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Claudio Calosi

COMPOSITION, IDENTITY, AND EMERGENCE

FOOL: "Why, after I have cut the egg I'th'middle and eat up
The meat, the two crowns of the egg. When thou clovest
Thy crown I'th'middle, and gav'st away both parts, thou
Bor'st thine ass on thy back o'er the dirt"

(W. Shakespeare, *King Lear*, I, IV, 153–156)

Abstract. Composition as Identity (CAI) is the thesis that a whole is, strictly and literally, identical to its parts, considered collectively. McDaniel [2008] argues against CAI in that it prohibits emergent properties. Recently Sider [2014] exploited the resources of plural logic and extensional mereology to undermine McDaniel's argument. He shows that CAI identifies extensionally equivalent pluralities — he calls it the Collapse Principle (CP) — and then shows how this identification rescues CAI from the emergentist argument. In this paper I first give a new generalized version of both the arguments. It is more general in that it does not presuppose an atomistic mereology. I then go on to argue that the consequences of CP are rather radical. It entails mereological nihilism, the view that there are only mereological atoms. I finally show that, given a mild assumption about property instantiation, namely that there are no un-instantiated properties, this argument entails that CAI and emergent properties are incompatible after all.

Keywords: mereology; composition as identity; emergence; mereological nihilism

Introduction

Composition as Identity (CAI)[1] is a fairly attractive reductive thesis. It maintains, to put it roughly, that a whole is, strict and literally, identical

[1] CAI — for Composition as identity — is perhaps the most widely used acronym for the view. See [Baxter and Cotnoir, 2014]. As McDaniel [2008] notes CAI is an

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to its parts considered collectively. Recall Shakespeare's great tragedy, *King Lear*. Lear divides his kingdom into three parts and gives them to his daughters, Regan, Goneril and Cordelia. Could he have retained the whole kingdom to himself? According to CAI he could not have. The three parts considered collectively *are* the kingdom, the kingdom just *is* them[2]. When he gives *them* away, he gives *it* away, as the Fool actually seems to imply. McDaniel [2008] argues against CAI on the grounds that it is incompatible with emergent properties. The argument has been criticized in [Bohn, 2012][3] and more recently in [Sider, 2014]. Using the formal resources of plural logic and extensional mereology Sider argues that CAI conflates extensionally identical pluralities. He labels this principle *Collapse Principle* (CP). CP in turns undermines McDaniel's argument. As a result, Sider claims, CAI is indeed compatible with emergent properties. In this paper I argue that Sider himself underestimates the consequences of CP and CAI more in general. They are much more radical than he thinks they are. In particular they entail mereological nihilism, i.e., the view that no composite objects exist. If so, I contend, CAI and emergent properties are incompatible after all[4], at least if one accepts Sider's formulation of CAI. The plan is as follows. In §1 I will briefly develop some formal frameworks that will be used throughout the paper. In §2 and §3 I will discuss McDaniel's and Sider's argument respectively. My discussion will follow them quite closely but the arguments will in general be different from the original ones[5]. In §4 I will then put forward my main argument. Throughout the paper I will present and discuss proofs of formal results that are of interests in themselves and go beyond the main focus of the paper.

intuition in search of a formulation. Different ones are given in the literature, for example in [Wallace, 2011] and [Cotnoir, 2014]. I will be interested here in a particular one, to be rigorously stated in §2.

[2] This way of phrasing things is in[Lewis, 1991, p. 81]. Van Inwagen [1994] argues that this formulation itself shows that CAI is plainly incoherent, even at the syntactical level. For a response to this syntactical challenge see [Cotnoir, 2013, §1]

[3] I will not consider his line of argument here.

[4] Though I will not argue in favor or against any of the two.

[5] Just to mention one notable difference, my arguments do not depend on the endorsement of any form of atomism.

