

## The Simplicity of Material Objects

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# **The Simplicity of Material Objects**

**Giulio Sciacca**

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Our 'intuitions' are simply opinions; our philosophical theories are the same. Some are commonsensical, some are sophisticated; some are particular, some general; some are more firmly held, some less. But they are all opinions, and a reasonable goal for a philosopher is to bring them into equilibrium. (Lewis 1983a, x)

It always looks as if there were complex objects functioning as simples, and then also *really* simple ones, like the material points of physics, etc. (Wittgenstein 21.6.16)

Progress can [...] be defined as man's ability to complicate simplicity. (Heyerdhal 1974, 262)

## Introduction

Philosophers are often blamed for dealing with abstract issues that are wholly detached from the ordinary world. Still, what is more down to earth than ordinary material objects? What is more familiar than tables, trees, dogs, and mountains? The present work deals with this sort of entities: the material objects that populate our material world. Particularly, the present work aims to offer the best characterisation of their nature in light of respectable philosophical theories concerning modality, parthood relation, and the nature of properties and property inheritance. The result is a picture that, although may seem far from an ordinary conception, actually makes sense of many features of many relevant features of everyday objects. For instance, it embraces the familiar adagio according to which material objects are numerically different from the matter that constitutes them; it provides a metaphysical ground to the distinction between natural material objects and structureless ones; it comes with a suitable relation that accounts for the natural decomposition of material objects into their 'real' parts.

However, I am only telling a half truth. On the behalf of the prosecution, I must admit that the present treatment of material objects is indeed quite philosophical in the detrimental way. From a logical point of view, it revolves around a paradox concerning the nature and persistence of material objects. And paradoxes are well known for often requiring subtleties for their resolution. It actually arises from two seemingly trivialities.

First, material objects differ from their matter. The reader will be soon acquainted with the statue Statue and the portion of bronze Alloy. It just happens that Statue and Alloy are spatiotemporally co-located. A certainly intimate relation holds between Statue and Alloy, and many philosophers simply regard it as the most intimate relation: identity. But are Statue and Alloy really identical? Apparently, they are not identical, since they differ with respect to certain properties. For instance, Statue cannot undergo radical alteration of its shape, whereas Alloy seems to be much more flexible in this respect. If this is actually the case, Statue and Alloy are numerically distinct entities, since any  $x$  and  $y$  instantiating different properties are indeed numerically distinct.

Second, there cannot be two non-atomic objects having the same proper parts. In other words, the proper parthood relation is extensional. This definitely seems *prima facie* true. By placing Tinkertoy upon Tinkertoy, you end up building a Tinkertoy house. However, it seems that nothing but the house is now built with all the Tinkertoys you have used for the house. Classical Extensional Mereology, the formal theory of parthood relation, substantiates such intuition by characterising the proper parthood relation extensionally. The guilty party is Extensionality of Proper Parthood, an infamous theorem of Classical Extensional Mereology (and, indeed, a theorem of weaker

mereological systems). Extensionality of Proper Parthood bears immediate consequences on the present issue. Statue and Alloy seem in fact to share all of their proper parts: like in the example concerning Tinkertoys, Statue and Alloy are made up of, say, the very same plurality of molecules (at the same times). As a result, Statue and Alloy should be identical.

Here is the paradox. According to our modal intuitions, since Statue and Alloy instantiate different properties, and thus must be numerically different. According to Extensionality of Proper Parthood, since Statue and Alloy share all of their proper parts, they must be identical. Throughout the discussion, I stick with both of the two sources generating the paradox. The vast majority of the options discussed in the literature end up either rejecting (or, more charitably, explaining away) our modal intuitions or some fragment of Classical Extensional Mereology. However, I think a metaphysical theory is definitely better off maintaining them both. In order to explain away the abovementioned modal intuitions, philosophers ultimately rely on counterpart theory, a theory of transworld identity that not only is counterintuitive but runs into various difficulties. And by weakening Classical Extensional Mereology, philosophers often end up with theories of parthood relations so weak that they barely deserve to be classified as mereologies. Moreover, one of the most relevant benefits Classical Extensional Mereology comes with is providing an extensional, topic-neutral theory that allows accounting for parthood relations as such, thus regardless of the ontological categories of objects.

To be fair, there seems to be already a theory strong enough to preserve the numerical distinction between Statue and Alloy together with Classical Extensional Mereology (at least, given some not too demanding considerations). The theory is the well-known mereological hylomorphism. Mereological hylomorphism is well-known mainly for conceiving hylomorphic forms as literally parts of their objects. I say nothing about hylomorphic forms being ‘hidden’, or even ‘mystical’ (Lechtaler 2020, 314) parts of their objects. Rather, I contest mereological hylomorphism on the grounds of its construction of hylomorphic forms. Briefly, mereological hylomorphism characterises hylomorphic forms so that they can satisfy two relevant conditions. However, I aim to prove that forms actually cannot consistently jointly satisfy them. As a result, mereological hylomorphism must abandon such a strong construction of forms. But then, the notion of hylomorphic form turns out definitely less appealing than it seems.

I name the theory I advance in the present work Aristotelian Parts Nihilism. I draw the label from Koons (2014, 161), who ironically uses it with a negative connotation. According to Aristotelian Parts Nihilism, hylomorphs do not really have proper parts, at least according to the genuine mereological meaning of the word. Rather, hylomorphs instantiate their primary kinds essentially and, accordingly, their being spatiotemporal realisations of their primary kinds is grounded in further suitable objects

being the spatiotemporal realisations of their primary kinds. With Classical Extensional Mereology on board, there seems to be no meaningful way to establish a mereological difference between hylomorphs and their constituting portions of matter. Aristotelian Parts Nihilism makes sense of such a difference by characterising the relations between hylomorphs and their ‘real parts’ as non-mereological. Unlike parthood relation, the sort of relation at stake imposes some structure on the relata and it is sensitive to the kinds they belong to. Accordingly, parthood relation still accounts for the relation between unstructured entities, such as portions of matter and gerrymandered objects, and their *bona fide* unstructured parts. Moreover, the present theory construes hylomorphs in a purely materialistic fashion while sticking to the extensional and rigid worldview that suits non-counterpartistic Classical Extensional Mereology so well. Before providing a full-fledged exposition of Aristotelian Parts Nihilism, though, I discuss various related issues over the chapters.

In the first chapter, I introduce the abovementioned paradox and discuss it at a greater length. Among the potential solutions, counterpart theory is surely the most popular and robust one that one-thingers endorse. I expose three different arguments to the effect that counterpart theory is not the staunch theory sometimes it is taken to be. As a result, I take multi-thingism to be a metaphysical view that is definitely worth exploring.

In the second chapter, I analyse some of the most promising developments of multi-thingism. I discuss Cotonoir’s Mutual Parthood and Lowe’s Constituting Parthood as two well-motivated multi-thingist theories that, however, are at odds with Classical Extensional Mereology. Next, I consider mereological hylomorphism and show that it is the multi-thingist theory with the best chance of compatibility with Classical Extensional Mereology. Still, I provide an argument to show that its core theoretical tool, namely hylomorphic forms, are construed in an untenable way, and that no plausible emendation returns the appealing theory mereological hylomorphism is supposed to be. Thus, I advance Aristotelian Parts Nihilism as the best theory that can pair multi-thingism up with Classical Extensional Mereology.

In the third chapter, I introduce the debate on persistence over time, both in its classical and its locative construction. The locative notions allow construing a specific theory of persistence over time, transdurantism, that suit the ontology of Aristotelian Parts Nihilism, whose citizen are hylomorphs and structureless entities, particularly well. Moreover, transdurantism is coherent with two further mereological theses that suit Aristotelian Parts Nihilism well: Mereological Semantic Simplicity and Mereological Essentialism. Thus, not only Aristotelian Parts Nihilism would be a multi-thingist theory that validates Classical Extensional Mereology, but also the modally strengthened ‘Pure Mereology’, the conjunction of Classical Extensional Mereology and Mereological Essentialism.

In the last chapter, I refine Aristotelian Parts Nihilism. Particularly, I elaborate on four aspects of the theory. First, I show that it is indeed both compatible with each of the main theories of persistence, although I lean over the endurantist ones. Second, I discuss whether the systematic interpenetration of material objects the present account is committed to is faulty. I discuss an argument from co-location to coincidence and conclude that at least one premise is doubtful. Relatedly, I briefly point to some actual or conceivable cases of interpenetration between material objects. Third, I introduce the *real parthood at a time* relation. I take it to be the appropriate relation to make sense of the part-whole structure of hylomorphs in non-mereological terms. Lastly, I discuss the thorny issue of causal overdetermination. Infamous related problems, like the double weight argument, are generally concerning for any version of multi-thingism. I endorse Baker's theory of instantiating a property derivatively, suitably modified to suit the accounts of properties compatible with Aristotelian Parts Nihilism, and show that causal overdetermination can be effectively contained in such a way to make it 'cheap' and therefore not threatening anymore.

## Chapter 1

### The Troublesome Argument and Problems with Counterparts

#### 1.1 The Troublesome Argument

The present work aims to advance a specific theory of hylomorphs, namely objects that, in Evnine's (2016) words, 'have a metabolism', meaning that they can change their parts or matter over time, and they might have, or might have had, different parts or matter than their actual ones. Hence, hylomorphs are objects that enjoy a specific temporal and modal flexibility. They are familiar sorts of things, such as tables, scooters, dogs, trees, planets. Hylomorphs generally belong to artifactual and natural kinds, and partake in our ordinary conception of the world. Still, spelling out their nature is not an easy business. Some of the main metaphysical theories that have some bearing on the nature of hylomorphs are *prima facie* simply jointly inconsistent. Consequently, philosophers too often regard with suspicion an ordinary conception of material objects. To fully appreciate the dialectic at stake here, I begin by showing the tension between some of our intuitions concerning the properties of hylomorphs and important metaphysical principles concerning parts, wholes, and identity.

Consider this particular alloy statue, Statue. Many metaphysicians acknowledge its existence, and, along with it, also the existence of ordinary objects falling under artefactual and natural kinds. Now consider the portion of alloy which makes Statue up, Alloy. Again, many metaphysicians acknowledge its existence. However, there is a subtlety lurking here. According to some, Alloy exists, but it is nothing over and above Statue, because it is *identical* with Statue. Suppose further that Statue and Alloy are perfectly coincident objects (Fine 2003, 199): they come into existence at the same time, as the result of pouring some molten copper and tin into a mould, and being simultaneously destroyed later.<sup>1</sup> According to others, Alloy exists, but it is numerically distinct from Statue. Let us follow Bennett (2004, 341) and name them 'one-thingers' and 'multi-thingers' respectively. Of course, these labels are umbrella terms encompassing many distinct theoretical positions. For instance, one-thingism independently follows from the endorsement of the metaphysical views typically associated with standard mereology (Calosi 2020, Lewis 1971), composition as identity (Bohn 2014, Wallace 2011), and constitution as identity (Noonan 1993). In contrast, multi-thingism is a strong theoretical desideratum of any broadly Aristotelian metaphysical picture, such as material constitution theory (Baker 2000, 2007, Lowe 2003a, 2013a, Simons 1987, Wiggins 1968, 2001) and

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<sup>1</sup> The original formulation of the present scenario comes from Gibbard (1975). Such a scenario is specifically designed to avoid any interference due to spurious temporal issues. Otherwise, it may be the case that historical properties of Statue and Alloy are enough to establish a numerical difference between them: for instance, Alloy could have been existing before than Statue.

hylomorphism (Fine 2003, 2008, Goswick 2018, Koons 2014, Jaworski 2016, Koslicki 2008, 2018a, Oderberg 2007).

The contrast between one-thingism and multi-thingism seems to arise from two theoretical assumptions: the endorsement of Classical Extensional Mereology (henceforth CEM) and the treatment of a specific class of properties. In a nutshell, whereas one-things generally maintain CEM, multi-things lean towards theoretical options that lead to the rejection of some fragments of it; and whereas multi-things offer a homogeneous treatment of properties, one-things have developed different strategies to deal with the problematic class.

The tension between CEM and the dualistic claim about objects and their matter arises as a consequence of the role proper parts play in the identity conditions of objects. For CEM, identity between entities is nothing over and above the complete sharing of the same mereological profile: if two entities have the very same proper parts, then they are identical. In other words, the identity of proper parts implies the identity of entities. Multi-things can at most accept the trivial converse claim: the identity between entities implies the identity of their proper parts.<sup>2</sup> Still, we have not shown yet why some philosophers should wish to maintain that Statue and Alloy are numerically distinct entities. After all, they are so similar in so many respects: they are exactly located at the very same spatiotemporal regions; they are made up of the very same material components; their causal powers are the same; and so forth. However, philosophers with dualistic inclinations claim that Statue and Alloy differ with respect to a number of specific kinds of properties. Koslicki (2018b, 334) provides the following list:

- *de re* modal properties: Statue is essentially statue-shaped, whereas Alloy is not
- sortal properties: Statue is a statue, whereas Alloy is a piece of alloy
- properties pertaining to their persistence conditions: Statue cannot be squashed and survive, whereas Alloy can
- axiological properties: Statue is Romanesque, well-made, it has representational content, etc., whereas Alloy is not

Bennett (2004, 341) calls such properties ‘sortalish’, since there seems to be an intimate connection between their instantiation and the sortal profile of their bearers. Clearly, the different pattern of instantiation of such kinds of properties generalises from Statue and Alloy to all the hylomorphs and their matter. Although such differences in properties instantiated are definitely fine-grained, it does not matter to Leibniz Law:

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<sup>2</sup> The claim is trivial since it is a mere consequence of Leibniz Law.

Leibniz Law: For every  $x$  and  $y$ , if  $x$  and  $y$  are identical, then  $x$  and  $y$  share all and only the same properties<sup>3</sup>

Since Statue and Alloy differ with respect to some properties they instantiate - no matter which ones -, Leibniz Law implies that they are numerically different. Hence, since Statue and Alloy differ with respect to the instantiation of sortalish properties, Statue and Alloy are two different entities.

The joint endorsement of CEM and an unsophisticated version of multi-thingism gives rise to the following argument, that I call *the Troublesome Argument*:

- (1) There is a plurality of entities  $xx$  such that Statue and Alloy are composed of the  $xx$
- (2) If  $x$  and  $y$  are composed of the very same plurality of entities, then  $x$  and  $y$  have all and only the same proper parts (trivial theorem of Classical Extensional Mereology)
- (3) Statue and Alloy have all and only the same proper parts (1, 2)
- (4) Statue is such that it could survive the replacement of some of its proper parts
- (5) Alloy is such that it could not survive the replacement of some of its proper parts
- (6) For every  $x$  and  $y$ , if at least  $x$  or  $y$  have proper parts, then  $x$  is identical with  $y$  if and only if  $x$  and  $y$  share all and the same proper parts (Extensionality of Proper Parts)
- (7) For every  $x$  and  $y$ , if  $x$  and  $y$  are identical, then  $x$  and  $y$  share all and only the same properties (Leibniz Law)
- (8) Statue and Alloy are identical (3, 6)
- (9) Statue and Alloy are different (4, 5, 7)
- (10) Contradiction! (8, 9)

The present argument is troublesome because it highlights a tension among seemingly trivialities statement, such as (3), (4), and (5), and two renowned and intuitive metaphysical principles, namely Extensionality of Proper Parts and Leibniz Law. Thus, it is difficult to choose the premise to give up in order to avoid the contradiction. Whichever premise one is willing to amend, a revisionary theory is really around the corner, since each of them is fairly intuitive.

The content of the first premise is straightforward: there is a plurality of entities, for instance material particles, that composes both Statue and Alloy. Mereological composition is the relation between the plurality of entity and Statue (Alloy), and its precise definition is a cornerstone of CEM. The second premise is just a theorem of CEM, and it states that sameness of composers implies

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<sup>3</sup> It is customary to axiomatise the identity predicate by means of Leibniz Law and the property of reflexivity, according to which, for every  $x$ ,  $x$  is identical with  $x$ . Leibniz Law and reflexivity are sufficient to prove that identity is an equivalence relation. Notice that, despite its beautiful formulation, Leibniz Law is almost a platitude. If two things are indeed identical, then 'they' are just one and the same thing: and how would it be possible, for one thing, to have and lack the very same properties?

sameness of proper parts. Premise (3) follows from (1) and (2) by modus ponens. As far as the next two premises are concerned, (4) and (5) capture the multi-thingist intuition according to which Statue and Alloy differ with respect to the sortalish properties they instantiate. The property here is a *de re* modal property, but the Troublesome Argument would work as well if (4) and (5) were formulated with any appropriate sortalish property. Next, there is the interaction between the premises and two core metaphysical principles. Extensionality of Proper Parts states that, given two entities with proper parts, if they share all and only the same proper parts, then they are identical. Hence, from premise (3), it follows that Statue and Alloy are identical. Leibniz Law states that if two things are identical, then they share all and only the same properties. Thus, together with premises (4) and (5), it implies that Statue and Alloy are different.<sup>4</sup> Since Statue and Alloy cannot be both identical and different, something must have gone wrong in the premises.

We should be more careful in characterising multi-thingism, though. Noonan (2015) usefully distinguishes between weak and strong pluralism. Their difference amounts to the acknowledgement of wholly materially coincident objects: strong pluralists admit them, while weak pluralists reject them. For the former, complete material coincidence does not imply identity, since two objects can be completely material coincident but still instantiating different (modal, sortal, etc.) properties. Hylomorphists such as Fine (1999, 2003, 2008) and Koslicki (2008, 2018a, 2018b), but also non-hylomorphists such as Shoemaker (2007), endorse complete coincidence without identity. For the latter, instead, complete material coincidence implies identity. Among weak pluralists, there are Lewis (1986) and Lowe (2001, 2003a). In the context of the Troublesome Argument, we can lump weak pluralists and one-thingers together. Indeed, the contradiction arises precisely because we wish to maintain that Statue and Alloy are numerically different despite having precisely the same career; and weak pluralists and one-thingers would solve the tension likewise by giving up (4) and (5).

The present work is an attempt at solving the Troublesome Argument in such a way to make sense of two main theoretical tenets. First, CEM is «perfectly understood, unproblematic, and certain» (Lewis 1991, 75). CEM is the correct theory of parthood relation and we should not alter it in any way. Multi-thingers typically expand its language in such a way that it can temporally qualify mereological properties (e.g., Koslicki 2008, Thomson 1983), or just weaken CEM by rejecting some of its principles (e.g., Koslicki 2008, Simons 1987, Lowe 2013a). One-thingers, on the other hand, generally preserve CEM and its language as they are. However, my second tenet is precisely that

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<sup>4</sup> Although being widespread in metaphysics (see Magidor 2011), some philosophers claim this pattern of inference that employs Leibniz Law to be circular (see Smid 2017a, Varzi 2000). In order to state that Statue and Alloy have different *de re* modal properties, we already suppose they are distinct, since we must take ‘Statue’ and ‘Alloy’ as referring to two distinct entities. At best, Leibniz Law explains *why* Statue and Alloy are different, but it cannot be used to infer *that* they are different. The circularity should not threaten us, since we will endorse multi-thingism as the theory that comes with the more plausible metaphysics of modality. Moreover, for a critique of the circularity argument, see Berto (2013).

hylomorphs are different from their matter, i.e., strong pluralism is true (and thus one-thingism is false). The main reason why I wish to accommodate strong pluralism is that one-thingers are better off endorsing a controversial theory of transworld identity to account for the different pattern of instantiation of sortalish properties for hylomorphs and their matter. Such a theory is the unfamous counterpart theory, as introduced and developed by Lewis (1968, 1971, 1986). Counterpart theory aims to solve the tension between the two theses, but we will see that such a theory is far from being uncontroversial. In the last fifteen years, philosophers brought many different arguments undermining its actual theoretical advantages. Hence, I wish to stick to traditional transworld identity relations to account for the existence of the same individual in various possible worlds. The identity of individuals across possible world is thus genuine identity, as opposed to resemblance with respect to contextual parameters. As it will become clear, once counterpart theory is put aside, two main problems arise for the conjunction of our theoretical tenets: namely, Extensionalism and the Rigidity of Proper Parthood. While Extensionalism is a theorem of Classical Extensional Mereology, we plausibly get the Rigidity of Proper Parthood from Extensionalism and further modal considerations on the identity of objects once we cast some doubts on a couple of metaphysical theses.

I now present an axiomatisation of CEM and spend some words on its extensional nature and the implications extensionality bears on the issues under exam. It will become clear that CEM *prima facie* provides a strong inferential tool that seems to encourage a one-thingist conception of material objects. Next, I consider the one-thingist way out of the Troublesome Argument and explain why one-thingers need counterpart theory. Crucially, though, counterpart theory is far from undisputed. I show and discuss some of the arguments that philosophers have recently advanced against the soundness of counterpart theory for the interpretation of *de re* modal properties. I thus conclude that it is definitely reasonable to resort to standard transworld identity theory and multi-thingism.

## 1.2 What is Classical Extensional Mereology?

Mereology is the formal theory of parthood relation. Mereology construes parthood as a wholly general and topic-neutral relation, whose instances relate whatever entity to any of its portions: no matter how much scattered, or gerrymandered, or temporal, or even abstract it may be. For instance, ‘the windshield is part of the scooter’ is as meaningful and true as ‘the left third of the windshield is part of the left half of the scooter’; and the same goes for sentences like ‘the Battle of the Bulge is part of World War II’ and ‘being a mammal is part of being a dog’ (see Varzi 2016 for many examples along these lines). Moreover, it is actually possible to obtain mereologies weaker than CEM by relaxing some of its axioms or definitions (for various examples see Casati and Varzi 1999, Cotnoir

2013, Loss 2021b). However, since my first theoretical tenet is precisely that CEM is the correct theory of parthood relation, in what follows I will only focus on CEM.

Since mereology is a formal theory, it has an axiomatization which enables the derivation of all the principles regulating parthood and cognate relations. Indeed, there are various equivalent axiomatizations of CEM (see Hovda 2009, Cotnoir and Varzi 2021). Every axiomatization must deliver three kinds of mereological principles. First, it must characterise parthood relation as a partial order, therefore as a reflexive, transitive, and antisymmetric relation. These principles are sometimes called core principles or lexical axioms, because they fix the unnegotiable minimal meaning of parthood. Second, the partial order must be furtherly supplemented by decomposition and composition principles, that make sense of, respectively, how a whole is decomposed into parts and how it is instead composed out of pluralities of objects. I actually take Unrestricted Composition and Weak Supplementation Principle as axioms: they are respectively the strongest composition principle and one of the weakest decomposition one. Still, there is a further decomposition principle that is worth proving: Strong Supplementation Principle. It is convenient to prove it from the start, since it makes easier proving all the other relevant mereological principles. Third, the aforementioned principles must jointly imply a number of extensionality theorems, that reduce identity to specific mereological relations. Extensionality theorems are surely among the most relevant and interesting principles of mereology. On the one hand, they provide clear-cut, seemingly topic-neutral identity conditions for entities; on the other hand, they are the most relevant crux for any multi-thingist theory of material objects.

