existence of some objects; you are thereby committed to the existence of any object(s) they are identical to. If composition is identity, then you can now accept a theory according to which those objects compose something, without thereby expanding your ontology (Hawley 2014: 72)

> If Lewis's claim were that the fusion is *literally identical* to the cats that compose it, he would clearly be entitled to ontological innocence. After all, a thing is "nothing over and above" *itself*, and should not be entered on the inventory of Reality twice. (Bennett 2015: 256)

Contrary to common lore, in this paper I will present a simple argument showing that, surprisingly, CAI fails to account for the innocence of mereology in the sense many authors seem to assume. As I will argue, however, friends of CAI can make good on the promise of ontological innocence by embracing a suitably 'restricted' version of CAI entailing that composite entities are identical only to a certain kind of pluralities of entities they fuse.

I will proceed as follows. After some stage-setting in section 2, I will discuss in section 3 what appears to be a very natural and straightforward way in which CAI-theorists can express the idea that a composite entity is an 'ontological free lunch' (that is, a new entity that doesn't count as an additional

[3]Three prominent examples are Baxter (1988), Lewis (1991), and Varzi (2014).

[4]A *locus classicus* on this point is van Inwagen (1994).

ontological commitment). In section 4, I will then present a short and straightforward argument to the effect that, given CAI, *no* composite entity can be said to be an ontological free lunch in the sense discussed in section 3. In section 5 I will argue that, although the problem of ontological innocence presented in section 4 is closely related to the problems surrounding the infamous 'Collapse Principle' (Yi 1999, Sider 2014), not every solution to the latter carries over to the former. In particular, I will show that Sider's (2014) proposal (on behalf of CAI-theorists) of weakening the usual comprehension principle for pluralities is not sufficient to avoid the problem of ontological innocence. Finally, in sections 6 and 7 I will focus on two 'restricted' versions of CAI and argue that the version of CAI claiming that composite entities are identical to the plurality of their atomic parts seems to be the best option for CAI-theorists.

2 | STAGE-SETTING

I will work within the framework of plural logic. I will take '*xx*', '*yy*', '*zz*', … to be plural variables and let '$\prec$' stand for the one-of relation, '$\subseteq$' for the being-among relation, and '$\leq$', '$<$', '*O* and '*D*' for parthood, proper parthood, overlap, and disjointness, respectively.[5] I will assume proper parthood to be a primitive notion and define the other mereological notions as follows:

PART $x \leq y =_{df} x < y \vee x = y$

OVERLAP $Oxy =_{df} \exists z\,(z \leq x \wedge z \leq y)$

DISJOINTNESS $Dxy =_{df} \sim Oxy$

I will also let '*xFyy*' stand for '*x* is a mereological fusion of the *yy*':

FUSION $xFyy =_{df} \forall z\,(z \prec yy \rightarrow z \leq x) \wedge \forall z\,(z \leq x \rightarrow \exists w\,(w \prec yy \wedge Owz))$

I will use '$[a_1, a_2, \ldots, a_n]$' as short for the plural definite description 'the plurality of entities such that something is one of them if and only if it is identical to either $a_1, a_2, \ldots,$ or a_n' (see Loss 2020: 13).[6] The following plural comprehension principle is usually taken to be an axiom of plural logic (Linnebo 2017: §1.2):

COMP $\exists x \phi_x \rightarrow \exists yy \forall x\,(x \prec yy \leftrightarrow \phi_x)$

[5] Notice that, while I take plural quantification *not* to be reducible to singular quantification over 'pluralities' thought of as *sui generis* entities, for simplicity's sake I will sometimes treat 'plurality' and plural terms as grammatically singular.

[6] If we let '$\iota xx.\,\phi xx$' stand for the plural definite description 'the *xx* that ϕ', and assume that plural definite descriptions are eliminable using Russell's theory of descriptions:

$$\psi\,(\iota xx.\,\phi xx) =_{df} \exists xx\,(\phi xx \wedge \forall yy\,(\phi yy \rightarrow yy = xx) \wedge \psi xx)$$

'$[x_1, \cdots, x_n]$' can be defined more precisely as follows:

$$[x_1, \cdots, x_n] =_{df} \iota xx.\,\forall z\,(z \prec xx \leftrightarrow (z = x_1 \vee \cdots \vee z = x_n))$$

(see Loss 2020:13).

I will start by assuming COMP. Then, from section 4 onwards I will focus on CAI-theorists endorsing a slightly weaker version of COMP generating only 'proper' pluralities of entities, that is, pluralities containing more than just one entity (a choice I will motivate in section 4):

$$\text{COMP2}\ \exists x \exists y \left(x \neq y \wedge \phi_x \wedge \phi_y\right) \rightarrow \exists yy \forall x \left(x \prec yy \leftrightarrow \phi_x\right)$$

Another standard principle of plural logic I will assume to be non-negotiable is the principle according to which identical pluralities have the same members:

$$\text{ONE-OF}\ \forall xx \forall yy\, (xx = yy \rightarrow \forall z\, (z \prec xx \leftrightarrow z \prec yy))$$