1. Formal Frameworks

CAI is at first sight a strange thesis in that it maintains that one thing, a whole, can be identical to many things, its parts. This calls for an expansion of our usual ideology. Following somewhat standard procedure I will use extensional mereology, plural logic[6] and hybrid (or plural) identity. In the following x, y, ..., z stand for singular variables whereas W, X, Y, ..., Z stand for plural ones. Furthermore $x \prec y$ abbreviates *is part of*, whereas Xy abbreviates y *is one of the* X. Using plural logic with identity we can define[7]:

Proper Part: $x \prec\!\prec y =_{\mathrm{df}} x \prec y \wedge x \neq y$

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

Fusion:
$$x \,\mathrm{Fu}\, Y =_{\mathrm{df}} \forall z(Yz \to z \prec x) \wedge \forall z(z \prec x \to \exists w(Yw \wedge \mathrm{O}(z, w)))$$

Atom: $\mathrm{A}(x) =_{\mathrm{df}} \sim\exists y(y \prec\!\prec x)$.

Friends of CAI should endorse at least an extensional mereology, a formal theory of parthood relations which comprises partial ordering axioms — Reflexivity, Anti-symmetry and Transitivity — plus the so called Strong Supplementation Principle:

Strong Supplementation:
$$\forall x \forall y(\sim x \prec y \to \exists z(z \prec x \wedge \sim\mathrm{O}(z, y)))$$

which in turn together with reflexivity of $\prec$ and assymetry of $\prec\!\prec$ entails Weak Supplementation Principle[8]:

Weak Supplementation: $\forall x \forall y(x \prec\!\prec y \to \exists z(z \prec\!\prec y \wedge \sim\mathrm{O}(z, x))$

For reasons that will become clear later on I will not require any fusion axiom (schema) to hold.[9] Furthermore I will not put any constraints on our plural logic except the following Plural Covering Principle:[10]

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[6] See [Boolos, 1984] or the more recent [McKay, 2006].

[7] Notation and formal development follows [Sider, 2014].

[8] See [Simons, 1987], and [Hovda, 2009] and [Varzi, 2016, 2014] for a slighlty different form of WS.

[9] For a recent take on different such schemas see [Gruszczyński and Pietruszczak, 2014].

[10] Furthermore see footnote 25 for a discussion about comprehension principles in plural logic.

1. PLURAL COVERING: $\forall x \forall y(y \prec x \to \exists W(x \operatorname{Fu} W \wedge Wy))$.

PROOF. Assume $y \prec x$ and let W be the plurality of things that are either x or y. Clearly Wy holds. Wx holds as well. Then each part of x overlaps a W, namely x itself. Furthermore each W is part of x, for y is part of x by assumption and x is part of itself by Reflexivity. Hence $x \operatorname{Fu} W$ and we are done.[11] $\dashv$

Finally we need a plural variant of Leibniz's law for identity. McDaniel [2008] calls it LL-P and Wallace [2011] calls it Hybrid Identity, which

> "is transitive, reflexive, symmetric, ad it obeys Leibniz's law — the exception is that the hybrid identity relation allows us to claim that many things can be identical to a singular thing." [Wallace, 2011, p. 810]

The underlying thought is that such variant of the familiar identity relation is required not to arouse any suspicion that CAI theorists are not talking of identity after all. Here is Sider [2007]:

> "Defenders of Strong Composition is identity must accept Leibniz's law; to deny it would arouse suspicion that their use of 'is identical with' does not really express identity".[12] [Sider, 2007, p. 57]

So we will have the familiar form of Leibnz's law:

2. PLURAL LEIBNIZ'S LAW: if $\alpha = \beta$ and $\psi(\alpha)$, then $\psi(\beta)$.

where variables could be flanked on both sides by singular or plural terms. CAI is the thesis that a whole is identical to its parts, where 'identical' is taken to be

> "identical in the very same sense of identical, familiar to philosophers, logicians, and mathematicians, in which I am identical to myself and 2+2 is identical to 4" [Sider, 2014, p. 211]

that is:[13]

3. CAI: $\forall x \forall X(x \operatorname{Fu} X \to x = X)$.

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[11] Thanks to Rafał Gruszczyński and Achille Varzi here.

[12] Cotnoir [2013, p. 307] quotes approvingly this passage.

[13] There are many other variants of CAI in the literature. Interested readers can start from [Cotnoir, 2014]. Since Sider's objection against McDaniel's argument, which is the main focus of the paper, depends crucially upon the use of this very formulation I will stick to it.