I follow a top-down axiomatization<sup>5</sup> and take the predicate ‘P’ for ‘part or improper part’ as primitive. The intended meaning of the predicate as for mereology deviates slightly from a more standard one, in that everything is taken to be a part, albeit an improper part, of itself. With the predicate ‘P’ on hand, we can then define three further important mereological predicates:

Proper Parthood:  $PPxy =_{\text{def}} Pxy \wedge x \neq y$

Overlap:  $Oxy =_{\text{def}} \exists z(Pzx \wedge Pzy)$

Fusion:  $Fyxx =_{\text{def}} \forall z(z < xx \rightarrow Pzy) \wedge \forall z(Pzy \rightarrow \exists w(w < xx \wedge Ozw))$

Notice that all these predicates refer to relations. Proper Parthood captures the more standard use of parthood: if  $x$  is a proper part of  $y$ , then  $x$  is a part of  $y$ , but it is also different from it. So, for instance, my hand is a proper part of myself, although I am only an improper part of me. The notion of Overlap

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<sup>5</sup> The label comes from Lando (2017, 35), who distinguishes between bottom-up and top-down axiomatizations. Since they are ultimately equivalent, their difference amounts just to the inferential strength of the principles they take as axioms. For bottom-up axiomatizations see Correia (2022), Simons (1987), and Varzi (2016). For top-down axiomatizations see Lando (2017), Lewis (1991), Loss (forthcoming-b).

is straightforward:  $x$  and  $y$  overlap if and only if they share a part. Lunigiana overlaps both Liguria and Tuscany. Lastly, consider the Fusion predicate. Syntactically, it is a two-places predicate that takes an individual as argument at the first place and a plurality<sup>6</sup> at the second place. Moreover, its present definition makes use of the predicate ‘to be one of’ (‘ $\prec$ ’), which is taken as primitive in plural logic and, like the Fusion predicate, is a two-places predicate taking individuals as arguments at the first place and pluralities at the second place. The definition of Fusion is then a conjunction of two conditions that we may call ‘containment’ and ‘covering’.<sup>7</sup> The containment condition states that each of the  $xx$ , the composing plurality, is a part of the composed entity,  $y$ . The covering relation states that every part of  $y$  must have some part in common with some of the  $xx$ .

With the definitions of these mereological predicates, we can advance the following axiomatization of CEM:

Transitivity:  $(Pxy \wedge Pyz) \rightarrow Pzx$

Weak Supplementation Principle:  $PPxy \rightarrow \exists z(Pzy \wedge \neg Ozx)$

Unrestricted Composition:  $\exists yFyxx$

Transitivity just states that the parthood relation is transitive. We will see in a moment how Reflexivity and Antisymmetry follow from these axioms. Weak Supplementation Principle states that if  $x$  is a proper part of  $y$ , then  $y$  has some part disjoint from  $x$ . Many authors regard it as «analytic – constitutive of the meaning of proper part» (Simons 1987, 116).<sup>8</sup> For instance, the label that Casati and Varzi (1999) use to refer to a mereology so weak that include just the axioms for the partial order of Parthood (that they call ‘Core Mereology’) and Weak Supplementation Principle is ‘Minimal Mereology’, suggesting that they take the decomposition principle to be necessary for a theory to be a mereology. Lastly, Unrestricted Composition is maybe the most characteristic mereological principle. According to it, any plurality of objects whatsoever composes a further object. Of course, Unrestricted Composition triggers an ‘incredulous stare’, and various authors find it simply unacceptable (for instance, Lowe 2003b, Korman 2015, Simons 2006). Still, it is the strongest composition principle in mereology,<sup>9</sup> and arguably the principle that builds wholes from their parts

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<sup>6</sup> The predicate ‘F’ is multigrade at the second place, since it admits a variable number of positions there. It admits improper pluralities as well, in the extreme case of an entity fusing itself. For more on multigrade predicates see Oliver and Smiley (2016, 172-174).

<sup>7</sup> I borrow the labels from Loss (2021b).

<sup>8</sup> However, see Cotnoir (2018) for a discussion of the analyticity of Weak Supplementation Principle.

<sup>9</sup> A weaker composition principle is Binary Composition, according to which, for every  $x$  and every  $y$ , there is their fusion. The most relevant difference between Unrestricted and Binary Composition is that only the former implies the existence of the Universe, that is, an object whose every object in the domain is part (the unicity of the Universe is then granted by the extensionality theorems). For a discussion, see Calosi (forthcoming), Contessa (2012).

in the most topic-neutral way possible, since there are not non-trivial conditions that objects must satisfy in order to compose a whole.

These three axioms provide a full axiomatization of CEM. I will now show that the three axioms, together with the definitions of the theoretical predicates, provide the three kinds of mereological principles: they characterise parthood as a partial order; they allow proving stronger decomposition principles; and they grant a number of extensionality theorems. For the sake of convenience, let us begin by proving a strong decomposition principle: Strong Supplementation Principle.

Strong Supplementation Principle:  $\neg Pyx \rightarrow \exists z(Pzy \wedge \neg Ozx)$

Proof: suppose Strong Supplementation is false. Then  $\neg Pyx$  and  $\forall z(Pzy \rightarrow Ozx)$ . Given Unrestricted Composition, there is a fusion of  $x$  and  $y$ , let us say  $f$ . By definition of Fusion, it follows that  $Pxf$ ,  $Pyf$ , and  $\forall z(Pzf \rightarrow (Ozx \vee Ozy))$ . Consider the latter formula: every part  $z$  of  $f$  overlaps with either  $x$  or  $y$ . Given the assumptions and the definition of Overlap, every part  $z$  of  $f$  that overlaps with  $y$  overlaps with  $x$  as well. It follows then  $\forall z(Pzf \rightarrow Ozx)$ ; given Weak Supplementation Principle, we have that  $\neg PPxf$ . Given the definition of Proper Parthood,  $\neg PPxf$  means that either  $\neg Pxf$  or  $x = f$ . However, it cannot be the case that  $\neg Pxf$ , since we have already stated  $Pxf$ ; and neither can be the case that  $x = f$ , since we would get a contradiction given the assumption  $\neg Pyx$ ,  $Pxf$ , and Leibniz Law. Therefore, Strong Supplementation Principle is true.

Strong Supplementation Principle is an inferentially strong principle that simplifies the proofs of basically all the remaining interesting principles. Before considering the proofs of Reflexivity and Antisymmetry, let us prove a decomposition principle even stronger than Strong Supplementation Principle: Complementation.<sup>10</sup>

Complementation:  $\neg Pyx \rightarrow \exists z \forall w (Pwz \leftrightarrow (Pwy \wedge \neg Owz))$

Proof: assume  $\neg Pyx$ . Given Strong Supplementation Principle, it follows that  $\exists z(Pzy \wedge \neg Ozx)$ . Then, there is the plurality  $zz$  such that  $\forall w(w < zz \leftrightarrow Pwy \wedge \neg Owz)$ .<sup>11</sup> Given Unrestricted Composition, there is the fusion of the  $zz$ ,  $f$ . Given the definition of Fusion, (i)  $\forall w(w < zz \rightarrow Pwf)$ ; and (ii)  $\forall w(Pwf \rightarrow \exists z(z < zz \wedge Ozw))$ . From the construction of the  $zz$  and (i), we already have the right-to-left

<sup>10</sup> I prove Complementation (or Remainder Principle) just for completeness's sake. In what follows, I will ignore the principle, though. Complementation is still noteworthy, since it is sometimes taken as the decomposition axiom of choice in some axiomatizations of CEM (for instance, in Cotnoir and Varzi 2019, 2021).

<sup>11</sup> The existence of such a plurality is granted by the assumption and the Plural Comprehension Principle of plural logic:

Plural Comprehension:  $\exists x \phi x \rightarrow \exists zz \forall y (y < zz \leftrightarrow \phi y)$

The Plural Comprehension Principle is usually taken as an axiom of quantified plural logic. Virtually any author accept it, and it is utterly innocuous, at least when paired up with a further axiom which ensures that there are not empty pluralities. See Linnebo (2017) and Oliver and Smiley (2016, 252).

direction of the biconditional. Now consider (ii). Given the construction of the  $zz$  and Overlap, it follows that every part of  $f$  has a part in common with a part of  $y$ , and therefore with  $y$ . In symbols:  $\forall w(Pwf \rightarrow Ow y)$ . Given Strong Supplementation Principle, it follows that  $Pfy$ . Given Transitivity, it follows that  $\forall w(Pwf \rightarrow Pwy)$ . Now consider the following definition:

$$\text{Fusion}^*: Fyxx =_{\text{def}} \forall z(Ozy \leftrightarrow \exists w(w < xx \wedge Ozw))$$

Fusion and Fusion\* are equivalent within CEM (particularly, given Strong Supplementation Principle: see Hovda (2009), Loss (forthcoming-a). Thus, since  $f$  is the Fusion of the  $zz$ , we have that  $f$  is the Fusion\* of the  $zz$  as well. Suppose now that a part  $w$  of  $f$  overlaps  $x$ . It follows that  $Ofx$ .<sup>12</sup> By the definition of Fusion\*, it follows that  $\exists w(w < zz \wedge Ow x)$ . However, none of the  $zz$  overlaps  $x$  by construction. Contradiction! It follows then  $\forall w(Pwf \rightarrow \neg Ow x)$ . Given the former result  $\forall w(Pwf \rightarrow Pwy)$ , it follows that  $\forall w(Pwf \rightarrow Pwy \wedge \neg Ow x)$ , which is the left-to-right direction of the biconditional. Therefore, Complementation is true.

The three axioms allow thus proving two strong decomposition principles. We now show that they also succeed in characterising parthood as a partial order. In order to do that, we must achieve two further independent results (readapted from Hovda 2009, fn. 22).

First, overlap is reflexive, or, equivalently, everything overlaps itself:  $Oxx$ . Take an  $x$  whatsoever. Given Unrestricted Composition, there is the fusion of  $x$ , say  $a$ . Given the definition of Fusion, every part of  $a$  overlaps  $x$ . Since the definition of Fusion also grants that  $x$  is part of  $a$ , it follows that  $x$  overlaps itself and, by generalising, everything overlaps itself.

Second, everything is the fusion of its parts:  $Fx(\cup zz(\forall y(y < zz \leftrightarrow Pyx))$ . Take  $x$  again. Every part of  $x$  is, of course, a part of  $x$ , so that the first conjunct in the definition of Fusion is satisfied. Moreover, the former result grants that every part of  $x$  overlaps some of the  $zz$ . Since the  $zz$  are by construction all and only the parts of  $x$ , such condition reduces to the claim that every part of  $x$  overlaps some part of  $x$ , which is granted by the reflexivity of overlap. Therefore, everything is the fusion of its parts.

With these two results at hand, we can finally prove that parthood is a partial order, that is, a reflexive, transitive, and antisymmetric relation.

Reflexivity:  $Pxx$

Proof: suppose Reflexivity is false. Then, there is a  $x$  such that  $\neg Pxx$ . Given Strong Supplementation Principle,  $\exists z(Pzx \wedge \neg Ozx)$ . Hence,  $Pzx$  and  $\neg Ozx$ . By the former results,  $x$  is the fusion of its parts. Given  $Pzx$  and the definition of fusion,  $z$  overlaps some part of  $x$ . By the definition of Overlap, it

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<sup>12</sup> This implication actually presupposes the reflexivity of parthood, that is proved in the immediately following paragraphs.

follows that there is a  $w$  such that  $Pwz$  and  $Pwx$ . By the definition of Overlap, it follows  $Ozx$ , which contradicts  $\neg Ozx$ . Therefore, Reflexivity is true.

Antisymmetry:  $Pxy \wedge Pyx \rightarrow x = y$

Proof: suppose Antisymmetry is false. We have then  $Pxy$ ,  $Pyx$ , and  $x \neq y$ . By the definition of Proper Parthood,  $Pxy$  and  $x \neq y$  are tantamount to say that  $PPxy$ . Given Weak Supplementation Principle, it follows that  $\exists z(Pzy \wedge \neg Ozx)$ . Since  $Pyx$  by assumption, Transitivity ensures that  $Pzx$ . Moreover, Reflexivity ensures that  $Pzz$ . But then  $z$  and  $x$  overlap after all. Therefore, Antisymmetry is true.

Therefore, the present axiomatization, together with the current definitions of the mereological predicates, correctly characterises parthood as a partial order.<sup>13</sup> These properties of the parthood relation, together with the axioms, allow proving various extensionality theorems.

Extensionality of Part:  $(Pzx \leftrightarrow Pzy) \rightarrow x = y$

Proof: assume  $Pzx \leftrightarrow Pzy$ . From Reflexivity, we have  $Pxx$  and  $Pyy$ . Given the assumption, it follows that  $Pxy$  and  $Pyx$ . By Antisymmetry, it follows that  $x = y$ . Therefore, Extensionality of Part is true.

Uniqueness of Fusion:  $Fxzz \rightarrow \forall y(Fyzz \rightarrow x = y)$

Proof: suppose Uniqueness of Fusion is false. We have then  $Fxzz$  and  $\exists y(Fyzz \wedge x \neq y)$ . Given Antisymmetry, it follows that either  $\neg Pxy$  or  $\neg Pyx$ . Suppose  $\neg Pxy$ . Given Strong Supplementation Principle, it follows that  $\exists z(Pzx \wedge \neg Ozy)$ . Given  $Pzx$ ,  $Fxzz$ , and the definition of Fusion, it follows that  $\exists w(w < zz \wedge Ozw)$ . Hence, there is a  $v$  such that  $Pvz$  and  $Pvw$ . Since  $w < zz$ , from  $Pvw$ ,  $Fyzz$ , the definition of Fusion, and Transitivity, it follows that  $Pvy$ . Since  $Pvz$  and  $Pvy$ , it follows that  $Ozy$ , that contradicts  $\neg Ozy$ . A parallel argument holds by considering  $\neg Pyx$  instead. Therefore, Uniqueness of Fusion is true.

Extensionality of Overlap:  $(Ozx \leftrightarrow Ozy) \rightarrow x = y$

Proof: assume Extensionality of Overlap is false. We have then  $\forall z(Ozx \leftrightarrow Ozy)$  and  $x \neq y$ . Now consider the plurality  $zz$  such that  $\forall w(w < zz \leftrightarrow Pwx \wedge Pwy)$ . We can prove that  $x$  is a fusion of the  $zz$ . First, each of the  $zz$  is part of  $x$  by construction. Second, take a  $w$  such that  $Pwx$ . From Reflexivity

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<sup>13</sup> Antisymmetry ensures that the definition of Proper Parthood we have adopted is equivalent with the following one:

$$PP^*xy =_{\text{def}} Pxy \wedge \neg Pyx$$

Proof: consider first that if  $PP^*xy$ , then  $PPxy$ . Since  $PP^*$  is by definition asymmetric, it cannot ever be the case that  $x = y$ . Consider now that if  $PPxy$ , then  $PP^*xy$ . If  $PPxy$ , then Antisymmetry grants that either  $\neg Pxy$  or  $\neg Pyx$ . Since  $Pxy$  holds by assumption, it must be the case that  $\neg Pyx$ . Therefore, if Antisymmetry holds, then  $PPxy$  if and only if  $PP^*xy$ , and thus the two definitions are equivalent. In the absence of Antisymmetry,  $PP^*$  is actually stronger than  $PP$ . The difference between the two definitions is particularly relevant for mereologies that reject Weak Supplementation Principle, and thus Antisymmetry (as in Cotnoir 2010, 2016).

and the definition of Overlap, it follows that  $Owx$ . From the assumption, it follows that  $Owy$ . Hence, by definition of Overlap, there is a  $v$  such that  $Pvw$  and  $Pvy$ . By Transitivity, it follows that  $Pvx$ .  $v$  is both part of  $x$  and  $y$ , and so  $v$  is one of the  $zz$  by construction. Of course, since  $Pvx$ , it follows that  $Ovx$ . Hence, by generalisation, every part of  $x$  overlaps with something which is both part of  $x$  and  $y$ . Consequently,  $x$  is a fusion of the  $zz$ . A parallel argument shows that  $y$  is a fusion of the  $zz$  as well. But then, Uniqueness of Fusion grants that  $x = y$ . Therefore, Extensionality of Overlap is true.

The next extensionality axiom is Extensionality of Proper Part, arguably the most distinctive extensionality theorem of CEM. Its formulation has a couple of characteristics that distinguish it from the extensionality theorems above. First, it features an antecedent granting that, for any  $x$  and  $y$  flanking the identity in the consequent, at least one has proper parts. By dropping such antecedent, the theorem would imply that there can at most be one atomic entity: that is not only certainly questionable, but, more on the point, it is a result that goes far beyond the content of an extensionality theorem. Second, whereas the former extensionality theorems are construed out of reflexive mereological relations,<sup>14</sup> Extensionality of Proper Part states is construed out of an irreflexive one, namely Proper Parthood. As such, Extensionality of Proper Part is the extensionality principle that more resembles the Extensionality Theorem of set theory, according to which any  $x$  and  $y$  that have all and only the same members are identical (we will see it later). Membership is irreflexive. Given the irreflexivity of Proper Parthood, Extensionality of Proper Part is the only extensionality theorem that, for any  $x$  and  $y$  flanking the identity in the consequent, excludes those very  $x$  and  $y$  from being among the entities the condition of the theorem ranges over. Hence, it may be the theorem that more closely and pre-theoretically makes sense of the idea that, so to speak, the sameness of the building entities determines the sameness of wholes. Given the relevance of Extensionality of Proper Part for CEM, as well as for the present work, I wish to show a number of proofs, some of which are present in the literature. It will be clear that Extensionality of Proper Part can be independently argued for on various different mereological grounds, and from mereologies even considerably weaker than CEM.

Extensionality of Proper Part:  $\exists z(PPzx \vee PPzy) \wedge \forall z(PPzx \leftrightarrow PPzy) \rightarrow x = y$

(i) First proof: from Uniqueness of Fusion. Before providing the proof, we must show that every complex entity  $e$  is the fusion of the plurality  $zz$  such that  $\forall w(w < zz \leftrightarrow PPwx)$ . First, for every  $w < zz$ ,  $w$  is a part of  $e$  by definition of Proper Parthood. Second, every part  $p$  of  $e$  is either a proper part of  $e$  or an improper part of  $e$  (that is,  $e$  itself). In the former case,  $p$  is identical with one of the  $zz$ , and

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<sup>14</sup> We have already proved that Parthood and Overlap are reflexive. We can use these properties to show that Fusion is a reflexive relation as well. Take an  $x$  whatsoever. First,  $x$  is part of itself, given the reflexivity of Parthood. Second, every part of  $x$  overlaps  $x$ , given the reflexivity of Parthood and Overlap. Therefore, everything fuses itself.

so it overlaps  $e$  ( $p$  and  $e$  have at least  $p$  itself as common part); in the latter case, every entity overlaps with each of its proper parts by Reflexivity and definition of Overlap and Proper Parthood.

Proof: assume  $\exists z(PPzx \vee PPzy)$  and  $\forall z(PPzx \leftrightarrow PPzy)$ . We are granted that either  $x$  or  $y$  have proper parts; and, since  $x$  and  $y$  have all and only the same proper parts, the  $zz$  compose both  $x$  and  $y$ . Given Uniqueness of Fusion,  $x = y$ . Therefore, Extensionality of Proper Parts is true.

(ii) Second proof: from Antisymmetry and Proper Parts Principle. Before providing the proof, I must introduce the Proper Parts Principle, that Simons (1987, 28) has introduced in the literature. According to Proper Parts Principle, if every proper part of  $x$  is also a proper part of  $y$ , then  $x$  is a part of  $y$ , proviso that  $x$  has any proper part at all:

Proper Parts Principle:  $\exists zPPzx \wedge \forall z(PPzx \rightarrow PPzy) \rightarrow Pxy$

Proof: assume  $\exists z(PPzx \vee Ppzy)$  and  $\forall z(PPzx \leftrightarrow Ppzy)$ . We are granted that either  $x$  or  $y$  have proper parts. Then, it follows that  $x$  and  $y$  have all and only the same proper parts. By Proper Parts Principle, it follows that  $x$  and  $y$  are mutual parts; given Antisymmetry,  $x = y$ .

(iii) Third proof: from Antisymmetry, Unrestricted Composition, Weak Supplementation Principle, Reflexivity. The proof comes from Varzi (2008).<sup>15</sup>

Proof: suppose  $\exists z(PPzx \vee PPzy)$ ,  $\forall z(PPzx \leftrightarrow PPzy)$ , and  $x \neq y$ . By Antisymmetry, it follows that either  $\neg Pxy$  or  $\neg Pyx$ . Suppose  $\neg Pxy$ . Given Unrestricted Composition, there is the fusion  $z$  of  $x$  and  $y$ . By definition of Fusion,  $Pxz$ . Either (i)  $PPxz$  or (ii)  $x = z$ . Suppose (i):  $PPxz$ . Given Weak Supplementation Principle, it follows that  $\exists w(Pwz \wedge \neg Owz)$ . By definition of Fusion,  $w$  must overlap either  $x$  or  $y$ . If  $Owx$ , the contradiction is clear. If  $Owy$ , instead, it means that there is a  $v$  such that  $Pvw$  and  $Pvy$ . Either  $PPvy$  or  $v = y$ . If  $PPvy$ , then  $PPvx$  by assumption, and therefore  $Owx$ . Then it must be the case that  $v = y$  and  $y$  is atomic: if  $y$  had proper parts, then, by assumption,  $x$  would have those same proper parts, and it would be the case that  $Owx$ . However, by assumption, if  $y$  is atomic, it must be then the case that  $x$  is complex and, again by assumption, every proper part of  $x$  must be also a proper part of  $y$ . But then,  $y$  is not atomic after all. Suppose then (ii):  $x = z$ . Since  $Pyz$  by definition of Fusion, it must be the case that  $Pyx$ ; and since  $x \neq y$ ,  $PPyx$ . Given the assumption, it follows that  $PPyy$ ; and given Weak Supplementation Principle, it follows that  $\exists z(Pzy \wedge \neg Ozy)$ , which is straightforwardly in contradiction with the definition of Overlap. A parallel argument holds by considering  $\neg Pyx$  instead. Therefore, Extensionality of Proper Parts is true.

(iv) Fourth proof: from Strong Supplementation Principle and Antisymmetry. The proof comes from Van Inwagen (1990a, 53).<sup>16</sup>

<sup>15</sup> For a discussion of this proof see Cotnoir (2016) and Loss (forthcoming-b).

<sup>16</sup> Van Inwagen's T1 is provably equivalent with Strong Supplementation Principle, given little mereological assumptions. For a proof, see Pietruszczak (2018, 90).

Proof: assume Extensionality of Proper Part is false. We have then  $\exists z(\text{PP}zx \vee \text{PP}zy)$ ,  $\forall z(\text{PP}zx \leftrightarrow \text{PP}zy)$  and  $x \neq y$ . Given Antisymmetry, it follows that either  $\neg \text{P}xy$  or  $\neg \text{P}yx$ . Suppose it is the case that  $\neg \text{P}xy$ . By Strong Supplementation Principle, it follows that  $\exists z(\text{P}zx \wedge \neg \text{O}zy)$ . Such a  $z$  can be either a proper part of  $x$  or identical with  $x$ . If  $z$  is a proper part of  $x$ , then  $z$  is a proper part of  $y$  as well by assumption, and thus  $\text{O}zy$ . Suppose instead  $z$  is identical with  $x$ . In such a case, the assumptions grant that either  $z (= x)$  or  $y$  has proper parts, and such proper parts are shared between  $z$  and  $y$ . Hence, by definition of Overlap,  $\text{O}zy$ . Therefore, Extensionality of Proper Parts is true.

Extensional theorems qualify CEM as an extensional theory that reduces, for any  $x$  and  $y$ , the identity between  $x$  and  $y$  to the holding of specific mereological conditions.<sup>17</sup> Consider set theory, the extensional theory *par excellence*. The extensionality of set theory is expressed by the following Extensionality Theorem:

Extensionality Axiom (Set Theory):  $\forall x \forall y ((\text{Set})x \wedge (\text{Set})y) \rightarrow (x = y \leftrightarrow \forall z (z \in x \leftrightarrow z \in y))$

According to the Extensionality Axiom, two sets are identical if and only if they share all and only the same elements. Like its mereological counterparts, the Extensionality Axiom of set theory is an identity criterion, that is, a principle stating that, for any  $x$  and  $y$ , the satisfaction of specific non-trivial and informative conditions is sufficient for the identity of  $x$  and  $y$ , the condition been here the sharing of all and the same members.<sup>18</sup> Still, there are two relevant differences between mereological and set-theoretical extensionalism. First, the Extensionality Axiom of set theory is an identity criterion *for a particular kind of objects*, namely sets. The antecedent makes the restriction to sets explicit; and the restriction to a kind of objects is indeed the norm for the formulation of identity criteria. Differently, mereological extensional theorems are unrestricted: they do apply to any  $x$  and  $y$  whatsoever, regardless of their kind (see Van Inwagen 2006). In this respect, again, mereology shows its topic-neutrality. Second, despite Extensionality of Proper Part being the mereological theorem that more closely resembles the set-theoretical extensionality, there is a noteworthy difference in their formulations, in that only Extensionality of Proper Part requires that at least one of the  $x$  and  $y$  considered is mereologically complex. Set theory does not need more than one memberless set, the null set, whose existence and uniqueness are granted by the Null Set Axiom and the Extensionality

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<sup>17</sup> Extensionality admits of rigorous definition: a binary relation  $R$  is extensional if and only if, for any  $x$  and  $y$ ,  $x$  and  $y$  are identical if and only if, for any  $z$ ,  $Rxz$  if and only if  $Ryz$  (Forster 2003, 7). Of course, for this definition to be suitable for mereology, we must explicitly add the usual conditional exceptions for atomic  $x$  and  $y$ .