This means that in this paper I will focus only on 'non-count-based' (Cotnoir 2014:10) versions of CAI, according to which being one of a plurality of entities is an absolute matter and is not relative to any 'way of counting' or any 'way of conceptualizing' the entities in question.[7] I will also assume, as it is customary, that there are no empty pluralities:

$$\text{NO-EMPTY}\ \forall xx \exists y\, (y \prec xx)$$

Finally, as it is common in the literature, I will start by taking the main claim of CAI-theorists to be the claim that, for every entity *x* and every plurality of entities *yy*, if *x* is a mereological fusion of the *yy*, then *x* is identical to the *yy*. I will label this claim 'U-CAI' (the 'U' is for 'unrestricted'):

$$\text{U-CAI}\ \forall x \forall yy\, (xFyy \rightarrow x = yy)$$

Therefore, in what follows I will use 'CAI' to refer to the general idea that entities are identical to (at least some of) the entities they fuse (taken together), and 'U-CAI', 'R-CAI-S', 'R-CAI-PP' and 'R-CAI-A' (see below) to refer to specific ways CAI-theorists can spell out their main thesis in more precise terms.

3 | CAI AND ONTOLOGICAL FREE LUNCHES

As it seems clear from the passages quoted in section 1, the reason why many authors concede that, if true, CAI would provide a clear account of how a composite entity can be a *new entity* (with respect to each of its proper parts) *without* being at the same time an *additional ontological commitment* (with respect to them taken together) is that, according to CAI, a composite entity is *identical* to the parts it fuses. A natural way to start unpacking this intuition appears to be the following. Consider a certain composite entity, say a table, and a certain plurality of proper parts it fuses, say the table top and its four legs. The table is identical to neither the table-top nor to any of its legs. In this sense, the table is indeed a 'new', additional entity with respect to the table-top and the legs: while the table-top and the legs of the table are *five* entities (supposing we are talking about a four-legged table), the table-top, the legs, and the table are *six* entities (see van Inwagen 1994: 213). However, if CAI is true, the table is *identical* to the table-top and its four legs, taken together: 'It *is* them. They *are* it', as Lewis (1991: 83)

[7]For some 'count-based' versions of CAI see, among others, Bøhn (2014, 2019), Wallace (2011a, 2011b), and Cotnoir (2013). For some interesting criticism see Lipman (2018).

(who came only close to embracing CAI) famously said.[8] Therefore, as far as ontological commitment goes, it may seem to be fairly intuitive that someone who was already committed to the existence of the table-top and the legs of the table wouldn't seem to incur any additional ontological cost by also admitting the existence of something that is *identical* to them and, thus, (in the strictest way possible!) *nothing* over and above them.

Consider the following definitions of the notions of 'being a new entity' and 'not being an additional ontological commitment':

NEW An entity x is a *new entity* with respect to a plurality of entities yy if and only if, for every z, if z is one of the yy, then x is different from z

$$NEW\,(x, yy) =_{df} \forall z\,(z \prec yy \rightarrow x \neq z)$$

NAC An entity x is *not an additional commitment* with respect to a plurality of entities yy if and only if, either x is one of the yy or for some plurality of entities zz, such that the zz are among the yy, x is identical to the zz

$$NAC\,(x, yy) =_{df} x \prec yy \vee \exists zz\,(zz \subseteq yy \wedge x = zz)$$

NEW is pretty straightforward. An entity x is a new, additional entity with respect to some plurality of entities yy just in case x is not one of them, that is, just in case no member of the yy is identical to x. In that case, in fact, if we count how many entities there are by using the existential quantifier we will say things like:

$$\exists y_1 \exists y_2 \ldots \exists y_n \exists x \left(y_1 \neq y_2 \wedge \ldots y_1 \neq y_n \wedge \ldots \wedge y_{n-1} \neq y_n \ldots \wedge y_1 \neq x \wedge y_2 \neq x \ldots \wedge y_n \neq x\right)$$

which entails that, while the yy are n entities, the yy *and* x are n+1 entities. Notice that the problem surrounding the alleged 'innocence' of mereology stems precisely from this kind of (broadly speaking) Quinean considerations:

> Suppose that there exists nothing but my big parcel of land and such parts as it may have. And suppose it has no proper parts but the six small parcels. […] Suppose that we have a batch of sentences containing quantifiers, and that we want to determine their truth-values: '$\exists x \exists y \exists z$($y$ is part of x & z is a part of x & y is not the same size as z)'; that sort of thing. How many items in our domain of quantification? Seven, right? That is, there are seven objects, and not six objects or one object, that are possible values of our variables, and which we must take account of when we are determining the truth-values of our sentences. (van Inwagen 1994: 213)
>
> […] surely a composite whole is numerically distinct from each of the things that compose it […]. Thus, on the face of it, the ontology of someone who endorses mereological fusions appears to be richer than the ontology of someone who does not; it countenances the fusions *and* it countenances the individual things that compose them, each of which is something else. (Varzi 2014: 49)

[8]One may object that the table and its parts have different existence conditions and so cannot be identical. Alas, the general issue of how CAI can deal with the possibility of mereological change is beyond the scope of this paper. It may be mentioned, however, that at least *prima facie* a natural option for CAI-theorists seems to be that of embracing eternalism in the temporal case and counterpart theory (or, alternatively, the theory of modal parts) in the modal case (for some discussion see Wallace 2011b, 2014).