2. CAI, Duplication and Emergence

CAI, together with the plural Leibniz's law entails that fusions of plural duplicates are singular duplicates. McDaniel [2008] calls this principle, the Plural Duplication Principle (PDP). He then argues that PDP, and so CAI, is incompatible with emergent properties[14]. Following Lewis [1986] we can appeal to the notion of duplication function. Intuitively a duplication function is an injective function that preserves (i) properties, (ii) mereological relations of parthood and (iii) relations between parts of a whole or members of a plurality. More precisely let us define:

SINGULAR DUPLICATES: x and y are singular duplicates (in short: $x \triangleq y$) iff there exists an injective function $\delta\colon \{w \mid w \prec x\} \longrightarrow \{w \mid w \prec y\}$ such that if $x_1, \ldots, x_n$ are parts of x and $R(x_1, \ldots, x_n)$, then $R(\delta(x_1), \ldots, \delta(x_n))$ (properties may be treated as 1-ary relations). Naturally, if u, v are parts of x and $u \prec v$, then $\delta(u) \prec \delta(v)$. We call δ *a singular duplication function* for X and Y.

PLURAL DUPLICATES: X and Y are plural duplicates (in short: $X \triangleq Y$) iff there exists an injective function $\Delta\colon \{w \mid Xw\} \longrightarrow \{w \mid Yw\}$ such that if $x_1, \ldots x_n$ are elements of $\{w \mid Xw\}$ and $R(x_1, \ldots, x_n)$ then $R(\Delta(x_1), \ldots, \Delta(x_n))$ (again, properties may be treated as 1-ary relations). Naturally if Xu, Xv and $u \prec v$, then $\Delta(u) \prec \Delta(v)$. We call Δ *a plural duplication function* for X and Y.

McDaniel claims that (2) and (3) together entail:

4. PDP: $\forall X \forall Y \forall x \forall y (x \,\mathrm{Fu}\, X \wedge y \,\mathrm{Fu}\, Y \wedge X \triangleq Y \rightarrow x \triangleq y)$

It is somewhat interesting to see that, given what McDaniel says, assumptions (2) and (3) do not in fact entail PDP (4).

PROOF. Assume the antecedent. Then (i) there is a duplication function between X and Y. By CAI (3) we get (ii) $x = X$ and (iii) $y = Y$. It follows by the definition of fusion that every member of X is part of x and every member of Y is part of y. Yet, this is still not enough to guarantee that there is a duplication function between *all* parts of x and y, for there may be parts of x which are not among the X for all[15] McDaniel says.

[14] The one I present here is a reconstruction and a generalization of McDaniel's argument. It relies on the discussion in [Sider, 2014] and on the formal resources of §1.

[15] And parts of y that are not among the members of Y for that matter.

This is however not the end of the story. As we will see in detail in the following section CAI entails the aforementioned Collapse Principle, according to which something is among a given plurality iff it is part of the mereological fusion of that very plurality. Given this principle PDP does indeed follow, for that principle ensures that every part of x is among the members of X on the one hand, and every part of y is among the members of Y on the other. Since $\varDelta$ preserves properties and relations between the members of X and the members of Y it does then also preserve properties and relations between all parts of x and y. Thus there is a singular duplication function between the two. Hence, the consequent of (4), i.e. $x \triangleq y$, follows.[16] $\dashv$

Next we have to show that PDP is incompatible with emergent properties. We first need a definition of such properties.[17]

5. EMERGENT PROPERTY: A property P is emergent iff:
   (i) it is natural[18],
   (ii) it is exemplified by a composite object,
   (iii) there is no plurality X such that:
      (iiia) $x\,\mathrm{Fu}\,X$ and
      (iiib) P locally supervenes upon natural properties or relations exemplified by members of X,

where a composite object is simply not a mereological atom.[19] On the other hand there is a complicated debate about the notion of supervenience.[20] Fortunately enough we do not have to enter into technicalities. We may simply say that given two sets of properties (and relations) A and B, properties (and relations) A supervene on properties (and relations) B iff for any individuals x and y, if x and y are B-indiscernible then they are A-indiscernible, where A-indiscernibility (resp. B-indiscernibility) simply means that the individuals in question

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[16] Thanks to referees for this journal here.

[17] The definition I provide here is different from both McDaniel's and Sider's in that it is intended to be a generalization of those definitions they work with. It does not assume atomism — see footnote 5 — the claim that everything is ultimately made up of atoms: $\forall x(\mathrm{A}(x) \vee \exists y(\mathrm{A}(y) \wedge y \prec x))$.