<sup>18</sup> More specifically, we are dealing with one-level identity criteria. For the distinction between one-level and two-level identity criteria, see Lowe (1989, 1991) and Williamson (2013).

Axiom. On the contrary, mereology better admits models that contemplate the existence of more than one simple entity.<sup>19</sup>

Let us now consider how the extensionality theorems are a threat for a multi-thingist conception of material objects by taking Statue and Alloy again. According to Extensionality of Part, Statue and Alloy are identical only if they have exactly the same parts. Recall that the theorem is trivial because, given Reflexivity, anything is part of itself and, given Antisymmetry, mutual parthood amounts to identity. However, even though it may be acceptable to regard Alloy as a part of Statue, it is not *prima facie* clear why Statue should be part of Alloy. Uniqueness of Fusion, on the other hand, seems to have immediate repercussions on the issue. Statue and Alloy are in fact very plausibly both composed by the same plurality of molecules *mm*: therefore, Statue and Alloy turn out identical.<sup>20</sup> Hence, whereas Extensionality of Part on itself seems to have little to say about the relation between Statue and Alloy, Uniqueness of Fusion pushes towards their identity. However, take now Extensionality of Proper Part. Sure enough, Statue and Alloy share many of their proper parts: for instance, each of the *mm* is a proper part of them both. Still, consider Nose, the nose of Statue. Is Nose a proper part of Alloy too? Intuitions are arguably vacillating here. Many philosophers, for instance, share Baker's (2000, 181) view, according to which: «I would have thought that [Statue] had a nose as a part but that [Alloy] did not. Part of [Alloy] is (i.e. constitutes) [Statue]'s nose; but [Alloy] itself does not have a nose». If this is true, then Statue and Alloy do not share all of their proper parts after all. But then they are not identical due to Extensionality of Proper Part.

All in all, the extensionality theorems seem to *prima facie* encourage different readings of the relation between Statue and Alloy. Alloy may very well be part of Statue, but since it is not clear that Statue is part of Alloy, Extensionality of Part just cannot tell anything about their relation. Nevertheless, since Statue and Alloy are ultimately composed by a same plurality of particles, Uniqueness of Fusion establishes their identity. Yet, if we are inclined towards Baker's view, instead, Extensionality of Proper Part commits us to regard Statue and Alloy as two numerically distinct entities. Fortunately, Strong Supplementation Principle eliminates any risk of contradiction by proving away our opaque intuitions. It does so by showing that in neither of the dubious cases above there is an appropriate remainder to substantiate the claims. Consider Extensionality of Proper Part first. Suppose Nose is really not a part of Alloy. Then, by Strong Supplementation Principle, Nose must have some part that is disjoint from Alloy, say *z*. *z* is arguably composed by a sub-plurality of the *mm*, say the *nn*. Hence, each of the *nn* is part of *z* by definition of Fusion. Since each of the *mm*

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<sup>19</sup> Interestingly, the null set is also the zero element of set theory, while any mereology including Weak Supplementation Principle (actually, the weaker Strong Company Principle) does not admit the zero element.

<sup>20</sup> I ignore Extensionality of Overlap, since it is provably equivalent with Uniqueness of Fusion given the lexical axioms for parthood and Weak Supplementation Principle (Loss 2021b, 3457-3458).

is part of Alloy by definition of Fusion, *a fortiori* each of the *nn* is part of Alloy. Therefore, each of the *nn* is both part of Nose and Alloy, so that Nose and Alloy overlap, *contra* Strong Supplementation Principle. Much the same holds with Extensionality of Part. Suppose that Statue is not part of Alloy. Then, by Strong Supplementation Principle, there must be some part of Statue that is disjoint from Alloy. But again, take whatever part *z* of Statue: *z* is composed by a sub-plurality of *mm*, the *nn*. By definition of Fusion, each of the *nn* is part of *z*; however, each of the *nn* is part of Alloy as well, since Alloy is composed by the *mm*.

However, it is important to notice that Strong Supplementation Principle is not necessary to get an extensional mereology. There are proofs of Extensionality of Proper Part, like Simons's and Varzi's, that do not require Strong Supplementation principle. Indeed, Simons's proof holds even in a mereology as weak as to include just the lexical axioms for parthood and the Proper Part Principle. Moreover, the same holds for Uniqueness of Fusion: there are proofs that do without Strong Supplementation Principle. For instance, given Weak Supplementation Principle and the lexical axioms for parthood, Uniqueness of Fusion is equivalent with Extensionality of Overlap, but such a mereology is still weaker than that obtained by simply adding Strong Supplementation Principle to the lexical axioms alone (Loss 2021, 3458). Therefore, the first serious tensions between multi-thingist conceptions of material objects and extensionality arise in mereologies much weaker than CEM.

### 1.3 One-Thingist Treatment of Sortalish Properties

One-thingers fully endorse CEM and its metaphysical consequences. Indeed, they are 'one-thingers' precisely because their acceptance of premise (3) of the Troublesome Argument and the extensionality theorems of CEM seem to imply the identity between Statue and Alloy. One-thingers must then have a story to tell about premises (4) and (5) of the Troublesome Argument, that is, they must substantiate their rejection of those intuitively true premises. Recall that the sub-argument employing Leibniz Law in the Troublesome Argument has the following structure:

- (1) *x* is P
- (2) *y* is not P
- (3)  $x \neq y$  (1, 2, Leibniz Law)

One-thingers deny that (1) and (2) here really have the logical form suitable for the application of Leibniz Law. Recall that there are different kinds of sortalish properties: *de re* modal properties, sortal properties, properties pertaining to persistence conditions, and axiological properties. One-thingers do not have a unified strategy to deal with them all, but rather follow the *dividi et impera* motto: they

distinguish the predicates referring to *de re* modal properties from the other predicates and explain away the problems with 1-3 differently.

As far as predicates referring to *de re* modal properties are concerned, one-thingers regard them as Abelardian predicates (the expression comes from Noonan 1991). Abelardian predicates are such that their reference can shift depending on the subject they are attached to. An Abelardian predicate that does not involve modal expressions is Quine's example of 'was so-called because of his size'. Indeed, the predicate refers to the property *was called Giorgione because of his size* when attached to the name 'Giorgione', and the property *was called Barbarelli because of his size* when attached to the name 'Barbarelli' (see Quine, 1953). Consider the following inference:

- (1) Giorgione was so-called for his size
- (2) Barbarelli was not so-called for his size
- (3) Giorgione  $\neq$  Barbarelli (1, 2, Leibniz Law)

The inference is fallacious, since its clearly false conclusion is obtained from two true premises and Leibniz Law. Although the same predicate appears in (1) and (2), 'was so-called because of his size' is an Abelardian predicate that refers to different properties in (1) and (2). Therefore, there is no single property that Giorgione has but Barbarelli lacks; hence, the application of Leibniz Law is illegitimate.

Crucially, counterpart theory allows treating modal predicates as Abelardian predicates.<sup>21</sup> Consider the sub-argument again, within the Troublesome Argument, concerning modal properties:

- (1) Statue is such that it cannot be squashed and survive
- (2) Alloy is such that it can be squashed and survive
- (3) Statue is different from Alloy (1, 2, Leibniz Law)

First, (1) and (2) are *de re* modal sentences: they respectively say, of an object, that it has and lacks a modal property. Second, in order to guarantee the validity of the inference through Leibniz Law, the property the modal predicates refer to in (1) and (2) must be the same. Yet, counterpart theorists reject this second point by arguing that modal predicates are Abelardian. Particularly, a predicate like 'being able to be squashed and survive' would shift its reference, i.e. the property it refers to, when attached respectively to Statue and Alloy. In (1), the predicate refers to the property *having statue-counterparts that are squashed and survive*, while in (2) to *having alloy-counterparts that are squashed and survive*. Moreover, the counterpart relation is context-sensitive: by calling an object

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<sup>21</sup> Lewis (1968, 1971, 1986) are *loci classici*. However, it is important to notice that, although Lewis developed this theory within his genuine modal realism, he showed that analogous Abelardian treatments of modal predicates are available to further metaphysical theories of modality, insofar representation *de re* is not achieved by means of transworld identity (1986, 259-261).

‘Statue’, a linguistic context is created such that the modal predicate ‘being able to be squashed and survive’ invokes the property involving statue-counterparts, while calling it ‘Alloy’ pushes for a reading of the modal predicate as involving an alloy-counterpart. Therefore, (1) and (2) do not provide a genuine case where a single property that is instantiated by Statue but not by Alloy, or vice versa, and thus the inference through Leibniz Law is illegitimate. Statue and Alloy are identical: they are one and the same object, picked out by different names. One-thingers resort to counterpart theory for every case of predicate referring to a *de re* modal property, and repropose the same pattern above.

So far for *de re* modal properties. Consider now non-modal troublesome properties, such as sortal or axiological property that are *prima facie* instantiated by Statue but not Alloy or vice versa. Since they do not involve modal considerations, their treatment does not rely on counterpart theory. Consider, for instance, the whole class of aesthetic properties.<sup>22</sup> Fine (2003, 206) points out that many such properties are instantiated by Statue but not by Alloy. Statue is Romanesque, while Alloy is not; Statue is well made, while Alloy is not. It is straightforward to construct a sub-argument with the same structure as the *de re* modal properties case:

- (1) Statue is Romanesque
- (2) Alloy is not Romanesque
- (3) Statue  $\neq$  Alloy (1, 2, Leibniz Law)

The one-thingist reply to the present sub-arguments is structurally analogous to the previous one, in that one-thingers regard the inference as involving an illegitimate use of Leibniz Law. Particularly, one-thingers claim that the logical form of (2) is more complex than it looks. (2) is apparently the simple negation of the atomic sentence (1). However, one-thingers claim that (2) expresses a meta-linguistic negation (Almotahari 2014a, 2014b, 2017; Schnieder 2006a; see also Lando 2017, 100 ff). According to Schnieder, the target of the negation in (2) is not the content of the sentence. Rather, the negation stands for a complete rejection of the sentence:

The negated sentence is uttered to convey something like ‘People don’t talk like that’, or perhaps ‘I don’t talk like that’, or even ‘Don’t talk like that’. But instead of making an explicitly meta-linguistic remark, the speaker chooses simply to negate the utterance that he wants to correct or repudiate. (Schnieder 2006a, 46).

In other words, the sentence in (2) cannot be properly asserted in English. However, the meta-linguistic negation in (2) does not tell that, strictly speaking, ‘Statue is Romanesque’ is false: rather,

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<sup>22</sup> Considerations on aesthetic properties of course generalise to all the kinds of non-modal sortalish properties.

the negation here amounts to a rejection of the assertability of ‘Statue is Romanesque’. Hence, the true logical form of (2) is:

(2\*) ‘Alloy is Romanesque’ lacks assertability; what you can say is ‘Statue is Romanesque’

Clearly, by replacing (2) with (2\*), the inference above turns out invalid, since Leibniz Law cannot be employed here.

Hence, one-things do have a story to tell to solve the tension in the Troublesome Argument: they show that the application of Leibniz Law in the argument is fallacious. Thus, there would not be any reason to distinguish between a hylomorph and its matter. Although one-things solve the abovementioned tension through a single strategy, how they achieve their goal remarkably varies between cases involving *de re* modal properties and cases that instead do not involve any modal expression. To manage the first class of cases, one-things employ counterpart theory; to manage the second class of cases, instead, they resort to metalinguistic negation. Clearly, they need both the theories to solve the Troublesome Argument in a way that conforms to one-thingism. In other words, the truth of one-thingism is conditional upon the validity of the counterpart theory, that allows treating predicates expressing *de re* modal properties as Abelardian predicates. And here is the problem: counterpart theory is far from an undisputed theory. To prove the point, I now present three powerful arguments that philosophers have recently advanced against the theory.

#### 1.4 Troublesome Counterparts

Counterpart theory enjoys a wide support among one-things as the sound theory of transworld (non) identity.<sup>23</sup> As we have seen, counterpart theory has a crucial role in providing a satisfying resolution of the tension between the one-thingist conception of material objects and the argument that employs Leibniz Law and sortalish predicates. Counterpart theory is an extremely powerful theory, and its ability to make sense of the flexibility of our modal intuitions is arguably one of its more appealing aspects. However, counterpart theory is not without its flaws. I want now to consider some arguments against counterpart theory and its treatment of sortalish predicates, with a particular emphasis on the modal ones. I take these arguments to show that counterpart theory is far from uncontroversial. Particularly, they show two criticalities with the theory. First, while counterpart theory satisfactorily accounts for the flexibility of some of our modal intuitions, it does so at the cost of denying certain others. Thus, in this respect, its advantage over genuine transworld identity may not be so robust, in the end. Second, counterpart theory aims to furnish to the one-thinger a linguistic tool that should

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<sup>23</sup> Just to mention a few endorsers: Borghini (2005), Cotnoir (2013b), Hawley (2001), Lando (2017), Lewis (1968, 1971, 1986), Rodriguez-Pereyra (2002), Sider (2001), Varzi (2001, 2020), Wang (2015), Wasserman (2002), Woodward (2017).

allow recovering the relevant multi-thingist statements on material objects without having to endorse the multi-thingist ontology. However, it seems to struggle on at least two points. On the one hand, the appeal to counterparts defies the most straightforward way to provide an adequate formulation of persistence conditions for objects belonging to sorts. On the other hand, it cannot account for the asymmetry of the material constitution relation, which is not only a staple of any multi-thingist framework, but also a substantive intuition that one-thingers arguably want, and should, make sense of as well.

#### 1.4.1 A New Humphrey Objection

The analysis of *de re* modal ascriptions in counterpartistic terms has the particular feature that what is *de re* necessary or possible regarding a specific individual, say *x*, is analysed in terms of what happens to individuals that are numerically distinct from *x*. These individuals are the counterparts of *x*, with respect to a salience parameter, that inhabit various possible worlds.<sup>24</sup> Famously, Kripke raised an objection against such an analysis on the grounds that it just seems to change the subject. This objection is known as the *Humphrey objection*, and the following is Kripke's original formulation:

[according to the analysis under discussion] if we say 'Humphrey might have won the election (if only he had done such-and-such),' we are not talking about something that might have happened to Humphrey, but to someone else, a 'counterpart'. Probably, however, Humphrey could not care less whether someone else, no matter how much resembling him, would have been victorious in another possible world. (Kripke 1980, 45)

The objection has an intuitive pull, although it is not immediately clear what is really the problem here. For sure, the Humphrey objection cannot be constructed as the plain denial of the claim that counterparts have something to do with such an analysis of modal ascriptions, on pain of blatantly begging the question against counterpart theory. Hence, some have tried to substantiate the Humphrey objection as a more plausible concern over the subject matter of *de re* modal ascriptions (Salmon 1988, 239-240; Woodward 2012, 66; Yablo 2014, fn. 17). Intuitively, by saying that Humphrey may have won the 1968 election, we are saying something concerning he himself and no one else. Hence, no matter how much any Humphrey-counterpart may resemble him, it should not play any role in making sense of what we are saying of Humphrey. An analysis of such a modal ascription that invokes any individual different from Humphrey is indeed just changing the subject (Merricks 2003, 522). The irrelevance of the fortunes of counterparts for *de re* possibility would then make sense of the psychological extension of the objection, according to which Humphrey really does not care about an alien individual who wins the election (Plantinga 1974, 116; Woodward 2012, 66).

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<sup>24</sup> The relation of counterpart is reflexive, so that *x* is always a counterpart of itself. It may be the case, though, that *x* has more than one counterpart at a possible world.

However, not even this phrasing manages to make the objection more convincing. As for the subject matter, the objection seems to imply that, for any analysis, the *analysans* and the *analysandum* should not be about distinct entities. There are many kinds of analysis, though.<sup>25</sup> For instance, eliminativist analyses attempt to explain away some entity or property in terms of other. If the analysis is successful, one will displace the commitment to the former entity or property with a commitment to the latter. This is the sort of analysis that Argle initially puts forward by dispensing holes in favour of shape properties in the famous paper by Lewis & Lewis (1970, 206). In the context of eliminativist analyses, any demand for the coincidence of subject matter in the *analysans* and the *analysandum* is surely hopeless. The very point of eliminativist analyses is to paraphrase away sentences in order to avoid their commitment.<sup>26</sup> Hence, the *analysandum* does not have, strictly speaking, any subject matter at all. Differently, reductive analyses attempt to identify the commitments of two specific classes of sentences. The content of the *analysandum* and the *analysans* are identical because the entities they commit to are identical.<sup>27</sup> Consider Loss's identification of a composite entity with the plurality of atoms it fuses (Loss 2019b, 2020). This theory allows, in principle, paraphrasing every sentence about a composite entity being such-and-such as a sentence about a certain plurality of atoms being such-and-such. Hence, according to this theory, the subject matters of 'Mario Draghi is talking' and 'The atoms that compose Mario Draghi are (collectively) talking' are identical. In the context of a reductive analysis, thus, any demand for the coincidence of subject matter in the *analysans* and the *analysandum* must necessarily revert to beg the question against the analysis itself. In fact, if the analysis is successful, the subject matters of the *analysans* and the *analysandum* are identical. A reductive analysis precisely aims to identify two specific classes of entities. Hence, if the Humphrey objection is the claim that the subject matters of *de re* modal ascriptions and their counterpartistic analysis are different, it winds up being no more than the claim that such an analysis is unsuccessful. This way, however, the Humphrey objection is still just question begging.

As for the psychological aspect of this formulation of the objection, it may well be true that Humphrey does not care at all whether someone numerically distinct from *him himself* wins the 1968 election; but why should such considerations play any role in the analysis of *de re* modality? What should such considerations tell us about the correctness of any analysis? Sider, for instance, regards the psychological version of the Humphrey objection as a trivial discomfort arising from

[...] the paradox of analysis. A reasonable person can care about a property under one description ('possibly winning') while not caring about the same property under another

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<sup>25</sup> See Beany (2014) for a general survey.

<sup>26</sup> There may be different rational grounds for invoking an eliminativist analysis. For instance, the ontological commitment of a specific class of sentences may be deemed too problematic, or contradicting some other true sentence of the language.

<sup>27</sup> Proviso an – allegedly harmless and suitable - adjustment of the remaining components of the sentences.

description ('having a counterpart who wins'), provided it is not obvious that the descriptions pick out the same property. Correct analyses need not be obvious to competent language users. (Sider 2006, 2).

The fact that a person may find psychologically implausible the counterpartistic analysis implies nothing regarding its correctness. At best, the fact tells something about the obviousness of counterpartistic analyses. Moreover, those psychological attitudes must not be immovable. Arguably, astronomers have learnt to care about one and the same object, Venus, under the two different descriptions 'the morning star' and 'the evening star'. In the same way, philosophers who study and embrace counterpart theory have arguably changed their concerns towards counterparts. Why should we assume reasonable people cannot? At least in a (barely) possible world in which the results of metaphysics are regarded as interesting and thus publicly divulged, people might certainly learn to revise their intuitions:

In taking counterpart theory to heart one might aim to revise, not one's interest in modality, but rather one's concern for certain distant strangers. Humphrey thinks he has no special reason to care about his counterparts. But when he accepts Lewis's analysis he will believe that the modal facts about him just are facts about his counterparts; and since he cares about the former, he will come to care about the latter. (Rosen, 1990, 350)

The strike of psychological implausibility is as strong as the robustness of the intuitions it relies on. However, there are no serious reasons to think that intuitions concerning *de re* modality are immovable in reasonable people. The precariousness of modal intuitions is well known, and it seems that everyone might change them if properly instructed.

Moreover, Benovsky (2015, 19-20) suggests that caring about (certain properties and actions of) a doppelgänger may be not crazy at all. For instance, suppose that you and a doppelgänger of yours have the same, say, level of athleticism, strength, have been both practicing hiking for twenty years, and so forth. Then, you come to know that your doppelgänger managed to climb up the Everest. Consequently, you wind up thinking that, other things being equal, you might climb up the Everest as well. In other words, similarity with respect to certain non-modal properties is projectable along many modal properties. Differently from doppelgängers, though, counterparts need not to be utterly similar to us: given the actual object *o* and a non-actual possible world *w*, a counterpart *c* of *o* in *w* is the inhabitant<sup>28</sup> of *w* that much resemble *o*, where similarity must be conceived as a context-sensitive relation (the context is in turn generally fixed by linguistic factors). Still, once the appropriate parameters for similarity are fixed, our counterparts may really tell a lot about ourselves. If counterpart theory is correct, then it is not true that one should not care about her counterparts when

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<sup>28</sup> If any, and possibly after having fixed the reference of the corresponding term 'c' (Lewis 1986, 256).

assessing what is *de re* possible for herself. Therefore, it seems that also the psychological formulation of the Humphrey objection is ultimately flawed.

Still, there is a further formulation of the Humphrey objection that deserves attention. De (2018, 164-165) usefully distinguishes between two ways in which the objection may be construed:

Respectfulness: an analysis of *de re* modality must respect certain attitudes we have toward modal properties: if a modal property P is analysed in terms of property Q, then one should e.g. care about having P iff they care about having Q;

Relevance: an analysis of *de re* modality must explain a modal attribution of the form ‘*a* has P’ (where P is a modal predicate of ordinary language of the required grammatical form) in terms of what is referred to by ‘*a*’ and by ‘P’ and by no more.

We have just analysed the Respectfulness reading of the objection and found it wanting as an argument against the counterpartistic analysis of modality. If the objection concerns its aboutness, it begs the question; if it concerns our modal intuitions, it is not strong enough to undermine it.

Before discussing the Relevance reading, though, a clarification is in order. De considers the Humphrey objection as an objection to modal realism. It is quite clear from what he says, though, that his understanding of modal realism figures it as the Lewisian brand of modal realism (or something in its vicinity). Accordingly, De’s construction of modal realism characterises it more properly as the conjunction of modal realism and counterpart theory (and further theses that are largely irrelevant for the matter under discussion). Here comes the salient aspect of the discussion: the Humphrey objection is not an issue for modal realism, but rather for counterpart theory. Still, it is understandable to regard the Humphrey objection as an objection to modal realism *tout court* given the fame of Lewisian brand of modal realism. However, modal realism and counterpart theory, although natural allies, can be surely decoupled.