Instead, NAC may appear to be more controversial. Notice, however, that what is at stake here is not whether NAC is true (or whether it is the best available account of the notion of 'being an additional ontological commitment') but just whether (at least in the simple case under consideration; more on this below) NAC is a plausible candidate for the kind of notion of 'not being an additional ontological commitment' that people have in mind when they say that, *if* CAI was true, then mereology would clearly be innocent. In this sense, NAC appears to be very natural and plausible. Consider the case of singular entities. If someone is already ontologically committed to a certain entity x, they wouldn't commit themselves to anything new by 'also' admitting the existence of something that is identical to x. If I already accept the existence of Hesperus, 'also' accepting the existence of Phosphorus doesn't increase the 'quantity of being' to which I am ontologically committed. However, once many-one identity is allowed into the picture, it seems natural to extend the same kind of reasoning also to pluralities of entities. If I am already committed to the existence of the atoms a_1 and a_2 accepting the existence of the composite entity b doesn't increase the 'quantity of being' to which I am ontologically committed, if b is *identical* to the *aa*. In the same way in which those who already accept the existence of Hesperus just appear to be 'reiterating' their commitment to its existence by also accepting the existence of Phosphorus, those who already accept the existence of the *aa* can be seen as simply reiterating their commitment to their existence when they also accept the existence of b. To paraphrase Lewis (1991: 81): *b is* the *aa*; the *aa are b*.

Before moving forward, two important points must be stressed. First, notice that in order to be an 'ontological free lunch' with respect to a certain plurality, not being an additional commitment with respect to them is clearly not sufficient. Take, for instance, the plurality of entities of a_1, a_2 and b, taken together ('$[a_1, a_2, b]$'). Clearly, b is one of $[a_1, a_2, b]$

(1) $$b \prec [a_1, a_2, b]$$

It follows, thus, from NAC that b is not an additional ontological commitment with respect to $[a_1, a_2, b]$

(2) $$NAC\,(b, [a_1, a_2, b])$$

However, b is clearly *not* a new entity with respect of $[a_1, a_2, b]$, as it is *one of them*:

(3) $$\exists x\,(x \prec [a_1, a_2, b] \wedge x = b)$$

(4) $$\sim NEW\,(b, [a_1, a_2, b])$$

Therefore, in this case we have that, although b is not a new commitment with respect to $[a_1, a_2, b]$ the existence of b doesn't come for free, given that b is 'already' among the entities to which we are committed.

Second, it may be claimed that, while the *definiens* of NAC seems to deliver the right results if taken to be a sufficient condition, it appears to generate some potential problems if taken to be a necessary one. Suppose for instance that a certain entity e_1 is identical to the plurality $[f_1, f_2]$, f_1 is identical to the plurality $[g_1, g_2]$, and that e_2 is an atom, different from g_1. In this case it may seem at least *prima facie* intuitive to say that g_1 is nothing over and above the plurality $[e_1, e_2]$, as g_1 appears to be in some sense already 'contained' in e_1. However, since g_1 is neither one of $[e_1, e_2]$, nor is it identical to any sub-plurality of $[e_1, e_2]$, NAC entails that g_1 is an additional commitment with respect to the $[e_1, e_2]$. Since in this and the following section I will only be concerned with the simple case of a fusion of two mereological atoms we can ignore this wrinkle for the time being. Notice, however, that in the final part of section 7 I will provide a general definition of NAC that seems to deliver the right results also in these cases.

Let's return to the case of b and the *aa*. If we assume U-CAI, we have in this case that b is identical to the *aa*:

(5) $b = aa$

It follows, therefore, that there is a plurality of entities *zz* such that the *zz* are among the *aa* and *b* is identical to them, namely the *aa* themselves:

(6) $aa \subseteq aa \wedge b = aa$

b is, thus, not an additional commitment with respect to the *aa*:

(7) $NAC\,(b, aa)$

However, we also have that *b* is *not* one of the *aa*:

(8) $\sim (b \prec aa)$

This means that *b* is a new entity with respect of the *aa*:

(9) $NEW\,(b, aa)$

We have, therefore, that *b* is both a new entity (with respect to the *aa*) without being an additional ontological commitment (with respect to the *aa*):

(10) $NEW\,(b, aa) \wedge NAC\,(b, aa)$

It appears, thus, possible to conclude that NAC and NEW represent a very natural and intuitive way to make precise sense of what people are thinking when they claim that under the assumption of CAI the 'ontological innocence [of mereology] is secured' (Hawley 2014: 72). It may thus come as a surprise that a simple argument shows that CAI entails that *no* entity complies with both NAC and NEW, so that, if CAI is true, no entity seems to be an ontological free lunch in this sense.