[18] McDaniel explicitly mentions naturalness so I did the same here. Note however that this notion will not play any role.

[19] Weak Supplementation guarantees that it has at least two non-overlapping proper parts.

[20] For an introduction see [McLaughlin and Bennet, 2014].

are exactly alike with respect to every A (resp. B) property (and relation). This is supposed to capture the following supervenience slogan: "No A-difference without B-difference". The main result of this section is the foll owing:

6. PDP (4) and the existence of Emergent Properties (5) are incompatible.[21]

Proof. Suppose it is not so. Then there is a composite object, let's say x, that exemplifies an emergent property P. Given the definition of emergent property, for any plurality X such that $x \operatorname{Fu} X$ there is no set $R = R_1, \ldots, R_n$ of relations (properties may be treated as 1-ary relations) among members $x_1, \ldots, x_m$ of X such that P supervenes on R. Consider a plurality Y such that $y \operatorname{Fu} Y$ and $X \triangleq Y$. For any $R_i \in R$ there are members $y_1, \ldots, y_m$ of Y such that $\Delta(x_1) = y_1, \ldots, \Delta(x_m) = y_m$, and if $R_i(x_1, \ldots, x_j)$ then $R_i(y_1, \ldots, y_j)$. Hence P does not supervene on relations between members of Y either. This means that x and y can be P-discernible despite being R-indiscernible. And this means, in turn, that it can be the case that y does not exemplify P. If this is the case we have $\sim x \triangleq y$. On the other hand the antecedent of (4) is satisfied. Hence $x \triangleq y$ follows. Contradiction. ⊣

3. CAI, Collapse and Emergence

As I already pointed out the previous argument has been criticized in [Bohn, 2012] and, more recently, in [Sider, 2014]. In this last response Sider exploits an important result, namely that CAI entails the, by now infamous, Collapse Principle[22] (CP):

7. CP: $\forall X \forall x (x \operatorname{Fu} X \to \forall y (Xy \leftrightarrow y \prec x))$.

Proof. Assume the antecedent, i.e., suppose x fuses X. If y is among the X by definition of fusion y is part of x and the left-to-right direction of the biconditional in (7) is established. On the other hand if y is part

[21] I have downplayed the modal strength of the original arguments. McDaniel accepts that if CAI is true then it is necessarily true. The mere possibility of emergent properties constitutes therefore a threat to that thesis.

[22] For a proposal of formulating CAI in such a way as not to entail Collapse see [Cotnoir, 2013]. Hovda [2014] suggests way to restrict Leibniz's law that would not sanction the instance of the substitutivity of identicals in the following proof.

of x, by Plural Covering (1) there will be a plurality W such that x fuses W. By CAI (3) we get $x = W$ and $x = X$. By symmetry and transitivity of identity $X = W$. Since Wy holds by (1), Xy follows, and the right-to-left direction is established as well. $\dashv$

As it was said already CP (7) says that something is among a given plurality iff it is part of the mereological fusion of that very plurality. We already saw that CP is crucial in order to prove that CAI (3) entails PDP (4). On the other hand it is also important in undermining the argument in §2 in that it entails that there are fewer pluralities than expected. Take for example the plurality of water molecules in the Atlantic ocean. Is there such a plurality? Surprisingly the answer is negative. If there were such a plurality something will be a member of it iff it was part of the mereological fusion of those water molecules, given CP. But there are lots of parts of that fusion which are not water molecules, e.g. hydrogen or oxygen atoms. So there is no such plurality.[23]

Now, the proof of (6) implicitly assumes that there are two pluralities X and Y such that $x\,\mathrm{Fu}\,X$ and $y\,\mathrm{Fu}\,Y$ respectively. But CP entails that in general there will be no such pluralities. For CP entails that every part of x and every part of y will be among X and Y respectively, and this in general will not be the case. Here is a simple way to put things. The incompatibility between PDP (4) and emergent properties can be phrased in the following way. PDP entails, by simple rules of quantified logic, the following:

8. $\sim \exists X \exists Y (x\,\mathrm{Fu}\,X \wedge y\,\mathrm{Fu}\,Y \wedge X \triangleq Y \wedge \sim x \triangleq y)$,