Indeed, counterpart theory is available to ersatzism as well. ‘Ersatzism’ is an umbrella term encompassing all those theories that take possible worlds to be abstract representational entities of some sort<sup>29</sup>. Interestingly, Lewis himself sketches an ersatzist metaphysics of modality that employs counterpart theory (1986, 237-239), and some authors recently developed some version of ersatzist counterpart theory, both in its metaphysical and semantical aspects (see Varzi 2020, Wang 2015, Woodward 2017). According to such a theory, counterpart relations hold between ersatz individuals,

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<sup>29</sup> Divers (2002, ch. 10) uses the label ‘actualist realism’ instead. As far as how the representation is achieved, Lewis (1986, ch. 3) distinguishes between linguistic, pictorial, and magical ersatzism. Again, what all the kinds of ersatzism share is their identification of possible worlds with non-concrete entities. This also explains why ersatzism is sometimes called ‘abstractionism’.

that is, abstract entities representing individuals.<sup>30</sup> Counterpart theory works here as well as in Lewisian modal realism when it comes to the reduction of *de re* modality into *de dicto* modality. Indeed, the following analyses are still completely available for ersatz counterpart theory:

$x$  instantiates P necessarily iff every world  $w$  which has a counterpart of  $x$ ,  $c$ , as part, and  $c$  is P  
 $x$  instantiates P possibly iff there is a world  $w$  which has a counterpart of  $x$ ,  $c$ , as part, and  $c$  is  
P

These two analyses reduce *de re* modality into *de dicto* modality.<sup>31</sup> All the technical notions they employ – possible world, counterpart, part – are available to ersatz counterpart theory. Whether ersatz counterpart theory manages to deliver a reduction *tout court* of modality is, of course, a further question. Lewisian modal realism enjoys non-modal definitions of possible world and counterparthood: possible worlds are connected and maximal mereological sums, and counterparthood is a reflexive relation that every individual bear to any other actual or possible individual that relevantly resembles it. Hence, ersatzist counterpart theory seems to have all the tools available, although there is no agreement on whether it really succeeds in the reduction.<sup>32</sup> On the other hand, standard ersatzist theories of modality are generally regarded as unable to offer such a reduction, since they define the notion of possible world through primitive modality.<sup>33</sup>

Be it as it may, let us consider Humphrey again. The sentence ‘Humphrey might have won the election’ is actually true. The truthmaker of the sentence, though, is a state of affair involving a winning Humphrey-counterpart at some possible world.<sup>34</sup> Such a counterpart is an ersatz-individual, whose ontological category depends on the endorsed ersatzist theory (for instance, a haecceity, or individual essence, on Plantinga’s (1974) account). Moreover, since Humphrey *qua* ersatz individual and his counterparts are numerically distinct ersatz individuals, they have distinct haecceities. Hence, if the Humphrey objection has any force at all, it must have force in the present case as well, despite

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<sup>30</sup> Some ersatz individuals represent actually existing objects, whereas the vast majority of them represent merely *possibilia*. The former ersatz individuals, though not the latter, are said to be actualised. See Woodward (2017, 238).

<sup>31</sup> Proviso a definition of ersatz counterpart devoid of primitive *de re* modality. See Woodward (2017, 240-245) for discussion and an attempt of definition that satisfies such a condition.

<sup>32</sup> See, for instance, the discussion in DeRosset (2009a).

<sup>33</sup> DeRosset (2009b) straight away brands ersatzist theories of modality as ‘non-reductive theories of possible worlds’.

<sup>34</sup> It may be objected that the actual Humphrey must be somehow part of the truthmaker of such a sentence. However, I think such an intuition can be substantiated without invoking a revisionary theory of truthmakers for modal sentences. Consider that the state of affairs that makes ‘Humphrey might have won the election’ true must involve a possible individual who is relevantly similar with the actual Humphrey. Hence, a possible world must include a counterpart of the actual state of affairs *Nixon winning the election* in which, though, a Humphrey-counterpart  $h$  replaces Nixon. Nevertheless, the fact that  $h$  *winning the election* is the truthmaker of ‘Humphrey might have won the election’ is (partially) grounded in the fact that  $h$  is a counterpart of Humphrey. In other words, the counterpart relation between the actual Humphrey and  $h$  plays a role in explaining why the state of affairs  $h$  *winning the elections* makes ‘Humphrey might have won the election’ true. For the use of counterparts of states of affairs as truthmakers within counterpart theory, see Bricker (2015).

counterparts being ersatz individuals. It is easy to adequately rephrase the objection in order to accommodate the ersatzist framework: Humphrey could not care less whether an ersatz individual that represents someone distinct from him has the property of winning the election. Furthermore, notice that the source of tension is not the representationality of the ersatz individuals, but rather the fact that counterparts of an individual are not (identical with) that individual. In fact, Humphrey certainly would care whether the ersatz individual that represents him would win the election because, in such a case, *he himself* would win the election. Therefore, such considerations suggest that the Humphrey objection is truly an objection against counterpart theory, and particularly to its treatment of *de re* modality, but not an objection against modal realism *per se*.

If, on the one hand, it is possible to get counterpart theory without modal realism, it is also possible, on the other hand, to get modal realism without counterpart theory. Modal realism *cum* overlapping worlds is a coherent theory that also allows making sense of *de dicto* and *de re* modal ascriptions, as McDaniel (2004, 2006) shows at great length. According to modal realism with overlap, individuals are not world-bound. Thus, one and the same – numerically the same – individual can be part of more than one world. In the original Lewisian formulation of modal realism, counterparts have the chief role of avoiding the collapse between the properties that world-bound individuals instantiate contingently and necessarily. For the same purpose, modal realism with overlap employs identity together with a reductive notion of possible world. Since it gets rid of counterparts and embraces identity, modal realism with overlap accepts the standard analysis of *de re* modality:

$x$  instantiates P necessarily iff  $x$  instantiates P at every possible world  $w$  whose  $x$  is part  
 $x$  instantiates P possibly iff  $x$  instantiates P at some possible world  $w$  whose  $x$  is part

Of course, these analyses do not offer a reduction of modality on themselves. This is unsurprising, though, since standard ersatzism with Kripke-style transworld identity defines *de re* modality in the very same way. The relevant improvement over ersatzism comes here from the possibility to define a possible world without employing primitive modalities. Modal realism is supposed to allow for a definition of possible world that does without primitive modality. Specifically, possible worlds are connected and maximal mereological sums of spatiotemporal regions, thus being spatiotemporal regions themselves (McDaniel 2004, 147). This way, no primitive modality occurs in the analysis, and the reduction is achieved.<sup>35</sup> Analogous considerations hold for *de dicto* modality.

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<sup>35</sup> At least for sentences concerning individuals. As for *de re* modal ascriptions concerning spatiotemporal regions, McDaniel maintains a counterpartistic account. Indeed, according to his theory, spatiotemporal regions are world-bound. Thus, it is not possible to analyse sentences concerning what is possible (necessary) of this particular spatiotemporal region by resorting to its literal existence at different possible worlds. See McDaniel (2004, 149-150).

Recall now Humphrey. Given its analysis of *de re* modality, modal realism is immune to the objection. The complaint that when we say ‘Humphrey might have won the election’ we are no longer considering Humphrey’s vicissitudes, but those of some doppelgänger of him, is no longer tenable, given overlap between worlds. In the worlds in which Humphrey wins the election, it is Humphrey himself, and not some other distinct individual, who wins the election. Hence, modal realism with overlap appears to be immune to the Humphrey objection. However, the only difference regarding Lewisian modal realism that matters in the present case is the appeal to identity instead of counterpart. Therefore, again, it turns out that Humphrey objection is not an objection against modal realism, but more properly to counterpart theory. To claim the Humphrey objection to be an objection against modal realism is, although not straightforwardly false if the target modal realism is the Lewisian brand, at best misleading. It is indeed an objection to Lewisian modal realism, but only inasmuch as it couples modal realism *stricto sensu* with counterpart theory. And obviously, if C is an objection to A, it is an objection to  $A \wedge B$  as well (provided that A and B are jointly consistent).

We can now consider again the Relevance reading of the Humphrey objection. De suggests that «[w]e could read Relevance as the demand that an analysis of modality be such that it analyze a modal property that is intuitively intrinsic to the sum of some things as intrinsic to that sum» (De 2018, 174). The *de re* modal property of ‘possibly having won the election’ appears to be an intrinsic property of Humphrey (or, as De suggests, of the fusion of Humphrey and the electorate). Yet counterpart theory construes it as an extrinsic transworld relation, that is, in terms of counterparthood. Interestingly, the Relevance reading of the Humphrey objection echoes familiar Lewisian complaints concerning intrinsicity. Famously, Lewis rejected constructions of intuitively intrinsic properties as disguised relations. He argued that an endorser of genuine transworld identity is naturally lead to construct intrinsic properties of objects as relations that they bear with respect to possible worlds and instants of time. But such constructions are inherently problematic, resulting in ‘the problem of accidental intrinsics’ and ‘the problem of temporal intrinsics’ (Lewis 1986, 202-209). Those problems consist in a faulty characterisation of the structure of intrinsic properties. For instance, shape properties are intuitively intrinsic properties of objects, in that they do not vary among duplicates.<sup>36</sup> But then, any construction of shape properties that characterises them as relations must be rejected. After all, «[i]f we know what shape is, we know that it is a property, not a relation» (ivi, 204).

The Relevance reading of Humphrey objection, thus, can be read as ‘the problem of *de re* intrinsics’ for counterpart theory. By caricaturing Lewis’s saying, the objector may very well say that ‘if we know what ‘possibly having won’ is, we know that it is a property, not a relation (let alone a

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<sup>36</sup> The intrinsicity of shapes is nonetheless controversial. See Skow (2007).

transworld relation)'. The very point of the Relevance reading of the Humphrey objection is not the exposition of an incongruity within the Lewisian framework, though. Rather, it aims to show that, if Lewis's complaints concerning accidental and temporal intrinsics are fair (as many indeed accept), then arguably they also undermine the rationale for counterpart theory.<sup>37</sup>

De (2018, 176-178) suggests that it is still possible to answer to the Relevance reading of the Humphrey objection within a broadly Lewisian framework by embracing five-dimensionalism.<sup>38</sup> Consider an ordinary object, such as the lamp on my desk. The lamp exists at many disjoint instants of time. According to perdurantism, the lamp is a four-dimensional object mereologically composed by many momentary lamp-stages, one for each temporal instant it spans over.<sup>39</sup> Five-dimensionalism is the modal extension of perdurantism. Accordingly, objects not only span over times but over possible worlds too. The perduring lamp on my desk winds up being just a world-stage of a transworld mereological sum of world-bound lamps.<sup>40</sup> Five-dimensionalism delivers a systematic translation of *de re* modal sentences into mereological sentences. Accordingly, the sentence 'Humphrey might have won the election' is translated as 'Humphrey has a part that won the election'. This way, the truthmaker of the *de re* modal sentence turns out to involve just a part of the subject of the sentence, thus dissolving any possible charge of extrinsicality. What drives and allows this kind of translation is a semantical revision, according to which the singular term 'Humphrey' refers to the transworld mereological sum of world-bound Humphrey stages. Moreover, notice that five-dimensionalism does not dispense with counterparts: the world-stages of ordinary objects are indeed counterpart-related to each other. The fact is that, whereas in the original Lewisian framework the truthmakers of *de re* modal sentences were counterparts of the subject, in the five-dimensionalist framework the truthmakers are simply mere parts of the subject.

In sum, it is not easy to make sense of the Humphrey objection as an objection to the Lewisian framework. On a trivial reading, the objection simply begs the question. On the Respectfulness reading, it is at best wanting and at worst utterly unconvincing. On the Relevance reading, though, the Humphrey objection is strong enough to expose an incongruity within the Lewisian framework. Such a criticism is not knock down, though, since the endorser of counterpart theory can still resort to five-dimensionalism in order to address the problem. However, despite being a theoretical move that Lewis, and many Lewisians as well, explicitly rejects, five-dimensionalism is a thesis which no doubt triggers an incredulous stare. Of course, though, to insist that the individuals which instantiate

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<sup>37</sup> Interestingly, De (2018, 175-176) mentions, and dismisses, a version of modal realism with overlap as an answer to the Humphrey objection for the very reasons that, although it successfully copes with the problem of *de re* intrinsics, it still falls victim of the problem of accidental intrinsics.

<sup>38</sup> Actually, Lewis already envisioned and discussed such a solution (Lewis 1986, 214-217).

<sup>39</sup> I leave a much more careful analysis of perdurantism for the chapter 3.

<sup>40</sup> For endorsement of five-dimensionalism see Graham (2015), Wallace (2014, 2019), Yagisawa (2010).

the intrinsic *de re* modal properties must be the familiar common-currency individuals is just reaffirming a trivial reading of the objection. I take the most relevant theoretical costs of five-dimensionalism to be not its serious acknowledgement of unusual individuals in the semantics for modal and non-modal language, but rather its consequences on the relation between predicates and the properties they refer to. Consider again the Relevance reading of the Humphrey objection. It states that an acceptable analysis of *de re* modality should explain the truth of ‘Humphrey might have won the election’ in terms of the references of ‘Humphrey’, ‘might have won the election’, and nothing else. We have seen that five-dimensionalism’s translation of that sentence is ‘Humphrey has a part that won the election’, where ‘Humphrey’ refers here to the transworld fusion of the actual Humphrey and all of his counterparts throughout the logical space. However, the Relevance reading suggests that the reference of the predicate must shift too: arguably, the predicate ‘might have won the election’ must refer to the property *having a part that won the election*. The result is a perfect mimic of the semantic counterpart theory delivers:

It follows from 5D that the expression ‘Humphrey’ refers not to our worldbound Humphrey, but instead to a [transworld fusion] that has our worldbound Humphrey as part, and the sentence ‘Humphrey could have won the election’ is true just in case Humphrey has a part who wins the election. All of this is truth conditionally equivalent, of course, to what original counterpart theory gives us since [the transworld fusion] has a part who wins the election just in case worldbound-Humphrey has a counterpart who wins the election. (De 2018, 177)

De is considering here the case of a sentence featuring a modal predicate. This sort of revisionism is still in line with the original counterpart theory, which uses counterparts only in the analysis of *de re* modal predicates. However, five-dimensionalism must enlarge the revision of language to non-modal predicates as well. Take the sentence ‘Humphrey has lost the election but might have won them’. A usual linguistic test for ambiguity is checking for zeugmas. Here, however, there does not seem to be any, so that there is no linguistic ambiguity. Five-dimensionalism answers the Relevance reading of the Humphrey objection by requiring that ‘Humphrey’ refers to a transworld sum, given the *de re* modal predicate in the second part of the sentence. Since the sentence is not ambiguous, however, ‘Humphrey’ must refer to the same transworld sum also with respect to the first part of the sentence. Thus, ‘Humphrey has lost the election’ here is really a sentence which refers to the transworld sum. Since ‘Humphrey has lost the election but might have won them’ is true, ‘Humphrey has lost the election’ must be true; and since ‘Humphrey’ refers to a transworld fusion, the predicate ‘having lost the election’ must refer to the property *having a part that has lost the election*. But then the revisionism envisaged by five-dimensionalism is more extreme than that of the original counterpart theory. According to counterpart theory, in fact, a non-modal predicate such as ‘having lost the election’ simply refers to the corresponding property *having lost the election*. Hence, five-

dimensionalism is more costly than original counterpart theory not only with regard to the relation between singular terms and their referents, but also that between non-modal predicates and the properties they refer to. Therefore, the Humphrey objection turns out being quite threatening, when taken seriously, since it leads the Lewisian to highly suspicious revisionary semantic claims. The Lewisian must concede that, while apparently straightforward and almost trivial, the logical form of even the simplest sentences concerning the instantiation of a property by an individual, like ‘*x* is *F*’, is much more complex than it seems.

### 1.4.2 The Vacuous Satisfaction of Identity Criteria

Endorsers of counterpart theory often remark that their theory allows making sense of the inconstancy of our modal intuitions.<sup>41</sup> However, Mackie (2018) argues that the flexibility counterpart theory guarantees may be too much. Particularly, it may end up preventing acceptable formulations of persistence conditions for objects belonging to substance sortals.<sup>42</sup> A satisfying formulation of persistence conditions would appear to require serious, irreducible *de re* modality, on pain of providing principles that are vacuously satisfiable, and thus inadequate. However, the counterpartistic analysis of *de re* modality as *de dicto* modality would push a stronger, substantive formulation of such principles back to vacuous satisfiability.

Consider again Statue and Alloy. Intuitively, there is a difference between their persistence conditions, which is plausibly grounded in their difference with respect to the kinds they belong to. Persistence conditions are associated with kinds, or sorts, which objects belong to, and inform about the conditions under which individuals belonging to a kind  $\phi$  will continue or cease to exist (Lowe 2009, 67-68). Statue is a statue, which is definitely a sort. As such, it cannot survive radical reshaping: if Statue winds up under a steamroller, it ceases to exist. Still, Statue survives the gradual replacement of the matter that constitutes it: if the replacements are gradual enough, it seems to be able to survive a complete replacement of its original matter. By contrast, Alloy belongs to a different sort (piece of alloy) and it has different persistence conditions: for instance, it can be reshaped much more radically than Statue, but cannot survive any replacement of its matter. Differences in sort, thus, ground and explain differences in persistence conditions. Moreover, differences in persistence conditions amount

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<sup>41</sup> As Fara & Williamson rightly point out, counterpart theorists often claim that «[...] only with the machinery of counterpart theory can we adequately explain the ‘inconstancy of representation *de re*’, the wavering back and forth of our intuitive judgements about essentialist claims» (2005, 1). For genuine expressions of the adagio, see for instance Lewis (1986, 251) and Woodward (2012, 62-63).

<sup>42</sup> Although persistence conditions concern the existence of objects over time, their formulations make irreducible use of modal operators as well. Crucially, when such operators are construed according to counterpart theory, some trouble arises for the formulations.

to differences with respect to instantiation of modal properties, that is, properties stating what is possible (necessary) for the subject.

In order to clarify the issue, it is useful to introduce the notion of a principle of individuation (Lowe 2012, 215-217). Principles of individuation tell, for a kind *K* of objects, what kinds of entities fix, or contribute to fix, the individual essence of a certain *K*. Consider events. For any event *e*, the very identity of *e* is fixed, at least partially, by the individuals that participate to *e*. In other words, *e* is identity-dependent upon its participants. Hence, ‘having its actual participants’ is arguably a principle of individuation for events. Or take again sets. The members a set has collectively fix the very identity of that set. Hence, ‘having its actual members’ is a principle of individuation for sets. Principles of individuations for *Ks* also provide the persistence conditions for *Ks*: if the very identity of a *K* is fixed by certain relations it has with further entities, clearly it cannot cease to stand in those relations with those very entities without ceasing to exist.<sup>43</sup>

We can state more precisely what is at stake here. The kind an object belongs to is associated with certain principles of individuation that determine, for every object of that kind, what fixes its very identity. Principles of individuation for *Ks* thus provide persistence conditions for *Ks*. Take statues. The identity of every statue is (at least partially) fixed by its actual shape, that make up a principle of individuation for statues. Hence, no statue can lose its actual shape and persist, precisely because the shape of a statue determines, at least partially, what is to be that very statue. Analogously, portions of matter cannot lose any replacement of their matter because the identity of each portion of matter is fixed by all of its actual matter.

Predicates such as ‘being a statue’, ‘being a piece of alloy’ pick out substance sortals, that is, properties characterising an object for what it fundamentally is. Substance sortals are, at the very least, necessarily permanent properties (Parsons 2005, 9):<sup>44</sup>

(NP) Necessarily, if *P* is a sortal and *x* has *P* at a time *t*, then *x* has *P* at every time of its existence

Together with the legitimate assumption that ‘statue’ and ‘piece of alloy’ pick out substance sortals, (NP) implies:

(S1) Necessarily, for all *x*, if *x* is a statue at any time of its existence, then *x* is a statue at all times of its existence

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<sup>43</sup> Lowe (2012, 217) notices that principles of individuations for *Ks* can also provide criteria of identity for *Ks*. Of course, if *x* depends for its identity upon *z*, then no *y* can be identical with *x* and not standing in the appropriate relation to *z* as well. The case of sets is probably the best example again. If the identity of the set *x* is totally fixed by the relation of membership between *x* and its members, say *a* and *b*, then clearly if a *y* does not have *a* and *b* as its sole members, it cannot be identical with *x*.

<sup>44</sup> Though see Lowe (2009, 109) for scepticism about such a principle.

(P1) Necessarily, for all  $x$ , if  $x$  is a piece of alloy at any time of its existence, then  $x$  is a piece of alloy at all times of its existence

(S1) and (P1) may be very well considered being analytically true statements, given that they are logical consequences of analytically true statements alone. Moreover, since *being a statue* and *being a piece of alloy* are substance sortals, they must be associated with principles of individuation that provide persistence conditions for the objects that belong to them. Mackie (2018, 1427) warns that the construction of the persistence conditions is not a trivial issue. On a first sight, it seems that *de dicto* principles like the following ones can accurately convey persistence conditions:

(S2) Necessarily, for all  $x$ , if  $x$  is a statue, then, if the matter that constitutes  $x$  at  $t$  is radically reshaped,  $x$  then ceases to exist

(P2) Necessarily, for all  $x$ , if  $x$  is a piece of alloy, then, if the matter that constitutes  $x$  at  $t$  is radically reshaped but preserved in one coherent mass,  $x$  survives

Inasmuch as (partial) formulations of persistence conditions for the corresponding sorts, (S2) and (P2) should be respectively associated with the sorts *being a statue* and *being a piece of alloy*. They must express (some of) the conditions which things of those sorts can, or cannot, undergo without ceasing to exist. However, for the theorist with multi-thingist inclinations, they must capture a further aspect of those sortals: namely, the impossibility, for one object, to belong to them both, that is, the impossibility for one object to be both a statue and a piece of alloy. Clearly, in order to satisfy this second requirement, the formulation of those principles must avoid that a single object may serve as a truthmaker for them both.

However, (S2) and (P2) fall short of vindicating the multi-thingist claim. Indeed, (S1), (S2), (P1), and (P2) are jointly consistent with the identity between Statue and Alloy. Suppose that Statue is identical with Alloy: then *of course* ‘they’ both exist. The truth of an identity statement requires the existence of the relata. Accordingly, ‘they’ did not undergo radical reshaping: otherwise, Statue would have ceased to exist by (S2), and such a case would contradict the assumption of identity. Moreover, (S1) is inconsistent with any claim stating that, at  $t$ , Statue does not really cease to exist, but merely changes its sort (by becoming, for instance, a piece of alloy). Hence, (S1), (S2), (P1), and (P2) are jointly consistent with the identity between Statue and Alloy. What is crucial for such a consistency is that the matter constituting Statue (Alloy) is never radically reshaped. In such a case, the *de dicto* principles (S2) and (P2) would turn out to be true, yet trivially so in virtue of the falsity of their antecedents.<sup>45</sup>

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<sup>45</sup> Importantly, these principles are jointly consistent only if the identity between Statue and Alloy is soft, that is, some sort of contingent identity (the labels ‘soft’ and ‘hard’ identity, respectively standing for contingent and necessary identity,

Mackie (2018, 1429) argues that this is not a satisfying result. Recall that (S2) and (P2) are meant to make sense of multi-thingist intuition that Statue and Alloy are different partially in virtue of their different persistence conditions. Yet, (S2) and (P2) fall short of adequately capture such a difference, since they are consistent with some sort of identity between Statue and Alloy. Accordingly, she joins the crowd of theorists expressing persistence conditions through stronger *de re* principles:

(M1) Necessarily, for all  $x$ , if  $x$  is a statue, then  $x$  *could not* have been subjected to a radical reshaping of its matter without being destroyed

(M2) Necessarily, for all  $x$ , if  $x$  is a piece of alloy, then  $x$  *could* have been subjected to a radical reshaping of its matter without being destroyed

(M1) and (M2) are strictly stronger than (S2) and (P2). Furthermore, differently from (S2) and (P2), they imply that Statue and Alloy have those very persistence conditions in every possible world. In itself, though, this implication may seem gratuitous: why Statue must have statue-like persistence conditions in every possible world in which it exists? It is not uncommon for multi-thingers to ground the necessary satisfaction of (M1) and (M2) on the further claim according to which objects belong to their sortals essentially, a thesis known as sortal essentialism (see Mackie 2006, ch. 7, 8). According to sortal essentialism, necessarily, if  $P$  is a sortal and  $x$  is  $P$ , then  $x$  is essentially  $P$ . Sortal essentialism is strictly stronger than (NP): clearly, if  $x$  is essentially  $P$ ,  $x$  must be  $P$  at every instant of its existence as well. Moreover, if  $x$  is essentially  $P$ , then  $x$  is also necessarily  $P$ : therefore, it turns out that, in every possible world in which it exists,  $x$  is  $P$  at every time of its career at that world. Historically, such a thesis dates back at least to Locke's *Essay*, and has several endorsers among contemporary multi-thingers such as Wiggins (2001) and Korman (2015). Baker (2007, 33-34) expresses the doctrine distinctly, and also associates it with the further claim that objects have their actual persistence conditions necessarily:

For any  $x$ , we can ask: What most fundamentally is  $x$ ? The answer will be what I call  $x$ 's 'primary-kind.' Everything that exists is of exactly one primary-kind – e.g., a horse or a passport or a cabbage. An object's primary kind goes hand in hand with its persistence conditions. Since a thing has the same persistence conditions in every possible world and time at which it exists, it has its persistence conditions essentially. And since an object's primary kind property determines what it most fundamentally is, an object has its primary-kind property essentially: An object could not exist without having its primary-kind property.