4 | THE ARGUMENT

Consider again the entity *b* which is the mereological fusion of the two atoms a_1 and a_2 taken together (the *aa*). Consider, in particular, the plurality of (proper and improper) parts of *b*, namely the plurality $[b, a_1, a_2]$. *b* is clearly a mereological fusion of $[b, a_1, a_2]$:[9]

(11) $bF\,[b, a_1, a_2]$

From U-CAI and (11) it follows that *b* is identical to $[b, a_1, a_2]$:

(12) $b = [b, a_1, a_2]$

In turn, from U-CAI, (12) and the transitivity of identity it follows that every plurality of entities *xx* collectively identical to *b* are also identical to $[b, a_1, a_2]$:

(13) $\forall xx\,(xx = b \rightarrow xx = [b, a_1, a_2])$

We are assuming that identical pluralities have the same members:

ONE-OF $\forall xx \forall yy\,(xx = yy \rightarrow \forall z\,(z \prec xx \leftrightarrow z \prec yy))$

[9]Each of $[b, a_1, a_2]$ is part of *b* and, since *b*, a_1, and a_2 are all the parts of *b* we also have that every part of *b* has a part in common (and, thus, overlaps) some of the $[b, a_1, a_2]$ (see the definition of mereological fusion in section 2).

We have, thus, from (13) and ONE-OF, that every plurality of entities that are collectively identical to b contain b as a member:

(14) $\forall xx\,(xx = b \rightarrow b \prec xx)$

In turn, it follows from (14) that every plurality of entities xx such that b is a new entity with respect to them is also such that, for no yy among the xx, b is identical to the yy:

(15) $\forall xx\,(NEW\,(b, xx) \rightarrow\ \sim \exists yy\,(yy \subseteq xx \wedge b = yy))$

In fact, in order to be a new entity with respect to the xx, b must *not* be included in the xx. On the other hand we have just said that every plurality to which b is identical contains b as a member. Therefore, if b is a new entity with respect to the xx, b cannot be identical to any (proper or improper) sub-plurality of the xx. It follows, thus, from (15) and NAC that there is no plurality of entities such that b is a new entity and yet not an additional commitment with respect to them:

(16) $\sim \exists xx\,(NEW\,(b, xx)\ \wedge NAC\,(b, xx))$

Generalizing the result just obtained we have that, for every entity x fusing a plurality of entities yy there is no plurality of entities zz such that x is a new entity with respect to the zz and yet not an additional commitment with respect to them:

(17) $\forall x \forall yy (xFyy \rightarrow\ \sim \exists zz\,(NEW\,(x, zz)\ \wedge NAC\,(x, zz))$

In other words, if CAI is true, mereology is *not* innocent.

5 | CAI, INNOCENCE AND MEREOLOGICAL NIHILISM

The argument presented in the previous section relies on three main assumptions: U-CAI, ONE-OF and, implicitly, the plural comprehension principle COMP (which says that if there is at least something that ϕs, then some plurality of entities is the plurality of all and only the things that ϕ):

U-CAI $\forall x \forall yy\,(xFyy \rightarrow x = yy)$

ONE-OF $\forall xx \forall yy\,(xx = yy \rightarrow \forall z\,(z \prec xx \leftrightarrow z \prec yy))$

COMP $\exists x \phi_x \rightarrow \exists yy \forall x \left(x \prec yy \leftrightarrow \phi_x\right)$

However, it is well-known in the literature that the conjunction of U-CAI, ONE-OF and COMP is problematic (see, among others, Yi 1999; Sider 2014; Calosi 2016; Loss 2018). In our case, for instance, we have from COMP that there is the plurality of entities $\left[b, a_1, a_2\right]$ to which b is identical by U-CAI. However, it also follows from COMP that there is the plurality $[a_1, a_2]$ (which is the plurality of the proper parts of b). b is a fusion of $[a_1, a_2]$. Therefore, we have from U-CAI that b is also identical to $[a_1, a_2]$. However, this means that also the pluralities $\left[b, a_1, a_2\right]$ and $[a_1, a_2]$ must be identical, which *contradicts* ONE-OF (given that b is one of $\left[b, a_1, a_2\right]$ but not one of $[a_1, a_2]$). Since the only other assumption beyond U-CAI, ONE-OF and COMP is that b is a composite object, this argument can be seen as showing that U-CAI, ONE-OF and COMP jointly entail mereological nihilism, that is the thesis that there are no composite objects. Therefore, one may think, first, that the argument presented in the previous section is just another bad consequence of assuming the joint truth of U-CAI, ONE-OF and

COMP, and, most importantly, that whatever strategy CAI-theorists may have to solve the problem of mereological nihilism will carry over to the argument concerning the innocence of mereology. As I will show below, however, the problem of mereological innocence persists also for some of the versions of CAI that do not collapse to mereological nihilism, and most notably for the strategy presented on behalf of CAI-theorists by Sider (2014).