[23] Certain CAI theorists could perhaps argue that there is a plurality of water molecules in the Atlantic, but the hydrogen atoms in question *are* members of that plurality. Cotnoir [2013] develops an account of composition as generalized identity which actually allows for this. However, Composition as Generalized Identity, as Cotnoir develops it, does not entail the Collapse Principle, so it will not be discussed here. It might still be argued whether such a plurality really deserves the name "plurality of water molecules in the Atlantic", insofar as some members of it are explicitly not water molecules. At the bottom, I believe, this is an issue regarding the admissible pluralities for CAI theorists. I will return to this in footnote 25 and in the main argument in Section 4. If that argument is on the right track it turns out that there are very few admissible pluralities, if one sticks to the formulation of CAI discussed in this paper, namely those pluralities that have a single member that is furthermore a mereological atom. Sider [2014, p. 213] provides some similar remarks to those in the main text about "the plurality of organs of human beings". Thanks to referees for this journal for having drawn my attention to this point.

whereas emergent properties make (8) false. But, given CP and its consequence that there are not many pluralities out there, (8) turns out to be true after all. So the incompatibility seems to vanish.

Can McDaniel argue at this point that, despite the fact that CP entails that there are fewer pluralities than expected, there are some that can do the job, that is, that can deliver the result we were after in the proof of (7)? Unfortunately this is not an option, for (8) says exactly that there are no such pluralities.

Where does this leave us? Are CAI and emergent properties compatible after all? I think not, at least, if CAI is phrased as (3). This is because Sider himself underestimates the consequences of CP. They are actually way more radical than he thinks they are. And if so, CAI and emergent properties are indeed incompatible, albeit for different reasons than the ones McDaniel envisaged. It is to this argument that I now turn to.

4. CAI, Nihilism and Emergence

In this section I will put forward three different arguments. First, I will give two independent arguments for the claim that CAI entails that there are only mereological atoms (see sections 4.1 and 4.2, respectively). Then I will argue that this establishes the incompatibility of CAI and emergent properties (§4.3)

4.1. CAI and Nihilism: Part I

Strictly speaking two things are singular duplicates iff there is a singular duplication function function among their parts that preserve natural properties, natural and mereological relations. Now, to every natural n-place relation R holding between n (proper) parts $x_1, \ldots, x_n$ of x, we can associate a property P of x itself expressed by the predicate: "having n R-related parts". Call this "a relational property". If two things differ in any natural or relational property there cannot be any duplication function between them, and if there is no duplication function between them they have to differ in at least one natural or relational property.

This is just to justify my slight abuse of terminology in the following. I will say that x and y are singular duplicates, if they have the same properties, be them natural or relational.

The surprising consequence of CP is that it entails duplication:

9. $\forall X \forall x(x \,\mathrm{Fu}\, X \rightarrow \forall y(Xy \rightarrow x \triangleq y))$.

PROOF. Assume for reductio it is not the case. We would have that $x \,\mathrm{Fu}\, X$ yet at least one of the members of X is not a singular duplicate of x. By definition of fusion each member of X is part of x. Thus we are left with two cases: either (i) there is a property P such that $P(x)$ and $\sim P(y)$ for at least one y such that $y \prec\!\prec x$, or (ii) there is a property P such that $P(y)$ and $\sim P(x)$.

Case (i). Consider the plurality W_1 of P-parts of x, that is, the plurality W_1 such that every P-part of x is a member of it. Each W_1 is part of x, and, since by construction[24] $W_1 x$, each part of x overlaps at least one W_1, namely x itself. Hence $x \,\mathrm{Fu}\, W_1$. By CP (7) each part of x is among the W_1, in particular we have $W_1 y$ and hence $P(y)$. Contradiction.

Case (ii). Consider the plurality W_2 of parts of x that have a P-part, that is the plurality W_2 such that every part of x that has a P-part is a member of it. Once again, each part of x overlaps at least a W_2 — given that $W_2 x$ holds — and each of W_2 is part of x. So we get $x \,\mathrm{Fu}\, W_2$. By CP every part of x is among the W_2, that is, every part of x has a P-part. Now, consider once again the plurality W_1 of P-parts of x. Each W_1 is part of x and each part of x overlaps a W_1, since each part of x has a P-part by the previous argument.