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come from Linnebo (2016, 6)). The existence of the statue Statue at a time  $t_0$  in some possible world  $w$  in which its constituting matter is then radically reshaped at a time  $t_1 > t_0$  seems, in fact, undisputed. Clearly, given (S2), at time  $t_1$  in  $w$ , Statue ceases to exist. Moreover, given (S1), it cannot be the case that Statue changes its sortal, since it is supposed to be a statue at  $t_0$ . Suppose that identity is necessary: since it is supposed that Statue = Alloy in the actual world, it follows that they are identical in every possible world in which they exist. Hence, they are also identical in  $w$ . Yet, in  $w$ , it seems that (P1) guarantees the existence of Alloy after  $t_1$ . Statue, however, does not exist anymore at that time, given (S2). Therefore, although soft identity is consistent with (S1), (S2), (P1), and (P2), hard, necessary identity is not.

Still, notice that sortal essentialism is not strictly mandatory in order to endorse the *de re* principles above. One may very well hold consistently that Statue necessarily has its actual persistence conditions, yet not its sort. It is just that such a position seems hard to justify on itself. However, if objects belong necessarily to their sorts and sorts are necessarily associated with persistence conditions, then objects surely retain their actual persistence conditions across possible worlds. Alternatively, it may be said that there is a context that determines which worlds are relevant for the assessment of (M1) and (M2) (as in Mackie 2020). In such a case, those principles would not be unrestrictedly true, yet true in all the possible worlds of the partition on modal space the context imposes (for instance, in all the possible worlds in which the objects retain the same primary-kind they actually belong to).

Be it as it may, the *de re* principles do the trick. The conjunction of (S1), (P1), (M1), and (M2) is incompatible with the identity, no matter how soft, between Statue and Alloy. Assume Statue is contingently identical with Alloy. Hence, there is a single object, let us call it *o*, that is both a statue and a piece of alloy. By (M2), *o* could not have been subjected to a radical reshaping of its matter without being destroyed. However, by (M1), *o* could have been subjected to a radical reshaping of its matter without being destroyed. Again, (S1) and (P1) prevent any change of sort for *o*. As a result, *o* satisfies two jointly inconsistent conditions. Therefore, we must drop the assumption of identity. Notice that the necessity of identity does not play any role here: (M1) and (M2) simply serve as two incompatible modal properties, such that one and the same entity cannot instantiate them both on pain of contradiction. Therefore, not only (M1) and (M2) straightforwardly suit a multi-thingist material constitution framework, according to which statues are not pieces of clay and vice versa, but also push the contingent identity theorist for a reply.

Famously, such a theorist can simply rely on counterpartistic analysis of *de re* modal statements. The story is familiar. Statue and Alloy differ with respect to persistence conditions: yet, such a difference does not really transfer to a difference with respect to modal properties. *De re* modality is analysed away in terms of *de dicto* modality. Accordingly, (M1) and (M2) are analysed as:

(M1\*) For all *x*, if *x* is a statue, then *x* has not statue-counterparts that are subjected to a radical reshaping of their matter without being destroyed

(M2\*) For all *x*, if *x* is a piece of alloy, then *x* has piece-of-alloy-counterparts that are subjected to a radical reshaping of its matter without being destroyed

Again, the conjunction of (S1), (P1), (M1\*), and (M2\*) is consistent with the contingent identity between Statue and Alloy. One and the same object is both a statue and a piece of alloy, *contra* the multi-thingist intuition.

However, Mackie (2018, 1432) argues that this last move is problematic. Recall that *de re* principles were invoked to construe persistence conditions, for statues and pieces of alloy, that are actually, as opposed to potentially, jointly inconsistent. The original (S2) and (P2) are unsatisfying because a single object can vacuously satisfy them both: all it takes is that the matter constituting the object never undergoes radical reshaping. In other words, (S2) and (P2) makes too easy for a single object to satisfy them both. This is not the case with (M1) and (M2): as checked above, no single object can consistently satisfy them both. Counterpart theory delivers an analysis of (M1) and (M2), respectively, as (M1\*) and (M2\*), that re-establishes their joint consistency. But such a re-establishment is faulty: in fact, counterpart theory allows endorsing (M1) and (M2) jointly precisely because it analyses them as the *de dicto* principles (M1\*) and (M2\*). But such principles are unacceptable for the very same reasons why the original *de dicto* principles (S2) and (P2) were unacceptable: they make too easy for a single object to satisfy them both. In other words, a counterpartistic analysis makes too easy for a single object to be both a statue and a piece of clay, a consequence that multi-thingers surely cannot accept. Therefore, since (M1) and (M2) are adequate constructions of persistence conditions whereas (M1\*) and (M2\*) are not, and the former entail the latter only with counterpart theory on board, Mackie concludes that counterpart theory should be rejected.

In order to show why irreducible *de re* modality is crucial in the adequate formulation of persistence conditions, Mackie draws a comparison with arguably less controversial issues. Let us consider her toy-analyses of bravery and cowardice. As above, she starts by formulating the following *de dicto* principles:<sup>46</sup>

(B1) Necessarily, for all  $x$ , if  $x$  is a person, then,  $x$  is brave only if, if  $x$  is confronted with danger,  $x$  stands firm

(C1) Necessarily, for all  $x$ , if  $x$  is a person, then,  $x$  is coward only if, if  $x$  is confronted with danger,  $x$  runs away

And again, as above, she rejects them on the ground that it is too easy for one and the same person to satisfy them both: it suffices that she is never confronted with danger. Clearly, though, such vacuous satisfaction does not show that a single person can be both brave and coward, but rather that (B1) and (C1) do not express adequately the modal aspects of bravery and cowardice.<sup>47</sup> Unsurprisingly, *de re* principles capture the modal aspects of bravery and cowardice more appropriately:

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<sup>46</sup> Notice that the following principles are construed as material conditionals, not counterfactual ones. Their truth conditions must be construed accordingly.

<sup>47</sup> Carnap (1936, 440) rejected an analysis of dispositions in terms of plain conditional sentences precisely on the grounds of a vacuous satisfaction argument.

(B2) Necessarily, for all  $x$ , if  $x$  is a person, then,  $x$  is brave only if  $x$  would have stood firm if  $x$  had been confronted with danger

(C2) Necessarily, for all  $x$ , if  $x$  is a person, then,  $x$  is coward only if  $x$  would have run away if  $x$  had been confronted with danger

Consider now the following respective instances of (B2) and (C2):

(BM) Brave Bill would have stood firm if he had been confronted with danger

(CM) Wimpy William would have run away if he had been confronted with danger

Given a counterpartistic analysis of (BM) and (CM), though, they would end up saying something about the counterpart of, respectively, Brave Bill and Wimpy William. As a consequence, it might be the case for a single person to be both Brave Bill and Wimpy William! Yet, surely no one can be both brave and coward. Importantly, this was exactly the reason why the *de dicto* principles (B1) and (C1) were discarded in the first place. Therefore, an eventual counterpartistic analysis of (BM) and (CM) does not adequately capture the modal aspects of bravery and cowardice. In this respect, thus, the resulting analyses are just like the above *de dicto* principles (B1) and (C1), and they should be rejected as well.

Although the two cases are clearly distinct, there is a deep analogy between them. Genuine *de re* modality appears to be necessary for capturing the modal aspects of the concepts at stake. Counterpartistic analyses of *de re* modality, though, end up only saying something about what, for instance, statue-counterparts or coward-counterparts do. In so doing, such analyses controversially allow a single object being both a statue and a piece of alloy, or coward and brave. By analysing *de re* modality as *de dicto* modality, counterpart theory re-establishes the non-incompatibility between the associated conditional formulations.

Notice, though, that Mackie's argument is not free of side assumptions. First, it is simply a non-starter for philosophers with strictly one-thingist inclinations. Indeed, her argument precisely relies on the multi-thingist claim that a single object cannot be both a statue and a piece of clay. Second, she also assumes that there are sort-associated *bona fide* persistence conditions for objects, provided by respective principles of individuation (as for Lowe 2009, 67-68; see also Lowe 2012, 217). Lastly, her argument would prove to be sturdier if she endorsed some version of sortal essentialism, as well as the necessary connection between sorts and their associated persistence conditions. Despite these marginal remarks, which many philosophers with multi-thingist inclinations would find largely acceptable, the vacuous satisfaction argument retains much of its strength. Some more clarifications are in order, though.

First, Mackie does not aim to prove that one-thingism is false, but rather than counterpart theory is untenable if we acknowledge certain rather weak multi-thingists intuitions as genuine, which is evidently what she does. True, one thingism is usually backed up by counterpart theory, but it is by no means dependent on it, as Burke's (1992) and Gibbard's (1975) theories make it plain. Hence, Mackie's argument should be read as claiming that, once we grant the genuineness of certain multi-thingist intuitions about the persistence conditions of kinds of objects and yearn for making sense of them, we cannot rely on counterpart theory.

Second, we have already considered that, while Mackie is not strictly committed to the acceptance of some version of sortal essentialism, she may be better off endorsing it, since it would offer a robust and principled reason to regard (M1) and (M2) as non-contextually true. However, recall the first point discussed above: Mackie is speaking on the behalf of those who share certain multi-thingist intuitions about the persistence conditions associated to certain kinds of objects. And those who share those multi-thingist intuitions are often attracted by such essentialist theses as well. For instance, Korman (2015, 167) regards some version of sortal essentialism as very plausible, and Mackie herself, in a previous work, recognised the existence of a «pretty general consensus» for the acceptance of sortal essentialism (Mackie 2006, 118).<sup>48</sup> Of course, though, philosophers who reject strong essentialist theses would also reject sortal essentialism. Particularly, some philosophers hold that objects instantiate some of their properties essentially only provided a certain context: a linguistic context, according to Lewis (1986); an explanatory context, according to Sullivan (2017). As a result, they would reject the unrestricted brand of sortal essentialism that helps to go through Mackie's argument. Yet, it is worth recalling that the acceptance of sortal essentialism is not a necessary condition for granting the truth of (M1) and (M2). The most promising alternative solution is regarding (M1) and (M2) as not unrestrictedly true, but still true in every possible world in which Statue and Alloy are, respectively, a statue and a piece of alloy.

The validity of the vacuous satisfaction argument is thus conditional on a certain number of assumptions that a multi-thinger is much more ready to accept than a one-thinger. Still, at the very least, Mackie's argument shows that those who reject one-thingism must reject counterpart theory as well. Moreover, since one-thingism needs supplementation by counterpart theory in order to resist the simple argument employing Leibniz Law, we can conclude that one-thingism is tenable if and only if counterpart theory is tenable.<sup>49</sup> However, Barker and Jago have an argument to the effect that

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<sup>48</sup> Yet, Mackie (2006) expends a great deal of effort in criticising sortal essentialism!

<sup>49</sup> To be fair, one-thingism does not *need* counterpart theory. For instance, Burke (1992) and Gibbard (1975) have advanced non-counterpartistic theories that should allow one-thingism coping with the Troublesome Argument. However, these two theories are largely ignored, since they are arguably inherently more problematic and less powerful than counterpart theory.

their conjunction still struggles to make sense of the asymmetry of material constitution relation. If they argument is successful, it is definitely bad news for the standard one-thingist metaphysics of material objects.

### 1.4.3 A Conjunction That Should Not Take Place

Many multi-thingers take the relation between hylomorphs and their matter to be material constitution. Minimally, there relation is characterised as a one-to-one relation between concrete objects - typically between portions of matter and hylomorphs, although some authors claim that hylomorphs may materially constitute further hylomorphs – which is also asymmetric (and thus irreflexive). Intuitively, if a portion of alloy materially constitutes a statue, then the converse is not the case. Hence, according to any construction of the relation, if it is the case that Alloy constitutes Statue, the converse cannot hold.

We have seen how counterpart theory can support one-thingism by avoiding the troublesome inference through modal properties and Leibniz Law. Whereas a multi-thinger would say that Statue, but not Alloy, can survive the replacement of some of its parts, and thus conclude that Statue and Alloy are distinct objects, a one-thinger would object that there is not really a single property at stake here. By relying on an Abelardian theory of modal predicates, she would say that the predicate ‘being able to survive the replacement of some of its parts’ shifts its reference, which is the property it refers to, in accordance with the subject it is paired with. Counterpart theory substantiates the claim by stating that the predicate refers to *having statue-counterparts that survive the replacement of some of their parts* when paired with Statue, and *not having piece of alloy-counterparts that survive the replacement of some of their parts* when instead paired with Alloy.

One may still wonder whether one-thingism can appropriately capture the asymmetry of material constitution. Indeed, such a theoretical position typically reduces material constitution either to overlap, if the constituee and the constituted are not wholly temporally coincident, or to identity, if they are; and both overlap and identity are symmetric relations. However, as Barker & Jago (2014) highlight, there is a clear sense in which the material constitution relation must be asymmetric. Indeed, the relation is intended to capture the fact that the constituted object is the constituee with, so to speak, ‘more structure’:

Claims of material constitution carry information about recipes for making things. If we tell you that the cardigan is made of one piece of thread, then we convey the information that one way of getting a cardigan is to take some thread and process it in a certain way. A single wool thread is part of at least one recipe for a cardigan. (Barker & Jago 2014, 2)

The presence of structures manifests itself particularly in the kinds of change that constituted objects and their constituee can endure through. These features are typically captured by modal properties.

For instance, the single wool thread may have materially constituted a scarf instead that a cardigan, but this is not true of the cardigan. By undoing the cardigan to get a scarf, in fact, one loses the structure of the cardigan, hence the cardigan itself. By comparison, the cardigan may arguably survive a slow replacement of its whole material, whereas this seems to be not true of the wool thread. Such an event, in fact, would preserve the structure of the cardigan, which is what matters for its identity, but would lead to the destruction of the wool thread. That  $x$  materially constitutes  $y$ , then, registers that  $x$  somehow realises (temporally, contingently) the structure necessary for the existence of  $y$ , and so that there are causal processes and interactions such that, given an object of the kind  $x$  belongs to, return an object of the kind  $y$  belongs to.

Therefore, the asymmetry between constituted objects and their constituees seems to be a genuine aspect of the world. Consequently, an exhaustive metaphysical framework should account for it. However, if the asymmetry material constitution hints at is real and one-thingism cannot adequately make sense of it, then one-thingism must be rejected. Clearly, the one-thinger has two strategies available: she can either deny the genuineness of such an asymmetry or claim that her account still manages to make sense of it.

Let us consider the first strategy. According to some authors, the perceived asymmetry is just a conceptual artifact due to pragmatic considerations. For instance, Wasserman (2004, 706) asks to consider typical cases of material constitution, such as a statue and a lump of clay; a person and a body; a flag and a piece of cotton; a sign and a piece of metal. For each of such couples, a multi-thinger would say that the second object materially constitutes the first object, which is obtained by adding more structure to its constituee: from here, there is the asymmetry. Wasserman acknowledges that there may really be a kind of hierarchy here, to the effect that materially constituted objects sit higher than their respective constituees. Still, he claims that such a hierarchy is nothing more than a construction out of human interests rather than a fundamental aspect of reality. Indeed, it would capture the fact that we, as human, generally regard statues to be more valuable than lumps of clay; persons than bodies; and so forth. Analogously, Biro maintains that «while it is often of more interest to us whether a piece of clay is a statue than whether a statue is a piece of clay, the latter, too, may well be of concern» (2018, 1179).

However, Barker & Jago (2014) argue that such a pragmatic explanation is ultimately untenable, in that it would lead to implausible claims in cases in which agents have uncommon interests with respect to materially constituted objects:

Consider Cortés, melting down Aztec statues to extract gold. He had no (or very little) interest in the statues *qua* statues. However, if [the pragmatic explanation] was right, it would have been appropriate for Cortés to say: this lump of gold is made up of (materially constituted by) this statue. This isn't plausible. The disagreement between the Conquistadors and the Aztecs

over what was valuable – the statues or the gold – was not a dispute about whether the statues materially constituted the lumps of gold. The agreed facts of material constitution cut across their differing interests. (Barker & Jago 2014, 3)

Despite a complete lack of interest in Aztec art, it is implausible to think that Cortés may have uttered a similar statement. Human interests cannot override the structure of statues. More plausible, Cortés may have said: I want you to collect all the Aztec gold. If one is really not interested in a statue but still intends to refer to it, she will probably ignore it by focusing instead on its constituting matter alone. Nevertheless, even Cortés would have recognised that Aztecs crafted those statues by imposing a certain structure on some lumps of gold. And, according to Barker & Jago, this is precisely what the relation of material constitution is meant to express.

Let us now consider the second strategy. One-thingers can still acknowledge the existence of some sort of asymmetry between constituted objects and their constituees, while denying that it pertains to the world. Rather, they can offer a framework that locates the asymmetry in the language. The present one-thingist approach proceeds in two steps. First, take a *modal* definition of material constitution. According to such definitions, the fact that  $x$  and  $y$  stand in a material constitution relation comes with further modal facts involving  $x$  and  $y$ . Second, apply the counterpartistic analysis, or any other analysis that allows maintaining an Abelardian reading of the modal predicates, to the sentences expressing such modal facts. This way, the one-thinger can maintain the existence of some sort of asymmetry embedded in the relation of material constitution but still deny that we should take it as a genuine aspect of the world.

Barker & Jago (2014, 8) scrutinise this second strategy and, ultimately, find it wanting. They consider a scenario involving three spatiotemporally coincident objects standing in relations of material constitution which is slightly more complicated than usual: (i) a mass of gold, (ii) a gold sheet, (iii) a gold sculpture. A multi-thinger may claim that, in the scenario, the mass of gold materially constitutes the gold sheet, which in turn materially constitutes the gold sculpture. A one-thinger must dissent by arguing that there is just one object, that is both the mass of gold, the gold sheet, and the gold sculpture. In other words, the denotation of the three definite descriptions is the same concrete piece of reality. Be it as it may, the two theorists must have something to say with respect to the following sentences:

- (1) The thing that is both a mass of gold and a gold sheet materially constitutes the sculpture
- (2) The thing that is both a mass of gold and a sculpture materially constitutes the gold sheet
- (3) The gold sheet materially constitutes the thing that is both a mass of gold and a sculpture

Barker and Jago take (1) to be acceptable, but regard (2) and (3) as bizarre. Intuitively, their oddness stems from stating that an object with a more complex structure constitutes an object with a simpler

structure. Consider (2): it bestows on the sculpture a role in materially constituting a gold sheet, and analogously, (3) bestows on the gold sheet a role in materially constituting a gold mass. Intuitively, though, the structure of a sculpture is more complex than the structure of a gold sheet; and analogously, the structure of a gold sheet is more complex than the structure of a gold mass. If the one-thingist strategy is viable, it must make sense of the present salient difference between (1) on the one hand, and (2) and (3) on the other.

Accordingly, the one-thinger must first endorse a definition of material constitution that allows the application of some Abelardian analysis to the relevant predicates. The most promising kind of definitions is thus a modal one. Barker & Jago (2014) consider three distinct definitions that have been advanced in the literature: (i) destruction (ii) essential parts, and (iii) favourable circumstances.

The Destruction definition is due to Doepke (1982) and Simons (1987):

Destruction: *a* materially constitutes *b* at *t* iff (i) *a* spatially coincides with *b* at *t*, and (ii) *a* could be a substratum of *b*'s total destruction

The mass of gold and the gold sheet spatially coincide at many distinct times. At each of these times, the gold sheet may be molten and reshaped, for instance, into a ring. The gold sheet is totally destroyed in such a scenario but, if no particle at all is lost, the mass of gold surely persists. Hence, it follows that the mass of gold materially constitutes the gold sheet at those times. Similarly, the gold sheet and the gold sculpture spatially coincide at many distinct times. At each of those times, you can unfold the gold sheet, thereby totally destroying the sculpture (plausibly, no sculpture cannot persist through a radical alteration of its shape). Again, it follows that the gold sheet materially constitutes the sculpture at those times. Analogously, the mass of gold turns out materially constituting the gold sculpture at each time they spatially coincide.

The Essential Parts definition is due to Thomson (1998):

Essential Parts: *a* materially constitutes *b* at *t* iff (i) *a* spatially coincides with *b* at *t*, (ii) something is an essential part of *a* at *t*, no part of which is an essential part of *b* at *t*, and (iii) all essential parts of *b* at *t* have a part which is essential to *a* at *t*.

Plausibly, the mass of gold is a structureless entity, and so each of its parts is essential for its identity. Still, none of its parts is essential to the gold sheet, which may persist through a complete but gradual replacement of its matter. Now consider the gold sheet. It has at least an essential part: its improper part, which is itself. The gold sheet has the mass of gold as a proper part, and thus it inherits all of its parts by transitivity of proper parthood. Hence, all of the essential parts of the gold sheet have a part which is essential to the mass of gold. It follows that the mass of gold materially constitutes the gold

sheet at each time they spatially coincide. Alike considerations hold for the gold sheet and the sculpture, as well as for the mass of gold and the sculpture.

The last account they consider is due to Baker (2000), and is the Favourable Circumstances definition:

Favourable Circumstances: *a* materially constitutes *b* at *t* iff there are two distinct kinds F and G and G-favourable circumstances such that (i) *a* spatially coincides with *b* at *t*, (ii) *a* is essentially F at *t* and *b* is essentially G at *t*, (iii) *a* is in circumstances C at *t*, (iv) it is necessary that: for any object *x* and time *t'*, if *x* is essentially F and *x* is in circumstances C at *t'*, then there is some object *y* which is essentially G and spatially coincides with *x* at *t'*, and (v) it is possible that: *a* exists and there is no time *t'* and object *x* which is essentially G and which materially coincides with *a* at *t'*

Consider the mass of gold and the gold sheet. They belong respectively to the kinds 'mass of gold' and 'gold sheet'. There are also gold sheet-favourable circumstances: for instance, the mass of gold has a certain shape at *t*, is at room temperature at *t*, is not immersed in aqua regia at *t*, and so forth. The mass of gold and the gold sheet spatially coincide at *t*, and also belong to their kinds essentially (or so it is plausible to assume). Then, it is simply a truth that, necessarily, if something which is essentially a mass of gold is in gold-sheet favourable circumstances at a time *t*, then some distinct object which is essentially a gold sheet will spatially coincide with it at *t*. Lastly, it is also clearly possible that the mass of gold never comes to spatially coincide with a gold sheet: for instance, it suffices that it never acquires the appropriate shape. It follows that the mass of gold materially constitutes the gold sheet at the time *t*. Again, alike considerations hold for the gold sheet and the sculpture, as well as for the mass of gold and the sculpture.