A commitment to mereological nihilism would clearly be an unwelcome consequence of CAI. I am assuming in this paper a version of CAI that takes ONE-OF to be non-negotiable (see section 1). Therefore, in this case CAI-theorists seem to be forced to embrace some 'restricted' version of their theory. This kind of restriction can come in two forms. In the first form (discussed by Sider 2014), U-CAI is left intact and it is the very comprehension principle for pluralities that is 'restricted', in the sense that is formulated so as to generate 'fewer pluralities than one normally expects' (Sider 2014: 213). In some previous work I have endorsed this strategy (Loss 2019, 2020). In particular, I have argued (Loss 2019) that CAI-theorists should endorse an 'atomic' comprehension principle which, conjoined with U-CAI, entails that there are only pluralities of mereological atoms (so that the plural quantifier quantifies only over pluralities of mereological atoms). However, weakening COMP in such a radical way may appear to be a rather desperate manoeuvre, given that it seems to make plural logic almost useless (Loss 2020: 6). For this reason, many may prefer the second restriction strategy, which consists in simply reformulating CAI as applying only to a certain kind of parts of a composite object. For instance, my proposal (Loss 2019) can be reformulated in this sense by claiming that—although there are indeed all the pluralities whose existence is guaranteed by COMP, and every composite entity is, thus, the fusion of different pluralities of entities—every composite entity is only identical to the plurality of its atomic parts.[10] Notice that this version of CAI also requires a slight weakening of COMP entailing that the plural quantifier doesn't quantify over improper pluralities of entities:

COMP2 $\exists x \exists y \left(x \neq y \wedge \phi_x \wedge \phi_y\right) \rightarrow \exists yy \forall x \left(x \prec yy \leftrightarrow \phi_x\right)$

In fact, if improper pluralities are allowed into the picture, it appears very natural to claim that every entity is identical to the improper plurality containing it as its only member (contrary to sets, pluralities are not something over and above their members). Therefore, assuming both that every entity is identical to the plurality of its atomic parts and that for every entity x there is its improper plurality $[x]$, we would have that, for every entity x, the plurality of atomic parts of x is identical to the improper plurality $[x]$ having x as its only member. This, however, is possible only if x is x's only part or, in other words, only if x—and, by generalization, every other entity—is a mereological atom. However, this kind of weakening seems to be perfectly harmless, given that, for every x, all the work done by $[x]$ can be equally done by x itself (see Loss 2020: 11-12).

Sider's (2014) proposal (made on behalf of CAI-theorists) can be translated as a restricted form of CAI as follows:

R-CAI-S $\forall x \forall yy \left(\left(xFyy \wedge \forall z \left(z \prec yy \leftrightarrow z \leq x\right)\right) \rightarrow x = yy\right)$

[10] As I have argued (Loss 2020), these two forms of restriction may be compatible, provided one distinguishes between more and less joint-carving plural quantifiers. For simplicity's sake in what follows I will ignore this possibility and focus only on the strategy of simply restricting CAI.

Coupled with COMP2 (and the plausible idea that in no other case there can be many-one identity), R-CAI-S entails that every composite entity is only identical to the plurality of its parts. This clearly solves the problem of mereological nihilism, since the argument to the effect that CAI entails nihilism crucially relies on identifying a composite entity with different pluralities.[11] In our case, for instance, it follows from R-CAI-S that b is identical to $[b, a_1, a_2]$, but it doesn't follow that b is identical to $[a_1, a_2]$, thus blocking the argument. However, since parthood is reflexive, and thus everything is (an improper) part of itself, R-CAI-S still entails that no composite entity is an ontological free lunch in the required sense. As a matter of fact, according to R-CAI-S every composite entity is identical only to a plurality of entities 'already' containing it, so that no composite entity can be both identical to some plurality of entities and something *new* with respect to them at the same time.

Therefore, the argument from ontological innocence presented above doesn't only show that CAI-theorists (endorsing ONE-OF) must embrace some kind of restriction strategy. It also shows that the relevant kind of restriction must be stronger than the one proposed by Sider (2014) and exclude that composite entities can be identical to pluralities containing them.

6 | TWO RESTRICTED VERSIONS OF CAI

The two most plausible alternative restrictions of CAI appear to be the following (where 'Ax' stands for 'x is a mereological atom' and is short for '$\sim \exists y(y < x)$', or 'x has no proper parts'):

R-CAI-PP $\forall x \forall yy\,((xFyy \wedge \forall z\,(z \prec yy \leftrightarrow z < x)) \rightarrow x = yy)$

R-CAI-A $\forall x \forall yy\,((xFyy \wedge \forall z\,(z \prec yy \leftrightarrow (Az \wedge z \leq x)) \rightarrow x = yy)$

According to R-CAI-PP, every composite entity is identical to the plurality of its *proper* parts. According to R-CAI-A, every composite entity is identical to the plurality of its *atomic* parts. As R-CAI-S, both R-CAI-PP and R-CAI-A are not affected by the problem of mereological nihilism (as they only entail that a composite entity is identical to one plurality of entities: the plurality of its proper parts, and the plurality of its atomic parts, respectively). Contrary to R-CAI-S, however, both versions of CAI are also left unscathed by the problem of ontological innocence, given that in both cases the pluralities of entities to which composite entities are identical never contain the composite entities themselves (since no composite entity is a proper part of itself—given the irreflexivity of proper parthood—and, of course, no composite entity is an atom). Clearly, in order to deliver the desired innocence of mereology across the board, R-CAI-A is committed to mereological atomism (that is, the idea that everything has atomic parts).[12] As I will argue in what follows, however, this is a cost that seems to be well worth paying, as R-CAI-PP faces some significant problems in fully accounting for the innocence of mereology even in the atomistic case.