Hence $x \,\mathrm{Fu}\, W_1$. By CP once again every part of x is among the W_1. In particular $W_1(x)$. It then follows $P(x)$. Contradiction. ⊣

It has just been proven[25] that given CAI and CP, if something is

[24] x has P by assumption and is part of itself by Reflexivity of parthood.

[25] In the proof I associated pluralities with properties. Usually this is done through the standard COMPREHENSION PRINCIPLE for plural logic: $\exists x\, \varphi(x) \rightarrow \exists X \forall y(Xy \leftrightarrow \varphi(y))$. If the standard comprehension principle is endorsed the proof does go through straightforwardly. Sider [2014] notes some tension between this principle and Collapse. He himself suggests that CAI theorists could weaken the Comprehension principle by claiming the existence of those pluralities that are (i) non empty and (ii) are "fusion-closed", where the fusion in question is given by the following SCHEMATIC FUSION (S-Fusion):

$$x \,\text{S-Fu}_v\, \varphi \;=_{\mathrm{df}}\; \forall z(\varphi_v(z) \rightarrow z \prec x) \wedge \forall z(z \prec x \rightarrow \exists w(\varphi_v(w) \wedge \mathrm{O}(w, z)))\,,$$

where φ and v are variables in the meta-language, that provide a *definiens* whenever they are replaced by some variables in the object language. Then, (i) non emptiness and (ii) closure under schematic fusion can be phrased as the following WEAKER a fusion of a given plurality each member of the plurality is a singular duplicate of that mereological fusion. Claim (9) entails mereological nihilism, the view that there are no composite objects whatsoever, only mereological atoms:

10. $\forall X \forall x(x \,\mathrm{Fu}\, X \to \forall y(Xy \to x \triangleq y)) \to \forall z\ \mathrm{A}(z)$.

Proof. Assume for reductio otherwise. Then there exists a composite object, that is, an object with at least two disjoint proper parts, given Weak Supplementation. So there is a non-empty plurality, namely that of those proper parts, that has a fusion. This ensures that both $x \,\mathrm{Fu}\, X$ and Xy, for at least one proper part y of x, hold. Since the antecedent of (10) holds true by assumption we have that $x \triangleq y$ holds as well. On the other hand — by assumption — $y \prec\!\!\prec x$, and so there cannot be any singular duplication function between (parts of) x and (parts of) y that preserves, for example, the properties expressed by the predicates "being a proper part of x"[26] or "being a part of y"[27]. Hence $\sim x \triangleq y$. Contradiction. ⊣

This is the radical consequence of CP (7) Sider underestimates. It is true that CP entails that there are fewer pluralities and fewer fusions than expected. It actually entails that the only fusions there are, are mereological atoms.[28]

4.2. CAI and Nihilism: Part II

There is yet another independent argument[29] in favor of the claim that CAI entails there are only atoms. It crucially depends on some inter-

Comprehension Principle: there exists any non-empty plurality whose members have a schematic fusion. Note that every plurality used in the proof of (9) is non-empty. There is in fact at least one φ-er in W_1 in the first case, namely x, and at least one φ-er in W_2, namely x, and a φ-er in W_1, namely y, in the second case. Furthermore x S-fuses all those pluralities so that their existence is guaranteed by the Weaker Principle of Comprehension. Note furthermore that in these cases if x S-fuses those pluralities it also simply fuses them. We thus have that x exists and counts as the fusion of those pluralities. So the fusion of those pluralities exists.

[26] Since Proper Parthood is irreflexive.

[27] Given anti-symmetry of Parthood.

[28] A mereological atom counts in fact as a mereological fusion of itself. Actually as Van Inwagen [2006, p. 618] puts it, everything is a mereological fusion.