For the sake of completeness, I want to add to Barker and Jago's list also Doepke's (1996, 201) Explanation definition of material constitution:

Explanation: *a* materially constitutes *b* at *t* iff there is some property F such that (i) *a* materially coincides with *b* at *t*, (ii) *a* is accidentally F at *t*, and (iii) the fact that *a* is F at *t* explains the existence and persistence conditions of *b* at *t*

Consider the mass of gold and the gold sheet. They materially coincide at many times. Let us assume, for instance, that the gold sheet came into existence at the instant in which the mass of gold solidified in an appropriately shaped mould. The relevant property F would then be *having been solidified in an appropriately shaped mould*. For easiness of exposition, let us call the mass of gold and the gold sheet respectively *m* and *s*; then, consider the following questions: (a) why does *s* exist at *t*? (b) why has *s* the persistence conditions it has at *t*? Of course, the answer to (a) is that *m* solidified in a

rectangular mould at  $t$ , that is, that  $m$  is F at  $t$ . As far as (b) is concerned, consider first of all that explaining the persistence conditions of an object amounts to specifying the kind the object belongs to. Hence, an answer to (b) indeed requires the answer to (c) why is  $s$  a gold sheet at  $t$ ? Of course,  $s$  is a gold sheet at  $t$  because the mass of gold it materially coincides with at  $t$ , namely  $m$ , has the appropriate shape at  $t$ . Furthermore,  $m$  has such a shape at  $t$  in virtue of having been solidified in an appropriately shaped mould at  $t$ : indeed,  $m$  did not undergo any further change of shape in the present scenario. Wrapping up, then, by means of the transitivity of ‘because’,  $s$  is a gold sheet at  $t$  because  $m$  is F at  $t$ . In other words, the fact that the mass of gold is F at  $t$  provides an answer to both (a) and (b). Hence, it follows that the mass of gold materially constitutes the gold sheet at time  $t$ . Again, alike considerations hold for the gold sheet and the sculpture, as well as for the mass of gold and the sculpture.

Notice that each of the examined definitions includes some clauses involving *de re* modality, or at least notions with *de re* modal implications. Destruction includes (ii); Essential parts (ii) and (iii); Favourable circumstances (ii), (iv) and (v); and Explanation (ii). The involvement of modal clauses is a crucial, in that such clauses allow for an Abelardian analysis of the corresponding modal predicates. Thus, the one-thinger can exploit the presence of those modal clauses to accept a definition of material constitution and still avoid the ontological commitment of multi-thingers. Moreover, each of these definitions correctly implies that if  $a$  materially constitutes  $b$  at  $t$ , then the converse is not the case. Hence, they all embody the asymmetry that any adequate phrasing of material constitution should preserve.

Consider Destruction. The definition suggests that the relation is irreflexive – nothing can be the substratum of its own destruction – but also transitive. Consider again the same scenario involving chains of material constitution relations. Suppose that (i) the mass of gold materially constitutes the gold sheet, (ii) the gold sheet materially constitutes the gold sculpture, but (iii) the mass of gold does not materially constitute the gold sculpture. It follows that (i) the mass of gold could be the substratum of the gold sheet’s total destruction, (ii) the gold sheet could be the substratum of the gold sculpture’s total destruction, but (iii) the mass of gold cannot be the substratum of the gold sculpture’s total destruction. The latter sentence says that there cannot be any change inner to the mass of gold which leads to the total destruction of the gold sculpture while preserving the existence of the mass of gold (cfr. Simons 1987, 238). Still, this is wildly implausible. It suffices to consider an event of scattering: the mass of gold, and indeed any structureless material mass, keeps existing as long as all of its parts exist, no matter if scattered.<sup>50</sup> On the contrary, this is generally untrue of structured and materially

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<sup>50</sup> The possibility for material masses to exist scattered is accepted even by foes of scattered hylomorphs such as Biro (2017).

constituted hylomorphs: the gold sculpture cannot survive radical alteration of its shape, let alone being scattered. Hence, Destruction provides a definition of material constitution according to which the relation is irreflexive and transitive; and of course, any irreflexive and transitive relation is also asymmetric.

Suppose Essential Parts is not asymmetric. Hence, there is a case in which  $a$  materially constitutes  $b$  at  $t$  and vice versa. From the supposition that  $a$  constitutes  $b$  at  $t$ , Essential Parts implies that something is an essential part of  $a$  at  $t$ , no part of which is an essential part of  $b$  at  $t$  (clause (ii) in the definition). However, from the supposition that  $b$  constitutes  $a$  at  $t$ , Essential Parts implies that all essential parts of  $a$  at  $t$  have a part which is essential to  $b$  at  $t$  (clause (iii) in the definition). These two statements are clearly contradictory. Hence, Essential Parts implies that material constitution is asymmetric.

Suppose Favourable Circumstances is not asymmetric. In this case, the asymmetry of material constitution is not built in the definition, but rather expresses itself in the form of the kinds of relations the definition can relate. Suppose that the relation of material constitution is not asymmetric. Take  $a$  and  $b$  such that  $a$  materially constitutes  $b$ . Given clause (ii),  $a$  is essentially an  $F$  and  $b$  is essentially a  $G$ , with  $F \neq G$ . Now assume that it is also the case that  $b$  materially constitutes  $a$ . Again, clause (ii) implies that  $b$  is essentially an  $F$  and  $a$  is essentially a  $G$ . This implication may be enough to reject the assumption of non-asymmetry: material constitution is customarily regarded as relating objects such as a mass of matter and a hylomorph, which arguably essentially belong to different and incompatible kinds. Still, suppose that it is possible that  $a$  and  $b$  are both essentially  $F$  and essentially  $G$ . Given clause (v), it should then be possible for  $b$  to exist and never materially coincide with anything that is essentially an  $F$ . However,  $b$  is essentially an  $F$ , thus necessarily and permanently an  $F$ , and of course  $b$  materially coincides with itself. Hence, Favourable Circumstances implies that material constitution is asymmetric.

Lastly, suppose Explanation is not asymmetric. Consider again the mass of gold and the gold sheet. We saw that the mass of gold materially constitutes the gold sheet; suppose that the gold sheet, in turn, materially constitutes the mass of gold. Given Explanation, there is an accidental property  $F$  of the gold sheet such that the fact that the gold sheet is  $F$  at  $t$  explains the fact that the mass of gold exists at  $t$  and has its persistence conditions at  $t$ . We saw that the persistence conditions at  $t$  of the gold sheet are explained by the fact that the mass of gold has the appropriate shape at  $t$ . However, the mass of gold has trivial persistence conditions: it exists as long as all of its parts exist. Moreover, the mass of gold has those persistence conditions in virtue of being a structureless piece of matter. There are two properties the gold sheet has at  $t$  that may explain the fact that the mass of gold has those persistence conditions at  $t$ : (i) *being materially constituted by a piece of matter*, and (ii) *being*

*materially constituted by that mass of gold.* However, (i) is arguably not an accidental property of the gold sheet: the fact that an object stands in a relation of material constitution seems suggesting that the existence of that object must be ultimately sustained by the existence of some piece of matter. On the contrary, (ii) is more plausibly had contingently by the gold sheet.<sup>51</sup> Yet, both (i) and (ii) are not suitable candidates, because otherwise Explanations would turn out being a circular definition of material constitution, in that they contain the very same notion they are supposed to help define (Wasserman 2004, 700-701). Hence, Explanation plausibly conveys an asymmetric notion of material constitution as well.

Therefore, the modal definitions of material constitution under consideration guarantee the asymmetry of the relation at stake and thereby are at least *prima facie* adequate. One-thingers should then endorse one of them, offer an appropriate analysis of the modal predicates in the modal clauses, and consequently show that, despite its genuineness, it is possible to fully account for the asymmetry of material constitution in linguistic terms.

However, Barker and Jago (2014) argue that the one-thingist strategy is ultimately unsuccessful. Recall the sentences (1), (2), and (3) concerning a mass of gold, a gold sheet, a gold sculpture, and their relations of material constitution. While (1) is acceptable, in that the instance of material constitution relation tells that an object with a simpler structure constitutes an object with a more complex structure, (2) and (3) are unacceptable, because the instance of the material constitution relation tells precisely the opposite. The problem with the one-thingist strategy is that the counterpartistic analysis of the present definitions fails to do justice to the difference between the acceptability of (1) and the bizarreness of (2) and (3). Regardless of the definition of material constitution on board, each of the three sentences turns out acceptable on a counterpartistic reading. In other words, counterpart theory indeed rescues the linguistic construction of asymmetry in the material constitution relation, but at a cost of conflating sound and unsound ascriptions of the relation itself.

Take Destruction and focus on (2). Let us call the thing that is both a mass of gold and a sculpture *x*. Heating up and turning *x* into a cylinder would destroy the gold sheet, since there would not be anything of the right shape to deserve to be called a sheet. Still, we may very well suppose that no particle is lost in the process, and that the art community regards the resulting object as still being the same sculpture as before. Hence, *x* survives the change. Given Destruction, *x* materially constitutes the gold sheet at each time they spatially coincide. Focus now on (3). Unfolding *x* would end up destroying it, since sculptures cannot survive radical change of their shapes. Still, the unfolding would

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<sup>51</sup> Proviso that the thesis of the necessity of the original matter is false. The thesis was famously advanced by Kripke (1980, fn. 56) but has been heavily criticised ever since (for instance, see Evinne 2016, 88 ff.).

just modify the geometrical properties of the gold sheet. Given Destruction, the gold sheet materially constitutes  $x$  at each time they spatially coincide.

Take Essential Parts and focus on (2). It seems that every part that is essential to the mass of gold is essential to  $x$ ; also, every part that is essential to the gold sculpture is essential to  $x$ . Moreover, it is plausible that the mass of gold materially constitutes the gold sheet. Hence, given Essential Parts, it follows that (i) the mass of gold has an essential part  $p$  no part of which is an essential part of the gold sheet, and (ii) all the essential parts of the gold sheet have a part that is essential to the mass of gold. We can infer two consequences. First,  $p$  is an essential part of  $x$  too. Second,  $p$  is arguably a portion of matter, given that the mass of gold is a structureless entity. Hence, given (i), there is an essential part of  $x$ , namely  $p$ , no part of which is an essential part of the gold sheet; and given (ii), all the essential parts of the gold sheet have a part that is essential to the mass of gold. Given Essential Parts,  $x$  materially constitutes the gold sheet at each time they spatially coincide.

Take Favourable Circumstances and focus on (2). Assume again, as it is plausible, that the mass of gold materially constitutes the gold sheet. Hence, Favourable Circumstances implies that there are favourable circumstances  $C^*$  such that, necessarily, for any  $y$  that is essentially a mass of gold and is in circumstances  $C^*$ , there is a  $z$  which is essentially a gold sheet and spatially coincides with  $y$ . Now consider  $x$  again, and suppose it is in favourable circumstances  $C^*$ .  $x$  is essentially a mass of gold and a sculpture, and an Abelardian would surely claim that anything that is essentially a mass of gold and a sculpture is thereby essentially a mass of gold. But then, since  $x$  is in favourable circumstances  $C^*$ ,  $x$  winds up spatially coinciding with an object that is essentially a gold sheet. Moreover,  $x$  can apparently exist without therefore being spatially coincident with the gold sheet: it suffices to recall the abovementioned scenario in which  $x$  is heated up and reshaped in the guise of a cylinder. Given Favourable Circumstances,  $x$  materially constitutes the gold sheet at each time at which they spatially coincide.

Take Explanation and focus on (2).  $x$  and the gold sheet materially coincide at many times. Now consider again the present major assumption: the sculpture can survive a deformation into a cylindrical artefact, given an agreement among art critics, while the gold sheet cannot, otherwise it would not be a sheet anymore. Since the gold mass surely does not have any shape necessarily, we may very well state that  $x$  instantiates at  $t$  the conjunctive property *having been solidified in a sheet shaped mould and preserving such a shape ever since* accidentally. Indeed, since the sculpture can survive a radical deformation, and thus considerations about its shape do not play any role in determining its identity, it is reasonable to suppose that the sculpture could have been cylindrically

shaped from the very beginning of its existence.<sup>52</sup> Accordingly, and consistently, since the gold sculpture and the gold mass are indeed one and the same thing,  $x$ , it is the case that  $x$  instantiates at  $t$  the property *having been solidified in a sheet shaped mould and preserving such a shape ever since* accidentally. Let us now consider the explicative clause. Since  $x$  is also a mass of gold, the fact that  $x$  instantiates this property at  $t$  surely explains the existence of the gold sheet at  $t$ . Moreover, since clearly the fact that  $x$  instantiates that property at  $t$  grants the fact that the gold sheet exists *qua* gold sheet (and not, for instance, as gold sphere), and this fact in turn explains the persistence conditions of the gold sheet, it is also the case that the fact that  $x$  instantiates *having been solidified in a sheet shaped mould and preserving such a shape ever since* explains the persistence conditions of the gold sheet at  $t$ . Given Explanation, thus,  $x$  materially constitutes the gold sheet at each time at which they materially coincide.

Therefore, given a one-thingist conception of material objects, each of these modal accounts of material constitution not only validates (1), whose truth is fairly plausible,<sup>53</sup> but also (2), which is instead unacceptable.<sup>54</sup> In other words, the most promising modal definitions of material constitution available deliver unwanted results when paired up with one-thingism.

Let us take it stock. There seems to be some sort of asymmetry between a materially constituted object and its constituee(s). At the very least, the asymmetry is informational: the constituted object ‘pops up’ when its constituee gains the right sort of structure. However, there is in principle room for skepticism. It may be the case that the asymmetry is nothing but a pragmatic by-product of human interests. We are generally more interested in objects that happen to be materially constituted than in what materially constitutes them. However, this line of argument has plausibly wrong implications concerning what agents may truthfully assert in specific contexts. Hence, the asymmetry must be accepted as a genuine phenomenon. Still, the question on its grounds is still open to debate. A one-thinger will try to locate the asymmetry in the language. Consequently, she would accept the truth of sentences such as ‘ $a$  materially constitutes  $b$  but  $b$  does not materially constitute  $a$ ’ without giving up her commitment to the identity of  $a$  and  $b$ . In order to do so, the one-thinger must rely on some Abelardian theory of modal predicates, and counterpart theory is famously the most promising one. Counterpart theory can *prima facie* re-establish the identity between  $a$  and  $b$  if the predicate ‘to materially constitute’ has also a *de re* modal import, and there are indeed at least four different modal definitions of material constitution. However, one-thingism and counterpart theory end up granting

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<sup>52</sup> For instance, it may be the case that what really determines the identity of the present sculpture is the creative intention of its actual crafter.

<sup>53</sup> I omit the proofs since it is easy to see that, given the appropriate pacific assumptions, those accounts of material constitutions validate (1).

<sup>54</sup> Destruction goes even further in validating (3) as well.

the truth of a class of sentences. Such sentences capture unacceptable scenarios concerning the material constitution of structured and unstructured objects. Moreover, every available modal definition of material constitution grants the truth of these sentences. The corresponding scenarios are unacceptable, given the previous considerations on the asymmetry of material constitution. Therefore, one-thingism and counterpart theory do not really manage to offer a framework which satisfyingly accounts for one of the most relevant properties of the material constitution relation.

#### 1.4.4 Leaving Counterparts Aside

One common line in favour of counterpart theory appeals to the way in which it accounts for the inconstancy of our modal intuitions. Yet, even if counterpart theory provides a valuable service to our modal intuitions, it really cannot be really considered an intuition-friendly theory. The original Kripkean phrasing of the Humphrey objection precisely highlighted the oddness of explaining the instantiation of seemingly intrinsic *de re* modal properties by actual individuals in terms of intrinsic non-modal properties instantiated by distinct individuals. De's Relevance reading stresses this aspect and concludes that the only reasonable way to meet the objection within a broadly Lewisian framework is by endorsing five-dimensionalism. Only five-dimensionalism can grant that the property *might have won the election* is intrinsic to Humphrey, by holding that it is instantiated by a part of Humphrey. And of course, five-dimensionalism may offer a satisfactory account of the instantiation of *de re* modal properties, but it joins it with a highly controversial account of which individuals and non-modal properties are relevant for the truth-evaluation of sentences. Hence, it is not clear that five-dimensionalism really would provide the counterpart theorist with an acceptable solution to the Relevance reading of the Humphrey objection. Moreover, consider that the main reward of counterpart theory is obtaining a well-structured explanation of the inconstancy of our modal intuitions. As we have seen, such an explanation works by building contextual parameters in the counterpart relations. Yet, the transworld identity theorist may still offer an analogous explanation by taking contextual parameters to restrict the set of possible worlds relevant for the assessment of the modal predication (as in Mackie 2020). If the present strategy works, it is definitely bad news for the counterpart theorist, since the transworld identity theorist offers a much more simple and intuitive account of *de re* modal properties instantiation and material objects.

Be it as it may, counterpart theory still provides a consistent one-thingist account of the nature of material objects. Particularly, the endorsement of an Abelardian theory of modal predicates is a necessary condition for any one-thingist conception of material objects.<sup>55</sup> If we take the most

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<sup>55</sup> Bar Burke's (1994) dominant sortal account, which nonetheless many authors criticise and reject. See Barker & Jago (2014, 4-5), Korman (2015, 206-207).

promising Abelardian theory to be counterpart theory, we have that counterpart theory is necessary for the endorsement of one-thingism: in other words, if one-thingism is true, then counterpart theory is true as well. Moreover, we have seen that the weakest conclusion we can draw from Mackie's vacuous satisfaction argument is that if multi-thingism is true, then counterpart theory is false. By putting the highly controversial thesis of mereological nihilism aside,<sup>56</sup> this sentence is equivalent to: if counterpart theory is true, then one-thingism is true (since multi-thingism is false). Hence, we obtain the following biconditional: counterpart theory is true if and only if one-thingism is true. However, if successful, Barker & Jago's argument show that the conjunction of one-thingism and counterpart theory is not enough to adequately make sense of the asymmetry of the material constitution relation, despite the support of modal definitions of material constitution which allow a counterpartistic treatment of modal predicates. Since the conjunction is false, either monism or counterpart theory must be false. However, given the preceding biconditional stating that one-thingism is true if and only if counterpart theory is true, Barker and Jago's argument supports the conclusion that *neither* monism *nor* counterpart theory is true. Hence, albeit Barker and Jago's argument is not *per se* an argument against counterpart theory, it still challenges it indirectly. The counterpart theorist may rejoin that their argument does not go through the right definitions. However, to my mind, Barker & Jago have examined all the relevant modal definitions of material constitution.<sup>57</sup> Therefore, the burden of proof is on counterpart theorists, and their best dialectical move would be to advance a new definition of material constitution. Such a definition must (i) result in an asymmetric relation: if *a* materially constitutes *b*, then *b* does not materially constitute *a*, and (ii) embody some clause, arguably modal in nature, that allows for an Abelardian treatment, to the effect that (iii) it may still be said that *a* is identical with *b*, despite *a* materially constituting *b* but not vice versa. Until such a definition will be provided, there are sound reasons for skepticism towards counterpart theory.

The aim of this section was just to expose some critical aspects of counterpart theory, and thus show that counterpart theory is far from being an uncontroversial theory of transworld identity. Still, one-thingers customarily rely on counterpart theory to provide a complete solution to the Troublesome Argument, and it seems that there are not really further promising theories that can deliver the same results. Hence, it is at least theoretically interesting to explore the logical space of the answers to the Troublesome Argument and check their robustness. From a multi-thingist perspective, there seem to be two major available rejoinders. First, to give up the principle leading

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<sup>56</sup> Mereological nihilism is the revisionary metaphysical thesis according to which there are no complex objects, but only atoms and pluralities thereof. See Sider (2013), Thunder (2017), Van Inwagen (1990a).

<sup>57</sup> As I have shown, their argument also works against Doepke's (1996) Explanation definition, which the authors neglected in their analysis.

from the seemingly innocuous premise 3 to the troubling premise 8, namely Extensionality of Proper Parthood. Such a rejection would in turn lead to the abandonment of some further mereological principles. Not only our first theoretical tenet is simply at odds with this sort of strategy, but the rejection of Extensionality of Proper Parthood is never free, since it comes with the rejection of further mereological principles that are often more plausible or firmer than Extensionality of Proper Parthood. Second, they may preserve Extensionality of Proper Parthood, and indeed every theorem of CEM, and instead give up the very premise 1, by claiming that Statue and Alloy do not really share any decomposition at all. Clearly, given the intuitive pull of premise 1, its rejection must come with some revisionary theory of material objects. In the next chapter, I am reviewing and discussing a number of theories that pursue these two strategies. I start by considering the theories that get rid of extensional mereology. As I have anticipated, none of them is ultimately consistent within the tenets of the present work; still, some of these non-extensional theories of material objects provide useful insights that I will eventually take into consideration. Then, I consider the most relevant theory that develops the second strategy: mereological hylomorphism. I first show that mereological hylomorphism is indeed compatible with CEM, even though its proponents generally endorse weaker mereologies. Next, I advance an argument that purports to cast some serious doubt on the robustness of the principal theoretical tool of mereological hylomorphism, namely hylomorphic form, and thus on the very tenability of mereological hylomorphism. To conclude, I put forward an alternative theory of material objects that is coherent with the pursuit of the extensionalist strategy.

## Chapter 2

### Varieties of Multi-Thingism and An Argument Against Hylomorphism

#### 2.1 The Multi-Thingist Strategies

Recall again our two theoretical tenets. First, CEM is the sound theory of parthood relation, and a theory of material objects should not reject any fragment of it. Second, the multi-thingist intuition must be taken seriously. The aim of the last three sections was to provide some reasons to put the one-thingist strategy aside, and thus to make a compelling case for the latter tenet. We have seen that one-thingers are better off relying on an Abelardian construction of predicates containing *de re* modal expression, but such a construction cannot account for the phenomenon of material constitution satisfactorily. Thus, it is instructive to check whether multi-thingers can afford further interesting answers to the Troublesome Argument.

Of course, I am simply ignoring the possibility of rejecting or restricting Leibniz Law. Such a move, though, is generally regarded as illegitimate. Together with Reflexivity, Leibniz Law is customarily used to axiomatize the identity relation. Reflexivity and Leibniz Law characterise identity as an equivalence relation, in that they allow proving that identity is transitive and antisymmetric as well. Indeed, Leibniz Law is taken as a constitutive principle of the identity relation. In the words of Williamson:

What seems clear is that, properly formulated, the law embodies an insight absolutely fundamental to our understanding of the logical notion of identity. If  $x$  and  $y$  are the very same thing, then whatever applies to  $x$  thereby applies to  $y$ . To suppose that there are exceptions to the best statement of the law is to lose one's grip on the topic. (Williamson 2002, 285)

Multi-thingers must thus pursue one of the two following main strategies. The first one is to give up the principle leading from the premise 3 to the premise 8, that is, Extensionality of Proper Parthood. Many multi-thingers would indeed regard the Troublesome Argument as an argument against Extensionality of Proper Parthood, and thus reject at least one of the mereological principles that allows proving the extensionality theorem. As we have seen in section 1.2, there are many different proofs for Extensionality of Proper Parthood, and thus many different mereological principles multi-thingers can reject in order to avoid extensionality. However, we are not interested in such a dialectic line here, since it would conflict with our first theoretical tenet. Still, we will consider various multi-thingist theories that do just that, and eventually preserve some of their suggestions. I would go as far as to state that this is the standard multi-thingist answer to the Troublesome Argument.

Since this strategy is at odds with one of our tenets, we are left with the second strategy available, that is, rejecting premise 1 and thus claiming that there is not any plurality that compose both Statue and Alloy, so that they do not really share all of their proper parts. There are different theories in this direction, but as we will see, they often end up conflicting with some theorem of CEM: it is not easy to accommodate multi-thingism and CEM. Generally, multi-thingers can rely on three main different approaches to the mereological relation between material objects and the portions of matter that constitute them (Walters 2017):

- Mutual Parthood: the material object and its constituting portion of matter are mutual part of each other
- Constituting Parthood: the material object has its constituting portion of matter as a part
- No Parthood: neither the material object is part of its constituting portion of matter nor vice versa

What is crucial for this second strategy is that such approaches must construe material objects and their constituting portion of matter as not completely overlapping, so that the premise 1 of the Troublesome Argument is falsified. Of course, the construction must be coherent with CEM, multi-thingism, and a standard theory of transworld identity. This means that we must put aside theories that do not adhere to our two theoretical tenets as well as to what I take to be the most plausible way to account for the instantiation of *de re* modal properties. In what follows, I sketch up some of the most relevant multi-thingist approaches and show their tension with CEM. As a result, I take them to be non-starters for the present overall project. Successively, I discuss at great length mereological hylomorphism, the approach that I regard as most promising. Indeed, mereological hylomorphism seems to be able to deliver a multi-thingist theory of material objects that respect both of our theoretical tenets. Still, I make a case for regarding mereological hylomorphism, and perhaps any brand of hylomorphism whatsoever, as way less staunch than it may strike at first. Particularly, I show that hylomorphic forms, the most theoretically relevant objects of hylomorphism, are typically associated with two properties, dependence and substantiveness, that, however, they really cannot instantiate together, on pain of committing hylomorphists to reject an important fragment of their theory or adopt a suspect revisionary stance concerning grounding relations. In the last part of the present chapter, I sketch instead my favourite multi-thingist theory of material objects, but I do not provide more details only in the last chapter. In order to ease the comprehension, I also introduce and discuss the most relevant features of the bizarre extended simples.