Consider the infinitary 'Christmas tree' model depicted in Figure 1 (where black dots represent composite entities and white dots represent atomic ones), which is a model of atomistic extensional

[11]See Loss (2019: 7-11) for some discussion.

[12]See Varzi (2017) for a recent defence of this definition of atomism.

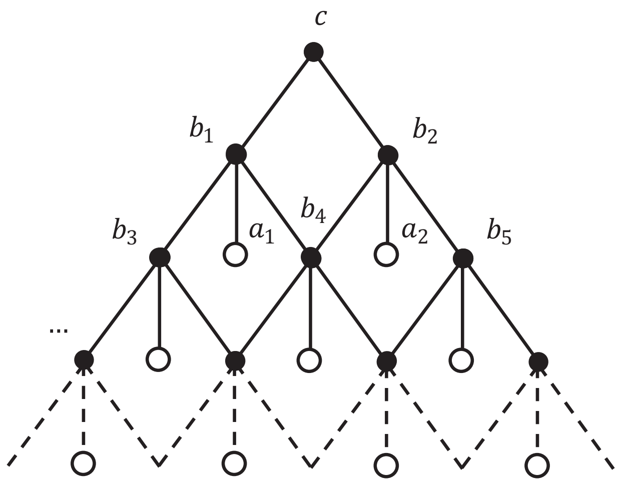

FIGURE 1 The 'Christmas tree'

mereology.[13] It is easy to check that c is the fusion of the plurality of atoms $[a_1, a_2, a_3 \ldots]$ (the '*aa*'): each of the *aa* is part of c and every part of c overlaps at least one of the *aa*. Since c is a fusion of the *aa*, we would like to be able to say that c is (in some sense) nothing over and above the *aa*. R-CAI-A can clearly account for this idea in the most straightforward way as, according to it, c is identical to the *aa* and, thus, nothing over and above them in the strictest possible sense. Instead, things appear to be more complicated for R-CAI-PP. In fact, according to R-CAI-PP, c is identical to the plurality $[b_1, b_2, b_3, a_1, b_4, a_2, b_5, \ldots]$ which is different from $[a_1, a_2, a_3 \ldots]$ (given that they have different members):

(18) a. $c = [b_1, b_2, b_3, a_1, b_4, a_2, b_5, \ldots]$

b. $[b_1, b_2, b_3, a_1, b_4, a_2, b_5, \cdots] \neq [a_1, a_2, a_3, \cdots]$

Therefore, R-CAI-PP has no straightforward way to claim that c is nothing over and above the *aa*, as it cannot claim that c is not an additional commitment with respect to the *aa* in the sense of NAC. One may reply, however, that also R-CAI-A finds itself in a similar predicament. In fact, although for R-CAI-A c is not an additional commitment with respect to the *aa*, it doesn't appear to be in position to claim the same for what concerns the *bb* (that is: $[b_1, b_2, b_3, \ldots]$), since c is not identical to them. So it may seem that both R-CAI-PP and R-CAI-A face the problem of expressing the idea that a composite entity is 'nothing over and above' a plurality of entities *different* from the plurality to which it is identical.

[13]Atomistic Extensional Mereology ('AEM') can be axiomatised by means of the following three principles:

(Strong Supplementation) $\forall x \forall y\, (x \nleq y \rightarrow \exists z\, (z \leq x \wedge Dzy))$

(<-Irreflexivity) $\sim \exists x\, (x < x)$

(<-Transitivity) $\forall x \forall y \forall z\, ((x < y \wedge y < z) \rightarrow x < z)$

(Atomism) $\forall x \exists y\, (y \leq x \wedge \sim \exists z\, (z < y))$

Notice that AEM entails both that proper parthood is a strict partial order, the Weak Supplementation principle and Extensionality of Proper Parthood:

(Weak Supplementation) $\forall x \forall y\, (x < y \rightarrow \exists z\, (z \leq y \wedge Dzx))$

(Extensionality) $\forall x \forall y\, (\exists z (z < x) \rightarrow (\forall z (z < x \leftrightarrow z < y) \rightarrow x = y))$

Mereological universalism fails in the model of Figure 1 (for instance, nothing on the Christmas tree is the fusion of $[a_1, a_2]$, since nothing is such that all of its parts overlap either a_1 or a_2). Notice, however, that the issue about whether CAI entails universalism is controversial (see Cameron 2012).