[29] I am indebted for the following considerations to Rafał Gruszczyński and Achille Varzi.

pretations of the formal framework Sider [2014] uses to undermine the emergentist argument against CAI. The interesting thing is that it does not pass through the Collapse Principle (7). It crucially depends upon the Plural Covering Principle (1). For that principle entails the following critical claim:

11. $\forall x \forall y (y \prec x \rightarrow y = x)$

PROOF. Assume $y \prec x$. By Plural Covering (1) there exists a W such that (i) $x \,\mathrm{Fu}\, W$ and (ii) Wy. By CAI (3) we have (iii) $x = W$. From (ii) and (iii) we get — by Plural Leibniz's Law (2) — (iv) xy. Arguably, the most natural interpretation[30] of formulas such as "xy", that is, "y is one of x", is that x and y are identical, i.e. $x = y$. If so, (11) holds. ⊣

It follows immediately from (11) and the definition of proper parthood that there exist only mereological atoms. Note also, that claim (9) follows trivially from (11) for everything counts as a singular duplicate of itself. Thus the argument would be simply the following: CAI entails Plural Covering which entails there are only atoms.

Let me spend a few words on this simple argument. As far as I can see there are three different ways in which it can be resisted. The first one is to argue that expressions such as "xy", where both the terms are singular terms, are not admissible[31]. The second one is to argue that, despite their being admissible, the interpretation of such formulas should not be given in terms of identity. Finally, it can be pointed out that the argument uses plural Leibniz's law unabashedly. Hovda [2014] lists four axioms schemas for substitutivity of identicals that are licensed by Plural Leibniz's law:

12a. $x = y \rightarrow (\varphi(x) \leftrightarrow \varphi(y))$,
12b. $x = Y \rightarrow (\varphi(x) \leftrightarrow \varphi(Y))$,
12c. $X = y \rightarrow (\varphi(X) \leftrightarrow \varphi(y))$,
12d. $X = Y \rightarrow (\varphi(X) \leftrightarrow \varphi(Y))$.

Defenders of CAI are suspicious about schemas (12b) and (12c). Now, the argument in Section 4.1 only uses an instance of (12d) in the proof of Collapse. The argument in this section uses an instance of the more

[30] Note that expressions such as "xy" are explicitly mentioned in a number of places in the literature on composition, mereological nihilism and plural logic, for example in [Van Inwagen, 1990], [Yi, 1999] and [Bohn, 2012], to mention a few.

[31] But see footnote 30.

problematic (12b) instead. Friends of CAI could then challenge the argument on these grounds.

Sider is silent on all these questions. On the face of it I contend the argument should be taken seriously. Yet I am the first one to grant that these worries deserve an independent scrutiny.

4.3. The Incompatibility of CAI and Emergent Properties

I have argued in the previous sections that CAI, at least one of its formulations, entails mereological nihilism. It is now fairly easy to see that CAI and emergent properties are indeed incompatible, even if McDaniel's argument does not go through. This is the last claim of the paper:

13. CAI (3) and the existence of Emergent Properties (5) are incompatible

Proof. CAI (3) entails CP (7), which entails duplication and mereological nihilism. Or, alternatively, given Plural Covering CAI entails mereological nihilism. In any event, CAI entails there are no composite objects. An emergent property is a property which is exemplified by a composite object. Thus, if CAI no emergent property can be ever exemplified. Given the fairly mild assumption that there are no uninstantiated properties[32], it follows that given CAI there are no emergent properties. On the other hand if there is at least an emergent property there is at least a composite object. By contraposition CAI does not hold. ⊣

Let me briefly sum up what has been done in the paper. An influential argument by McDaniel holds that CAI is incompatible with emergent properties. The argument does not go through for it neglects the consequences of CAI, or better, of a particular formulation of CAI, namely that it identifies extensionally equivalent pluralities. However, this also shows that consequences of CAI are far more radical. That formulation entails that there are no composite objects whatsoever.This in turn entails that CAI is incompatible with the existence of emergent properties after all. Naturally enough, one way to resist the arguments in this paper is to change the formulation of CAI in such a way as to avoid the entailment of the Collapse Principle (7) and to resist the independent

[32] This metaphysical thesis goes back at least to Aristotle. For a defense see [Armstrong, 1978].

argument from Plural Covering.[33] But if one sticks to what is probably the most straightforward way to formulate CAI the conclusion is the following: you can have CAI, you can have emergent properties, but you cannot have both.

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[33] As I already pointed out, to my knowledge the best and most developed attempt by far is the one in [Cotnoir, 2013].

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Claudio Calosi
University of Neuchâtel
Institute of Philosophy
Espace Louis-Agassiz 1
2000 Neuchâtel, Switzerland
claudio.calosi@unine.ch