### 2.1.1 Cotnoir's Mutual Parthood Approach

According to the Mutual Parthood approach, Statue and Alloy are mutual parts of each other, yet in such a way that does not imply their identity. The main endorser of Mutual Parthood is Cotnoir (2010, 2013a, 2016; see also Cotnoir & Bacon 2012), who actually develops two different versions of the theory.

Here is the first version. Cotnoir (2010, 2016) considers the two following definitions of proper parthood:

(PP)  $PP_{xy} =_{\text{def}} P_{xy} \wedge x \neq y$

(PP\*)  $PP_{xy} =_{\text{def}} P_{xy} \wedge \neg P_{yx}$

Such definitions are equivalent within CEM.<sup>58</sup> Crucially, the equivalence relies on Antisymmetry of Parthood; otherwise, (PP\*) is strictly stronger than (PP). Then, Cotnoir notices that, absent Antisymmetry, Extensionality of Proper Parts is no longer a theorem of mereology. Recall the proofs in section 1.2. The first proof uses Uniqueness of Fusion, whose proof requires in turn Antisymmetry (or principles that entails it, such as Weak Supplementation Principle). And each of Simons's, Varzi's, and Van Inwagen's proofs explicitly uses Antisymmetry. The rejection of Antisymmetry runs over the very extensional nature of CEM and leads to the rejection of *every* theorem with extensional import.<sup>59</sup> Take now Statue and Alloy and consider Strong Supplementation Principle.<sup>60</sup> From the supposition that Alloy is not a part of Statue, it follows that Alloy has some part that is disjoint from Statue. Since Alloy does not have such parts, it follows that Alloy is part of Statue. Clearly, by parity of reasoning, the converse holds as well: Statue is part of Alloy. The rejection of Antisymmetry precisely prevents the conclusion that Statue and Alloy are identical. Statue and Alloy are thus mutual parts, but numerically distinct. They are not mutual *proper* parts, though, since (PP\*) forces Proper Parthood to be asymmetric (and irreflexive) by construction.

The second version of the Mutual Parthood approach is developed by Cotnoir and Bacon (2012). The authors construe their theory within a non-wellfounded mereology, that is, a mereology that admits of entities that are proper parts of themselves. Non-wellfounded mereologies take proper parthood to be transitive, yet neither irreflexive nor asymmetric. Cotnoir and Bacon stick here to (PP), but still reject Antisymmetry. Again, Strong Supplementation Principle implies that Statue and Alloy

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<sup>58</sup> See again the proof in fn. 13.

<sup>59</sup> The Extensionality of Overlap entails Antisymmetry, given Transitivity. The Extensionality of Proper Parthood is not provable anymore. And neither is the Uniqueness of Composition, whose proof requires Transitivity, Antisymmetry, and Strong Supplementation Principle (Gilmore forthcoming).

<sup>60</sup> As far as decomposition principles are concerned, Cotnoir (2010, 399–400) shows that, although Weak Supplementation Principle entails Antisymmetry, we can preserve it provided that the notion of proper parthood that figures in the antecedent is (PP\*) and not, as customary, (PP).

are mutual parts; however, Statue and Alloy are numerically different by supposition, and thus (PP) tells us to regard them as mutual *proper* parts. Clearly, if Alloy is a proper part of Statue, and Statue is a proper part of Alloy, it follows that Alloy is a proper part of itself, and that is why the Mutual Parthood approach, when conjoined with the standard (PP), needs to be modelled within a non-wellfounded mereology.<sup>61</sup>

Cotnoir's Mutual Parthood approaches are interesting for sure, since they allow solving the problems under considerations. Moreover, Cotnoir's mereological systems are, to my mind, the most elegant non-extensional mereological systems, and can even accommodate the main decomposition and composition mereological principle. For instance, both Unrestricted Fusion and Strong Supplementation Principles are valid, and Weak Supplementation Principle just needs a little adjustment of its antecedent, that must be now formulated with (PP\*). Of course, though, a non-extensional mereology runs over our theoretical tenet of a classical extensional mereology in all its strength.<sup>62</sup> Hence, we should put it aside and see what the other multi-thingist theories propose.

### 2.1.2 No Parthood Approaches

No Parthood theorists reject any definition of constitution figuring mereological terms. No Parthood accounts come into two different guises. The most relevant strain of No Parthood comes with Baker (2000, 2007, 2008), who offers the following non-mereological definition of constitution (2007, 161):

(C\*)  $x$  constitutes  $y$  at  $t$  =<sub>def</sub> There are distinct primary-kind properties  $F$  and  $G$  and  $G$ -favourable circumstances such that:

- (1)  $Fx \ \& \ Gy \ \&$
- (2)  $x$  and  $y$  are spatially coincident at  $t$ , and  $\forall z(z$  is spatially coincident with  $x$  at  $t$  and  $Gz \rightarrow z = y)$ ,  $\&$
- (3)  $x$  is in  $G$ -favourable circumstances at  $t$ ;  $\&$
- (4) It is necessary that:  $\forall z[(Fzt \ \& \ z$  is in  $G$ -favorable circumstances at  $t) \rightarrow \exists w(Gwt \ \& \ z$  is spatially coincident with  $w$  at  $t)]$ .
- (5) It is possible that:  $\exists t\{(x$  exists at  $t \ \& \ \neg\exists w[Gwt \ \& \ w$  is spatially coincident with  $x$  at  $t])\}$ ;  $\&$
- (6) If  $x$  is of one basic kind of stuff, then  $y$  is of the same basic kind of stuff.

<sup>61</sup> An alternative solution would be restricting Transitivity of proper parthood in such a way to prevent that an entity may turn out proper parts of itself (Smid 2019, 38). Restricted Transitivity certainly avoids the need for a non-wellfounded mereology, but still shakes up the standard view of proper parthood.

<sup>62</sup> A further defender of the Mutual Parthood approach is Thomson (1983, 1998). I have not presented her view here. A perhaps interesting point to notice is that, while her commitment to the Mutual Parthood approach follows from her symmetric definition of material constitution, Cotnoir's account is silent about such a relation. It suffices to say that her approach falls short of CEM as well.

When specific kinds of objects are in favourable circumstances, then some new kinds of entities are created, and they stand in a relation of constitution. Consider a piece of cloth  $x$ : if it is intentionally painted in specific ways, it would be in flag-favourable circumstances. In such a case, there will also be a flag  $y$ , uniquely co-located with the piece of cloth. Two further specifications: the implication from being in favourable circumstances to the existence of the constituted object holds of necessity, while it is not necessary that the constituting object  $x$  of the kind  $F$  is co-located with a constituted object  $y$  of the kind  $G$ , with  $F \neq G$ . Material constitution holds just when kind-favourable circumstances hold, but of course the holding of such circumstances is contingent. Moreover, notices that the present definition features modal terms, locational terms, and terms concerning the kind of the relata, but makes no reference to mereological condition altogether.

However, consider the following counterexample due to Zimmerman (2002, 603-604). Suppose there is a specific kind of fundamental physical particle such that, when a bunch of them aggregates, it generates a further specific physical particle, co-located with it. In such a case, the aggregate of particles would turn out to constitute the aggregate of all the preceding particles plus the new generated one; however, the former only constitutes a part of the latter. Generally, scenarios where objects generate further objects are at odds with Baker's definition of constitution. Zimmerman (2002) suggests adding a mereological clause:

- Every part of  $y$  has some part in common with some part of  $x$ , and *vice versa*

As noticed by Evine (2011, 224), such a clause would allow dropping clause (2), since objects are where their components are, and (6) as well, since  $x$  and  $y$  would share a decomposition. Indeed, Zimmerman's clause is logically equivalent to:

- $x$  and  $y$  share at least one complete decomposition

Adding the clause may avoid Zimmerman's counterexamples, but it would lead to the rejection of CEM. If  $x$  and  $y$  share at least one complete decomposition, then there is a plurality  $xx$  such that both  $x$  and  $y$  are fusions of the  $xx$ . However then, by Uniqueness of Composition, it would follow that  $x = y$ . In other words, if Zimmerman's clause is added to Baker's definition of constitution, CEM is rejected. More precisely, Uniqueness of Composition is rejected, and thus, arguably, Strong Supplementation Principle. The rejection of Strong Supplementation Principle, in turns, is poured out on either Weak Supplementation Principle or Unrestricted Composition. All in all, Zimmerman's criticism shows that Baker's definition of material constitution is better off going mereological, particularly non-extensionally mereological, which is clearly incompatible with our first theoretical tenet.

A second strain of No Parthood approaches is simply primitivism, that some authors, like Evnine (2016), Markosian (2004, 2015), and Zangwill (2012), endorse. According to such a view, we can say very little about the notion of constitution. For instance, it is surely an asymmetric, and thus irreflexive, relation (its transitivity is already controversial). It implies that its relata spatially coincide if they are concrete; however, there may be instances of constitution that relate abstract entities as well (Zangwill 2012, 2). Importantly, constitution relation may also relate extended simples, that is, spatially extended objects lacking proper parts, to mereologically complex portions of matter (see Markosian 2004, 2015. More on the concept of extended simple later). According to the primitivist view, thus, constitution cannot have mereological implications. Suppose that constitution would imply that its relata share all of their proper parts: in such a case, it could not relate complex portions of matter and extended simples, on pain of construing, contradictorily, extended simples as having proper parts.

Primitivists regard constitution as a fundamental relation between objects, on a par, for instance, with parthood or identity. Like these relations, constitution is characterised by some formal features, like asymmetry and irreflexivity. Although it is not possible analysing it, constitution may be used to explicate further notions or metaphysical facts, to explain the intimate relation between certain objects, or to make sense of qualitatively heterogeneous extended simples. Therefore, the relation would retain many theoretical virtues despite being primitive.

### **2.1.3 Constituting Parthood Approaches**

According to Constituting Parthood, Alloy is part of Statue. Since Alloy is also numerically different from Statue, Alloy must be a proper part of Statue, as for (PP). Remember that the numerical difference between Alloy and Statue is the multi-thingist way out of the Troublesome Argument, which we accept on pain of being committed to counterpart theory. The main Constituting Parthood approaches in the literature are Material Constitution and Mereological Hylomorphism. In what follows, I address the two theories in order. We will see that, whereas Material Constitution theories again fail to meet our first theoretical tenet, since they end up endorsing non-classical mereologies, Mereological Hylomorphism is much more promising.

#### **2.1.3.1 Lowe's Material Constitution Theory**

Material Constitution theories are a class of theories which minimally share the acknowledgement of material constitution as a *sui generis* relation that contingently holds between any structured entity and a structureless portion of matter. We have quickly considered Baker's theory of material constitution as a case of No Parthood theory, but there are developments of material constitution

theories definitely belong to the Constituting Parthood approach. Among the philosophers that have advanced Constituting Parthood Material Constitution theories there are Doepke (1982), Gilmore (forthcoming), Goodman (ms), and Lowe (2013a). I discuss now Lowe's (2013a) theory, since its analysis suffices to clarify the main problems of such approach given our two theoretical tenets.

Lowe's idea, and indeed the very rationale behind Material Constitution theory, is well expressed by Baker (2000, 181): «I would have thought that [Statue] had a nose as a part but that [Alloy] did not. Part of [Alloy] is (i.e. constitutes) [Statue]'s nose; but [Alloy] itself does not have a nose» (see also Doepke 1982, 51; Smid 2022 5; Wasserman 2002, 202-203). Materially constituted objects would generally be more structured than their constituting portions of matter, and such a difference with respect to the richness of their structure would reflect in their mereological profile. Lowe aims to prove that Alloy and Statue do not really share all of their proper parts. According to his theory, an entity such as Nose would be a part of Statue, but not a part of Alloy. He defends his claim by means of what he calls the Pairing Down Argument (Lowe 2003a, 2013a). Here is a version of the Pairing Down Argument:<sup>63</sup>

- (1) Nose is part of Alloy
- (2) If Nose is part of Alloy, then Nose is part of every element of a continuous series of ever smaller parts of Alloy converging upon and including  $A_n$
- (3)  $A_n$  materially constitutes Nose
- (4) Nose is part of  $A_n$  (1, 2)
- (5)  $Nose \neq A_n$  (4, material constitution is not identity)
- (6) Nose is a proper part of  $A_n$  (4, 5, definition of proper parthood)
- (7)  $A_n$  has some part disjoint from Nose (6, Weak Supplementation Principle)
- (8) Every part of  $A_n$  overlaps Nose
- (9) Contradiction! (7, 8)
- (10) Nose is not part of Alloy

$A_n$  is the portion of Alloy that materially constitutes Nose, as premise (3) acknowledges. Premise (2) basically states that, if (1) is true, then it would be arbitrary to deny that Nose is part of every portion of Alloy 'big enough', so to speak, to include it. The least portion of Alloy including Nose is the portion that materially constitutes it, that is  $A_n$ . Hence, Nose must be part of  $A_n$ . Since, however,  $A_n$  materially constitutes Nose, and material constitution is not identity, Nose must be a *proper* part of  $A_n$ . The difference between the relations of material constitution and identity is clear once we consider Lowe's definition of the former:

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<sup>63</sup> I omit the temporal qualification on parthood, since it does not play any relevant role within the argument.

$x$  is materially constituted by  $y$  at  $t =_{\text{def}} x$  and  $y$  coincide spatially at  $t$  and every proper part of  $y$  at  $t$  is a part of  $x$  at  $t$  but not every proper part of  $x$  at  $t$  is a part of  $y$  at  $t$  (Lowe 2013a, 136)

Just ignore the temporal qualification on parthood, and suppose that material constitution is identity. Then, it is always the case that a thing  $x$  materially constitutes itself, since identity is reflexive. The third conjunct of Lowe's definition of material constitution would imply that there is proper part of  $x$  that is not a part of  $x$ , which is false according to every definition of proper parthood. Weak Supplementation Principle delivers then the false conclusion that achieves the *reductio*.<sup>64</sup>

Moreover, Lowe's definition of material constitution allows proving that Lowe's theory is indeed a version of the Constituting Parthood approach. Suppose, otherwise, that Alloy is not a proper part of Statue. From Lowe's definition of material constitution, it follows that Statue has a proper part that Alloy lacks. Therefore, Alloy is numerically different from Statue, but it is not one of its proper parts. Hence, Alloy is not a part of Statue. Recall Simons's (1987, 28) Proper Parts Principle:<sup>65</sup>

$$(PPP) \exists z PP_{zx} \wedge \forall z (PP_{zx} \rightarrow PP_{zy}) \rightarrow P_{xy}$$

Since, by supposition, Alloy is not a part of Statue, it follows from (PPP) that either (i) Alloy has not proper part, or (ii) there is a  $z$  that is proper part of Alloy but not of Statue. (i) can be set aside as absurd: Alloy does have proper parts.<sup>66</sup> So we are left with (ii): Alloy has some proper parts that Statue Lacks. But Statue is materially constituted by Alloy. From the definition of material constitution, every proper part of Alloy is also a part of Statue. Therefore, for *reductio*, it follows that Alloy is a proper part of Statue, and thus Lowe's theory of material constitution belongs to Constituting Parthood.

Be as it may, we must discard Lowe's theory for the same reasons above: Lowe's material constitution theory is at odds with CEM. Clearly, Lowe's theory is incompatible with Strong Supplementation Principle. Suppose that Nose is really not a part of Alloy. According to Strong Supplementation Principle, then, there must be a part of Nose that does not overlap Alloy. However, since Lowe is generally happy to acknowledge that Statue and Alloy are ultimately composed of the same plurality of particles (for instance, Lowe 2003a, 142; 2005, 521), it is clear that Statue, and thus

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<sup>64</sup> It is important to remark that Lowe (2013a) also advances a version of the Pairing Down Argument that does without Weak Supplementation Principle, in order to accommodate his later rejection of the principle. However, such version of the Pairing Down Argument crucially relies on a definition of material constitution for its validity.

<sup>65</sup> As Simons (1987, 30) shows, Proper Parts Principle follows from Weak Supplementation Principle by granting the existence of unique mereological products. Otherwise, the two principles are independent.

<sup>66</sup> However, this shows the incompatibility of Lowe's theory of material constitution with any metaphysical theory according to which there are co-locatable atomic extended entities. For example, consider Lewis's claim that impure singletons are exactly located where their member is (1991, 31-33). According to Lowe's theory of material constitution, any non-atomic object would turn out to be material composed by its singleton, which is utterly absurd. Even worse, Statue would turn out to be composed by Alloy, {Statue}, and, if material constitution is transitive, {Alloy} too.

*a fortiori* Nose, does not have any part disjoint from Alloy. And of course, the claim that Statue and Alloy are ultimately composed of the same plurality of particles and yet are not the same entity is at odds with Uniqueness of Composition too. What is more surprising, perhaps, is that Lowe's theory is incompatible with Weak Supplementation Principle as well. Lowe (2013a, 137) actually claims to reject Weak Supplementation Principle on the grounds of the following scenario. Tibbles is at time  $t$  a perfectly sane cat. Of course, it has a head, Head, at time  $t$ , and Head is a proper part of Tibbles at  $t$ . Tibbles has an accident, and at time  $t^*$  only his head, Head, remains alive, in virtue of a life-supporting system. Is Tibbles identical with Head at time  $t^*$ ? It cannot be the case: identity is an absolute relation, not holding relatively to times, for example. Hence, since Tibbles was different from Head at  $t$ , it cannot become identical with Head at  $t^*$ . Moreover, Head is not the right kind of object to be considered a cat, while Tibbles is a cat. Hence, it is more appropriate to say that Head is a proper part of Tibbles at  $t^*$ , even if there is not a part of Tibbles at  $t^*$  which does not overlap Head. The proper statement to make here is that Head and Tibbles are co-constituted by the same portion of organic tissue at  $t^*$ . However, although Head is a proper part of Tibbles at  $t^*$ , there is no part of Tibbles that does not overlap with Head at  $t^*$ , *contra* Weak Supplementation Principle.

The Tibble scenario is actually redundant, since Lowe's theory is arguably at odds with Weak Supplementation Principle from the beginning. Weak Supplementation Principle already fails in the scenario according to which Alloy is a proper part of Statue.<sup>67</sup> According to Weak Supplementation Principle, in fact, Statue should have some part that is disjoint from Alloy, but we have seen above that this cannot be the case. Interestingly, if we read Lowe's (2013a, 133) lines carefully, we figure out that the decomposition principle he endorses, and successively drops as a consequence of the Tibble scenario, is the following one:

(SCP) Strong Company Principle: if  $x$  is a proper part of  $y$ , then  $y$  has some proper part  $z$  such that  $z$  is not a part of  $x$

(SCP) is strictly weaker than (WSP). The Tibble scenario indeed invalidates (SCP) as well, since at  $t^*$  every proper part of Tibble is also a part of Head. Moreover, (SCP) is enough for the Pairing Down Argument. With (SCP) on board, premise (7) must be replaced by

(7\*)  $A_n$  has some part that is not part of Nose

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<sup>67</sup> Of course, such considerations rely on the appropriateness of construing Alloy as a proper part of Statue within Lowe's theory, and we have shown that must be the case given Lowe's definition of material constitution and Proper Parts Principle.

Since  $A_n$  materially constitutes Nose, the definition of material constitution ensures that every proper part of  $A_n$  is a part of Nose as well, and thus the Pairing Down Argument still manages to deliver the reduction.<sup>68</sup>

All in all, then, Lowe's Constituting Parthood approach is clearly incompatible with CEM. Indeed, any philosopher willing to endorse a mereology at least as weak as Casati and Varzi's (1999) Minimal Mereology should reject Lowe's theory of material constitution, and more generally any Constituting Parthood approach. Indeed, such a philosopher should reject *any* Constituting Parthood approach of this kind. Constituting Parthood approaches share the claim that Alloy is a proper part of Statue, since it is a part of Statue and also numerically different from it. Given (WSP), Statue must have some part that does not overlap Alloy. However, since Statue has just material parts, any part of Statue must ultimately be composed by some plurality of material entities, for instance atoms. And of course, those atoms are also parts of Alloy.

### 2.1.3.2 Mereological Hylomorphism

Thus, Material Constitution theories à la Lowe cannot provide a multi-thingist theory that suits CEM. They are in tension with a mereological principle as weak as (WSP), the tension originating from the full overlap between wholly coincident objects. Statue and Alloy fully overlap because, even though Statue mereologically outstrips Alloy, it does so by means of parts, such as Nose, that still overlap Alloy. This is the case because parts such as Nose are *material* parts, and thus must be ultimately composed of a plurality of entities (atoms, particles, or some ultimate material element) that is a sub-plurality of the plurality of entities composing Alloy.

Mereological hylomorphists precisely claim that Statue's outstripping part is not *material*, but rather *formal*. Mereological hylomorphists (Fine 1999, 2003, 2008 Goswick 2018, Oderberg 2007, Koslicki 2008, 2018a, 2018b) share the commitment to the existence of formal parts of hylomorphs. Statue and Alloy are indeed made up of the very same material particles; however, Statue has a formal proper part which Alloy lacks. Koslicki (2008, 179-181) argues for the claim by means of an interesting argument that employs Weak Supplementation Principle.

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<sup>68</sup> I suspect that Strong Company Principle is still too strong for Lowe's theory, though. Suppose Nose has no further hylomorphic proper parts, but just material structureless parts.  $A_n$  is a proper part of Nose; however, Nose has not proper parts that are not also parts of  $A_n$ . Lowe's theory is still compatible with Gilmore's (forthcoming) Quasi-Supplementation Principle:

(QSP) if  $x$  is a proper part of  $y$ , then  $y$  has two disjoint proper parts

If Lowe just endorses Quasi-Supplementation Principle, though, he may get a consistent metaphysical theory of material objects, but at the noticeable cost of losing the inferential engine of its Pairing Down Argument. Moreover, see Loss (forthcoming-b) to check the controversial mereological models that Quasi-Supplementation allows.

First of all, Koslicki claims Alloy to be a part of Statue. She does so by accepting a principle along the line of the following (Bennett 2011, 287):

(MIIP) Material Ingredients as Proper Parts: If the material ingredients from which an object is created persist through the process of creation, they are proper parts of that object at the beginning of its existence

In the case of Statue and Alloy, we have that Alloy is the only material ingredient of Statue, and trivially persist through the process of creation, since the creation of Statue and the creation of Alloy are coincident. Thus, (MIIP) entails that Alloy is a proper part of Statue (it is a part of Statue and it is also different from Statue, since they have different sortalish properties). However, Weak Supplementation Principle requires that Statue has a part disjoint from Alloy, and from our previous discussion of Lowe's theory we now know that such a part cannot be found if we search among *material* parts of Statue. Mereological hylomorphism claims then that such a part is *formal*: it is an Aristotelian form which characterises Statue as a structured whole.<sup>69</sup>

According to hylomorphism, not only formal parts distinguish coincident objects but also performs many further theoretical roles: let us call the explanatory power of hylomorphic forms the substantiveness of forms.<sup>70</sup> Formal parts dictate the variety of the parts available to the wholes which include them, as well as their different possible arrangements. For instance, Socrates's form would let his material mereological profile to gain lipocytes and lose hair, but not to gain wheelbarrows and lose all his body minus his left thumb. Moreover, Socrates's form would not let his head and stomach to switch position.<sup>71</sup> Other metaphysically relevant roles formal parts play are: accounting for the high-degree of unity which their compounds exhibit, as well as the range of their specific behaviours, and, importantly, explaining why their compounds belong to the primary kinds<sup>72</sup> they do. Moreover, there are certain dependence relations between forms and their compounds. Koslicki (2018, 189) claims that hylomorphic forms ontologically depend on hylomorphic compounds. Specifically, she claims that, on an Aristotelian understanding of hylomorphic forms, either (i) they generically depend on their bearers, if forms are construed as universals (as in Koslicki 2008), or (ii) they rigidly depend on their bearers, if forms are construed instead as particulars (as in Fine 1999, 2008, Oderberg 2007,

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<sup>69</sup> Bennett (2011) rejects Koslicki's argument by rejecting (MIIP). Still, it is clear that the claim that Alloy is a proper part of Statue still follows from the Proper Parts Principle and quite trivial assumptions. Moreover, Koslicki's argument can be restated by employing Strong Supplementation Principle in place of Weak Supplementation Principle, and thereby getting rid of (MIIP) (see Tomaszewski 2016).