7 | 'NOTHING OVER AND ABOVE' AND 'BEING THE SAME PORTION OF REALITY'

Let's take a step back. As we observed in section 1, many find intuitive the idea that any composite entity is, in some sense, 'nothing over and above' the entities of which it is a fusion, or that they are in some sense 'the same portion of reality'. The problems related to the Collapse principle (see above) show that the notion of being the same portion of reality cannot be simply taken to be identity (on pain of a commitment to mereological nihilism).[14] As I have shown (Loss 2020: 15), however, R-CAI-A can give a simple account of the notion of being the same portion of reality. Let's define the notion of *atomic footprint* as follows:

FOOTPRINT-A
a. the atomic footprint of an atom x ('$AF(x)$') is the atom itself;
b. the atomic footprint of a composite entity b is the plurality of its atomic parts;
c. the atomic footprint of a plurality $[c_1, c_2, \ldots]$ ('$AF([c_1, c_2, \ldots])$') is the plurality that has as members the footprint of each of the cs and nothing else.[15]

Equipped with the notion of atomic footprint one can define 'being the same portion of reality' as the notion of having the same atomic footprint (in what follows 'α' and 'β' are thought of as generic schematic letters that can be replaced with either singular or plural terms and the two-place predicate '$\approx$' stands for '(is/are) the same portion of reality as'):

PORTION-A $\alpha \approx \beta =_{df} AF(\alpha) = AF(\beta)$

Returning now to the Christmas tree model of Figure 1, it is easy to prove that c and the bb have the same atomic footprint, namely the aa:

(19)
a. $AF(c) = [a_1, a_2, \ldots]$
b. $AF([b_1, b_2, \ldots]) = [a_1, a_2, \ldots]$

It follows, thus, from (19) and PORTION-A that c is the same portion of reality as the bb:

(20) $c \approx [b_1, b_2, \ldots]$

Can R-CAI-PP-theorists endorse something similar to PORTION-A in order to make sense of the idea that in the Christmas tree model c is nothing over and above the plurality of its atomic parts? Things appear to more complicated in this case. To appreciate this fact consider that the notion of 'atomic footprint' is defined by means of using, for every composite entity x, the plurality of entities to which, according to R-CAI-A, x is identical. This means that we can give a more general notion of 'footprint' as follows:

FOOTPRINT
a. the footprint of an atom a is a itself;
b. the footprint of a composite entity b is *the plurality of entities to which b is identical*;
c. the footprint of a plurality $[c_1, c_2, \ldots]$ is the plurality that has as members the footprint of each of the cs and nothing else.

[14] For some discussion of this idea independently of CAI see Gilmore (2010: 181-2).

[15] More precisely:

$$AF([c_1, c_2, \cdots]) =_{df} \iota xx.\, (\forall y\, (y \prec xx \leftrightarrow \exists z\, ((z \prec [c_1, c_2, \cdots] \wedge Az \wedge y = z) \vee y \prec AF(z))))$$

(see footnote 5 on the plural definite description '$\iota xx.\, \phi xx$').

In the case of R-CAI-PP the relevant notion of footprint ('proper footprint' as we way call it) can, thus, be defined as follows:

FOOTPRINT-PP
a. the proper footprint of an atom a is a itself;
b. the proper footprint of a composite entity b is *the plurality of its proper parts*;
c. the proper footprint of a plurality $[c_1, c_2, \ldots]$ is the plurality that has as members the footprint of each of the cs and nothing else.

One may then be tempted to claim that in the case of R-CAI-PP α and β are the same portion of reality just in case they have the same proper footprint:

PORTION-PP $\alpha \approx \beta =_{df} PF(\alpha) = PF(\beta)$

However, this account doesn't deliver the desired results even in the simplest cases. Consider, for instance, the model depicted in Figure 2. In that case we have that the proper footprint of c is $[b_1, b_2, b_3, a_1, a_2, a_3]$, while the proper footprint of $[a_1, a_2, a_3]$ is just $[a_1, a_2, a_3]$, so that PORTION-PP predicts in this case that c is *not* nothing over and above the *aa*.

The case of Figure 2 may seem to suggest an intuitive fix on behalf of R-CAI-PP-theorists. In fact, although $[b_1, b_2, b_3, a_1, a_2, a_3]$ and $[a_1, a_2, a_3]$ are different pluralities, all of the *b*s are identical to some sub-plurality of $[a_1, a_2, a_3]$ so that they can be said to be in some sense 'latent' in $[a_1, a_2, a_3]$. Following this train of thought one may then be tempted to say that R-CAI-PP should regard α and β as being the same portion of reality just in case every member of the proper footprint of α is either a member of the proper footprint of β or at least 'latent' in it (in the sense of being identical to some sub-plurality of the proper footprint of β), and vice versa (in what follows, '$x \propto PF(\alpha)$' is short for '$(Ax \wedge x = \alpha) \vee x \prec PF(\alpha)$'):

PORTION-PP-2 $\alpha \approx \beta =_{df}$

(i) $\forall x\,(x \propto PF(\alpha) \rightarrow (x \propto PF(\beta) \vee \exists yy\,(yy \subseteq PF(\beta) \wedge x = yy)))$

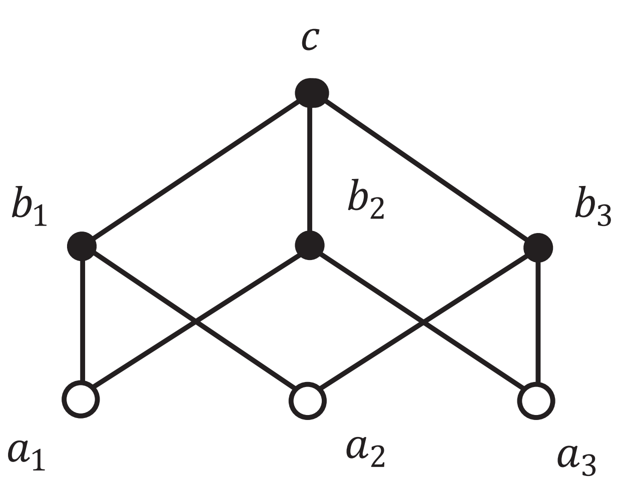

FIGURE 2 A simple atomistic model

(ii) $\forall x\,(x \propto PF\,(\beta) \to (x \propto PF\,(\alpha) \lor \exists yy\,(yy \subseteq PF(\alpha) \land x = yy))\,)$

PORTION-PP-2 delivers the right results in the case of Figure 2. Consider, in fact the proper footprints of the following entities and pluralities of entities:

(21) a. $PF\,(c) = [b_1, b_2, b_3, a_1, a_2, a_3]$

b. $PF\,([b_1, b_2, b_3]) = [a_1, a_2, a_3]$

c. $PF\,([a_1, a_2, a_3]) = [a_1, a_2, a_3]$

b. $PF\,([b_1, b_2]) = [a_1, a_2, a_3]$

d. $PF\,([b_1, a_3]) = [a_1, a_2, a_3]$

It is clear that in this case c, $[b_1, b_2, b_3]$, $[a_1, a_2, a_3]$, $[b_1, b_2]$, $[b_1, a_3]$, etc. are all the same portion of reality in the sense of PORTION-PP-2. However, this solution doesn't carry over to the case of Figure 1. In fact, contrary to the model in Figure 2, there is no composite entity on the Christmas tree model that is identical to a plurality of atoms, as *every* composite entity is identical to a plurality of entities comprising both atoms *and* other composite entities. It follows, thus, that no composite entity can be said to be 'latent' in $[a_1, a_2, a_3, \ldots]$ in the sense of PORTION-PP-2.

A different way to appreciate the problem of R-CAI-PP in this case is the following. As we noticed in section 1, one of the most attractive features of CAI is its apparent ability of accounting for the alleged innocence of mereology and, thus, the idea that a composite entity is nothing over and above the entities it fuses. The way in which CAI appears able to do this is by employing the notion of *identity*. Therefore, a general CAI-based account of the notion of being nothing over and above should intuitively be such that whenever α is said to be nothing over and above β this fact is ultimately explained *via identity*. In the case in which a composite entity is thought of as being nothing over and above (or the same portion of reality as) a plurality of atoms, it should thus be possible for the composite entity in question to be 'generated via identity', as it were, from the atoms in question. In the case of c and the *aa* in the Christmas tree model of Figure 1 this is done by R-CAI-A by claiming that c is identical to the *aa*, so that once the *aa* are posited, c can be 'generated' as the entity to which they are collectively identical. Instead, given R-CAI-PP *no* composite part of c can be generated from the $[a_1, a_2, a_3, \ldots]$ in the same sense, as no composite part of c is *identical* to a sub-plurality of $[a_1, a_2, a_3, \ldots]$. If God had created only the *aa* and then rested, R-CAI-PP would seem to have no way to recover from them any of the composite entities depicted in Figure 1.

Admittedly, this may not be R-CAI-PP-theorists' last word. However, the simple and straightforward way in which R-CAI-A accounts for these two cases seems sufficient to at least tilt the scale in its favor and show that a commitment to atomism may be the right price to pay for an innocent mereology. Notice, furthermore, that R-CAI-A can give a simple general account of the notion of 'not being an additional ontological commitment' (see section 3). In fact, R-CAI-A-theorists can simply claim that an entity x is not an additional ontological commitment with respect to a plurality of entities *yy* just in case the atomic footprint of x is included in the atomic footprint of the *yy*:

NAC-A An entity x is not an additional commitment with respect to a plurality of entities *yy* if and only if the atoms in the atomic footprint of x are among the atoms in the atomic footprint of the *yy*

$$NAC\,(x, yy) =_{df} AF\,(x) \subseteq AF\,(yy)$$

Maybe x is a proper part of some of the *yy* that is neither one of the *yy*, nor identical to some sub-plurality of the *yy* (see section 3). However, if x is a proper part of some of the *yy*, each of its atomic parts will also be an atomic part of some of the *yy*, thus guaranteeing (given the definition of atomic footprint given above) that the atomic footprint of x is included in the atomic footprint of the *yy*.

8 | CONCLUSION

Many authors agree that one of the most attractive features of CAI seems to be its ability to straightforwardly account for the ontological innocence of mereology. In this paper I have argued that things are not as simple as it may seem at first glance and that at least CAI-theorists who don't want to either radically weaken the usual comprehension principle for pluralities or reject the ONE-OF principle should endorse some kind of restricted version of CAI. Furthermore, if what I have argued in the final part of the paper is on the right track, it follows that the version of CAI according to which composite entities are identical to the plurality of their atomic parts may be CAI-theorists' best shot at a non-nihilist, yet innocent mereology.[16]

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