<sup>70</sup> Various remarks on the substantiveness of form can be found in Fine (2008, 113-115), Koslicki (2008, 182), Oderberg (2007, 66), and especially Koslicki (2018, 63).

<sup>71</sup> As Koslicki nicely puts it, forms «act as a sort of recipe in specifying the range and configuration of material components eligible to compose a whole of this kind» (Koslicki 2008, 182) (see also Goswick 2018, 54).

<sup>72</sup> I draw the expression from Baker's (2000, 2007) works on material constitution.

Koslicki 2018a). Let us simply call the ontological dependence of forms on their bearers the dependence of forms. Inasmuch dependent entities, hylomorphic forms cannot exist alone, but always require partaking to some compound of the right kind.

Hence, mereological hylomorphism captures the difference between an hylomorph and its matter in terms of mereological difference: Statue and Alloy do not completely overlap, as Weak Supplementation Principle prescribes. Therefore, there is no violation of any extensional principle. Indeed, Koslicki (2008, 181) shows that mereological hylomorphists can endorse all of CEM bar Unrestricted Composition. Recall that Unrestricted Composition states that, for every plurality of objects  $xx$  whatsoever, there is an object  $y$  such that  $y$  is composed by the  $xx$ . Now consider that mereological hylomorphists countenance Aristotelian forms among what there is, and that forms are substantive in the sense above specified. Consider now that the truth of Unrestricted Composition would countenance the existence of bizarre entities, such as the fusion of a marble sphere two metres in diameter and the Aristotelian formal proper part of a dog. These entities are not only bizarre, but straightforwardly metaphysically impossible. Arguably, according to the formal proper part of a dog, the whole whose it is proper part must have certain kinds of organs among its proper parts. It cannot, however, have any big marble sphere among them. Yet, the existence of such entities follows from the endorsement of Unrestricted Composition. Hence, mereological hylomorphism is incompatible with Unrestricted Composition, and *a fortiori* with CEM.

Nevertheless, a rejection of mereological hylomorphism due to tension with our first theoretical tenet would be too quick. Indeed, it is still possible to accommodate Unrestricted Composition within the framework. We may follow Sattig's (2015, 23) intuition and introduce a non-fundamental operation of hylomorphic composition.<sup>73</sup> When  $a$  is a material object and  $F$  is a hylomorphic form:

$$\Sigma_h(a, F)y =_{\text{def}} \text{(i) } a \text{ and } F \text{ compose } y, \text{ and (ii) } a \text{ is the subject of } F$$

The *to be a subject of*  $_$  is the specific relation between the matter of a hylomorphic compound and its form. According to the present definition of hylomorphic composition, if there is Alloy, and Alloy is the subject of the appropriate hylomorphic form  $F$ , Statue exists, and it is the hylomorphic compounds of Alloy and  $F$ .

Consider again the case of the big marble sphere and the form of a dog. Unrestricted Composition just implies the existence of the fusion of the big sphere and the dog form. However, since the sphere clearly is not the subject of the form, such fusion is not a hylomorphic compound, and thus does not come with the alleged metaphysically impossible modal properties. Therefore, mereological

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<sup>73</sup> Some alike remarks are already expressed in Fine (2008, 111-112). See also Fine (2010, 586).

hylomorphists may very well endorse Unrestricted Composition, and thus CEM, without endorsing the existence of metaphysically impossible entities.

Despite its compatibility with CEM, I think mereological hylomorphism is problematic. Particularly, the concept of hylomorphic form comes with some features that seem jointly incompatible, and dropping any of such features is at best unpromising. In the next section, I first show such a tension, arising from what I call the dependence of forms and their substantiveness. Then, I discuss how hylomorphists can revise the concept of form, to conclude that each option is largely undesirable.

## 2.2 An Argument Against Mereological Hylomorphism

Hylomorphism claims that material objects are hylomorphic compounds having both material and formal parts. Of course, material objects are individual, i.e., non-repeatable entities. However, some versions of the theory construe hylomorphic forms as universals or properties, i.e., entities that are repeatable or multiply instantiable. Koslicki (2008) and Goswick (2018) endorse such a conception of hylomorphic forms and characterise them respectively as universals and sortal properties.<sup>74</sup> Accordingly, material objects of the same primary kind, such as two human beings, would formally overlap in virtue of their sharing the same universal form. Although it may be *prima facie* counterintuitive to claim that, say, Socrates and Plato really share a part, recall the many theoretical roles that forms play according to hylomorphism. And of course, the fact that Socrates and Plato have the same form, with ‘sameness’ expressing numerical identity, straightforwardly accounts for the metaphysical truths which forms underlie.

More recently, Koslicki (2018a) has developed a conception of hylomorphic forms as robust particulars.<sup>75</sup> According to such a particularistic construction, forms maintain all the properties associated with their universal construction, but they are also non-repeatable and non-sharable, and bear different relations with the form-matter compound they contribute to constitute, and with the matter, respectively. The particularistic version of hylomorphism regards Socrates and Plato as really mereologically disjoint. However, since their individual forms are still forms of the same kind and play the same theoretical roles their universal counterparts are supposed to play, the particularistic version of hylomorphism is not explanatorily weaker than the universalist version.

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<sup>74</sup> Despite being universals and properties clearly two distinct kinds of entities, their difference is largely irrelevant in the present context. Who already is inclined towards a construction of universals as parts of their instances (such as Lewis 1983b) will be more attracted by Koslicki’s (2008) theory.

<sup>75</sup> Already Fine (1999) regarded forms as particulars, specifically as tropes; Oderberg (2007, 66) has a particularistic conception of forms as well. Indeed, if Merricks (2009) is right, the construction of forms as universals is just inconsistent, since it would be incompatible with certain plausible metaphysical scenarios, at least if a mereological principle as weak as Weak Supplementation holds.

Importantly, Koslicki (2018a) has carefully analysed the various kinds of dependence relations holding between forms, be they construed as particulars or universals, the matter they are hylomorphically unified to, and their compounds. Among the results of her analysis, there is the dependence of forms, i.e., the claim that forms ontologically depend on their compounds. Yet, Koslicki's phrasing of ontological dependence is inadequate. Indeed, she equates ontological dependence with mere necessitation (Koslicki 2018a, 189). Thus, for instance, the universal form human being generically depends on human beings because, necessarily, the existence of the universal form entails the existence of human beings. However, the problems with such a simple conception of ontological dependence are well known.<sup>76</sup> Just to mention the more obvious one, it makes everything dependent on necessary existent entities. Since the number nine exists necessarily, it is trivially true that, necessarily, if  $x$  exists, then the number nine exists, no matter what  $x$  is. In order to answer such problems, philosophers have formulated the relation of ontological dependence through the hyper-intensional relation of grounding, thus capturing a relation between the dependent entity and its dependee(s) which is stronger than mere necessitation (Correia 2005, 2008, Schnieder 2006b, 2020, 2021).

I take grounding to be a many-one relation between facts. One fact grounds another fact when the latter obtains 'in virtue of' the former. Moreover, I stick to the standard conception of grounding as a strict partial ordering, hence as an irreflexive and transitive (and thus asymmetric) relation. It is also customary distinguishing between partial and full grounding. A fact partially grounds another fact if the latter obtains in virtue of the obtaining of a plurality of facts, which includes the former fact. Differently, a fact (or a plurality of facts) fully grounds another fact if the latter holds just in virtue of the holding of the former (or of each fact of the plurality). In what follows, I will use a notion of partial grounding (as in Rosen 2010, 115).

Let us consider the universalist version of hylomorphism first. According to such a construction, hylomorphic forms are universal and are thus generically dependent on their bearers, that is, on the individual having them. Here are two formulations of generic existential dependence:

(GD1)  $x$  generically depends on some  $F =_{\text{def}}$  necessarily, if  $x$  exists, then there are a property  $G$  and a  $y$  such that (i)  $y$  is  $F$ , and (ii) the fact that  $y$  is  $G$  grounds the fact that  $x$  exists (Correia 2008, 1021)

(GD2)  $x$  generically depends on some  $F =_{\text{def}}$  necessarily, if  $x$  exists, then there is a property  $G$  such that the fact that some  $F$  is  $G$  grounds the fact that  $x$  exists (Costa 2021, 4332)

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<sup>76</sup> The classical reference is Fine (1994a) but see also the examples in Tahko and Lowe (2020).

These two principles slightly differ from one another. Take (GD1) first. Consider the form H, standing for the universal human being. Plausibly, the existence of H is grounded in the fact that y is a human being. (GD2) is similar to (GD1), but it differs in regarding the existence of H is taken to be grounded by the existentially quantified fact <some F is G>, which in the present context would be <some human being exists>. If forms generically depend on their compounds, their existence must therefore be grounded in some fact concerning hylomorphic compounds of the right kinds. In this respect, thus, the dependence of forms on their compounds has the same structure as the dependence of Aristotelian universals on their bearers (Cameron 2014, Correia 2005, 2008, Costa 2021, Lowe 2006). Generally, the debate between Platonic vs Aristotelian conceptions of universals revolves around the existence of uninstantiated universals, which is accepted by Platonists and denied by Aristotelians. Aristotelians are sceptic about the existence of uninstantiated universals because they regard universals as dependent on their instances: particularly, a universal exists because some object instantiates it. For instance, Correia (2008, 1026) says: «Aristotelians about, say, the universal redness claim that in order to exist, redness must be exemplified by something (a red thing for that matter)». <sup>77</sup> Analogously, hylomorphic forms must partake in the formal mereological profile of some compound in order to exist.

(GD1) and (GD2) thus account for the existential dependence of universal hylomorphic forms on their compounds. Furthermore, they informatively substantiate Koslicki's claim of necessitation, since instances of generic dependence always imply necessitation. The existence of forms necessitates the existence of their bearers, and that is the case because the existence of the former is grounded in some features of the latter. Now consider the following principle stating what grounds the holding of relations, which Costa (2021, 4332) names 'relata first':

(RF) <R(x, y, ...) > is grounded in <x exists>, <y exists>, ...

According to this principle, the fact that a relation R holds is grounded in the existence of the relata of R, and thus partially grounded in the existence of each relatum. The relata are 'first' with respect to the relation because their existence is ontologically prior to the holding of the relation, and (RF) take such a priority at face value by insisting on the existence of a grounding relation underneath.

I now show that the hylomorphist's commitments to the dependence and the substantiveness of forms generate a contradiction when coupled with (RF). Hylomorphism states that universal forms

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<sup>77</sup> I am drawing a parallel between Aristotelian universals and universal hylomorphic forms, but what about individual forms? In such a case, we can draw an even more familiar parallel with a typical kind of Aristotelian entities, namely tropes. Tropes rigidly depend on their bearers. For instance, Giacomo's smile depends for its existence on Giacomo behaving in certain ways (smiling) (Schnider 2020, 114). Analogously, individual forms would depend for their existence on being formal parts of their specific bearers. Oderberg is explicit on such a topic: «[Substantial form] does not and cannot, contra Platonism, exist apart from instantiation by a particular individual» (2007, 66).

generically depend on their bearers. Specifically, (GD1) states that the existence of a universal form is grounded in the fact that some existing entity is a human being. Let us consider the universal form H, standing for human being. Given (GD1), we have that

(1) <H exists> is grounded in <y is a human being>

This is a simple statement of the dependence of forms. In the actual world, then, a value of y is Socrates. Hence, it follows that

(2) <H exists> is grounded in <Socrates is a human being>

Consider now <Socrates is a human being>. Recall the substantiveness of forms: hylomorphic forms are taken to be primarily responsible for explaining many relevant metaphysical facts concerning the hylomorphic compounds. Among these, there are facts concerning the most specific kind or species hylomorphic compounds belong to and, relatedly, the sortal properties they instantiate (Fine 2008, 114; Koslicki 2018a, 63). Accordingly, we have that

(3) <Socrates is a human being> is grounded in <Socrates has H as hylomorphic form>

Consider now <Socrates has H as hylomorphic form>. Such a fact is the holding of a relation between Socrates and his hylomorphic form H. Hence, given (RF), it follows that

(4) <Socrates has H as hylomorphic form> is grounded in <Socrates exists>, <H exists>

Given the transitivity of grounding, (2), (3) and (4) jointly imply that

(5) <H exists> is grounded in <H exists>

which is inconsistent, given the irreflexivity of grounding.

We can repeat the same pattern of argument with slight variation by considering the alternative definition of generic dependence (GD2). To proceed with (GD2), we need a further principle governing grounding relations:

(IF) <Something is F> is grounded in F(a)

The principle (IF), which I name ‘instance first’ after Costa’s (2021, 4332) label, states that instances ground existential quantifications.<sup>78</sup> Consider now (GD2): it states that the existence of a universal form is grounded in the existentially quantified fact that some entity of the appropriate kind has it as

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<sup>78</sup> See Fine (2012, 59), Rosen (2010, 117).

formal part. Let us consider the universal form H, standing for human being. Given (GD2), we plausibly have that

(6) <H exists> is grounded in <some human being exists>.

The fact <Socrates is a human being> obviously obtains in the actual world. Given (IF), it is thus the case that

(7) <some human being exists> is grounded in <Socrates is a human being>

From here on, the argument proceeds as in the previous case. <Socrates is a human being> is grounded in <Socrates has H as hylomorphic form>, by the substantiveness of form. The transitivity and irreflexivity of grounding ensure that an inconsistency follows.

Much the same holds also given a particularistic conception of hylomorphic forms, which is Koslicki's (2018a) and Oderberg's (2007) favourite option. In such a case, the kind of dependence at stake would be rigid:

(RD)  $x$  rigidly depends on  $y$   $\text{=}_{\text{def}}$  necessarily, if  $x$  exists, then there is a property F such that the fact that  $y$  is F grounds the fact that  $x$  exists (Schnieder 2021, 114)

As with universal forms, the existence of the individual hylomorphic form H of Socrates is grounded in the existence of some entity of the appropriate kind. The appropriate kind is again picked out by the property being a human being, for the same reasons given above. Yet, in the present case, the relevant entity is Socrates, a specific individual. Hence, by considering any world in which there is Socrates, it follows from (RD) that

(2) <H exists> is grounded in <Socrates is a human being>

Clearly, from here, we can proceed analogously as in the previous (GD1) case. The conclusion is again that <H exists> is self-grounded, which is inconsistent with the assumption that grounding is a strict partial order.<sup>79</sup>

Some may be sceptic of (RF), or at least of the use of (RF) in the present context. For instance, Imaguire (2021) criticises (RF) by means of a class of counterexamples, namely by pointing out a kind of relations that contravenes (RF). Specifically, he claims that 'creating relations' are such that the existence of one of the relata is grounded in the fact that the relation holds. Among his examples, there are writing, giving birth to, building. Consider: Wittgenstein wrote the *Tractatus*, thus the

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<sup>79</sup> Actually, Koslicki (2018a, 188) warns about a threat of circularity arising from the dependence relations between hylomorphic forms and their bearers. She suggests avoiding construing hylomorphic forms as *essentially* and *constitutively* dependent upon their bearers. Notice, though, that the present argument just assumes that hylomorphic forms *existentially* depend upon their bearers; and hylomorphists regard the assumption as sound and uncontroversial.

existence of the *Tractatus* is not ‘ontologically prior’ to the instance of the writing relation between it and Wittgenstein. Rather, the opposite is true: the instance of the relation is ‘ontologically prior’ to the existence of the *Tractatus*. Hence, the existence of the *Tractatus* is grounded in the instance of the creating relation Wittgenstein bears to it. Furthermore, Imaguire claims that the exemplification relation between objects and Aristotelian universals is indeed a creating relation, in that «the apple ‘creates’ redness by exemplifying it» (Imaguire 2021) Since there may be a sense in which Socrates, or maybe any human being, ‘creates’ his individual form by having it, the soundness of (RF) in the present context may be questioned.

I think that *having \_ as hylomorphic form* respects (RF). Particularly, I think there is a specific class of relations whose instances entitle the application of (RF); and crucially, the relation *having \_ as hylomorphic form* would be such a relation according to hylomorphism. Let us start by having a grip on the notion of internal relation. Roughly, internal relations are relations that hold ‘for free’ when their relata exist. Whereas there is not a general non-controversial definition of internal relation,<sup>80</sup> two among the most renowned proposals are due to Moore and Lewis. According to Moore (1919, 47), internal (binary) relations are such that if they hold between two relata  $x$  and  $y$ , then they do so by necessity. In other words, if two entities stand in an internal relation  $R$ , then their existence is all it takes to them being  $R$ -related. Differently, Lewis (1986, 62) takes the mark of internal relations to be duplicate-invariance: accordingly, he defines them as supervening on the intrinsic natures of their relata. The two definitions end up disagreeing on the supposed internality of several properties. For instance, being as tall as is Lewis-internal but not Moore-internal. In fact, height is an intrinsic property, and thus does not vary between duplicates: hence, being as tall as is Lewis-internal. However, height is generally not a necessary property of objects: even if Giovanni is as tall as Maria, it is certainly possible for the former to be taller than the latter or vice versa. Hence, being as tall as is not Moore-internal. The two accounts of internality still agree on certain kinds of properties: for instance, being the successor of, which relates natural numbers, or being a logical consequence of, which relates propositions, are both Moore- and Lewis- internal. I am not interested in settling the dispute on the definition of internality here. Rather, I merely observe that the two definitions carve out two (overlapping) interesting classes of relations. For this reason, I distinguish between relations that are Moore-internal and Lewis-internal, and I take Moore-internality to be defined as follows:

(MI) A relation  $R$  is Moore-internal iff, if  $Rxy$ , then, necessarily, if  $x$  exists and  $y$  exists, then  $Rxy$

Examples of Moore-internal relations are *to be the successor of*, which takes natural numbers as arguments, *to be a logical consequence of*, which takes propositions as arguments, but also *having*

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<sup>80</sup> See McBride (2020) for clarifications.

*atomic number greater than*, which takes chemical elements as arguments, at least if a principle in the vicinity of micro-essentialism is true for chemical elements.

It seems to me that (RF) is a perfectly plausible principle when the relation under consideration is Moore-internal. The very mark of a Moore-internal relation is that it holds ‘for free’ just in virtue of the existence of its relata, no matter how they are contingently characterised. The relation is then an ‘ontologically free lunch’, to use David Armstrong’s famous expression, that merely adds up to the existence of the relata. The fact that a Moore-internal relation holds between  $x$  and  $y$  has a complete metaphysical explanation in the facts that its relata exist. Nothing more is requested for the relation to hold. Whenever there are the numbers 1 and 2, the number 2 would be the successor of the number 1; whenever there are the natural kinds of gold and carbon, the gold would have an atomic number greater than the carbon; and so forth.

Interestingly, some putative instances of what Imaguire would regard as ‘creating relations’ can really be taken as Moore-internal relations, once some further appropriate principles are accepted. For instance, the relation *being biologically originated from* is arguably a creating relation, since the existence of an organism can be said to be grounded in the holding of its conception. Nevertheless, the relation must be regarded as Moore-internal if a principle like the necessity of biological origin turns out to be true.<sup>81</sup> The same goes with the relation *being authored by*, holding between books and their authors, proviso the truth of some principle like the necessity of authorship. Hence, we can concede to Imaguire that he is right in claiming that instances of creating relations do not entitle the application of (RF) on themselves. However, some of them may do so conditionally on the acceptance of some further principles; and this is so because those principles ensure that the respective creating relations are Moore-internal relations.

Given a single further assumption that nicely suits the hylomorphic framework, the relation *having \_ as hylomorphic form* turns out to be Moore-internal. The internality of the relation is ensured by the (essential) identity dependence of hylomorphic compounds upon their form (Koslicki 2018a, 188; Oderberg 2007, 66). By following Tahko and Lowe (2020), we can formulate identity dependence as follows:

(ID)  $x$  depends for its identity upon  $y$  =<sub>def</sub> There is a relation ‘R’ such that it is part of the essence of  $x$  that  $x$  is related by R to  $y$

A pacific case of identity dependence is that between a set and each of its members. For instance, the set {Plato, Aristotle} is identity dependent upon Plato, and is identity dependent upon Aristotle as

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<sup>81</sup> Indeed, *being biologically originated from* is MacBride’s (2020) example of choice for Moore-internal relations, when the necessity of biological origin is on board.

well. In fact, part of the essence of {Plato, Aristotle} is that it stands in the relation *having \_ as member* with Plato and Aristotle. The Rigidity of Membership ensures these instances of identity dependence.

Since Socrates is identity dependent on its form, the relation ‘R’ which relates them is precisely the relation *having \_ as hylomorphic form*. As Koslicki remarks, «[...] it is part of Socrates’ essence that he is the hylomorphic compound which results from the presence of Socrates’ soul in some suitable body» (2018a, 188).<sup>82</sup> We find an analogous claim in Oderberg: «[Substantial form is] that which the identity of the substance is derived – that in virtue of which the substance is what it is» (2007, 66). Having his actual hylomorphic form is part of what to be Socrates is: Socrates is what he is in virtue of having his actual hylomorphic form as part. It should now be apparent why the relation *having \_ as hylomorphic form* is Moore-internal: necessarily, if Socrates and his hylomorphic form exist, then Socrates’ identity dependence upon his form ensures that they stand in that relation. They cannot jointly exist without being such related. Hence, the identity dependence of hylomorphic compounds on their forms ensures that the relation *having \_ as hylomorphic form* is Moore-internal. Accordingly, the relation obeys (RF), and thus we have defused any scepticism towards it in the present context.

Furthermore, one may wonder whether (GD1), (GD2), or (RD) really provide genuine ways to account for the dependence of hylomorphic forms on hylomorphic compounds. Indeed, when Koslicki claims hylomorphic forms to ontologically depend on their compounds, what she means is just that the former necessitate the latter. However, ontological dependence is not mere necessitation, but it is rather defined in terms of grounding relations between facts concerning its relata. At the very least, we can regard Koslicki’s Aristotelianism as an attempt to avoid construing hylomorphic forms as free-floating entities. Indeed, a core commitment of any brand of Aristotelianism is the ontological primacy of the substances, and substances are surely the best candidates which forms may depend on for their existence. We have considered above that philosophers customarily ground the existence of Aristotelian universals in their instances: the same Aristotelian intuition should grant here that the existence of hylomorphic forms is grounded in the compounds they partake in. Like universals, forms are abstract entities that characterise their bearers in important respects. Still, their existence is parasitic upon their bearers. Hence, in order to exist, forms must be had by something: by a bearer of the right kind, if they are construed as universals; by their specific bearer, if they are construed as individuals. (GD1), or alternatively (GD2), and (RD) would thus correctly express the kind of dependence between hylomorphic forms and their compounds.

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<sup>82</sup> In the quote, ‘Socrates’ soul’ is clearly a colourful expression to refer to Socrates’s hylomorphic form.

However, suppose those formulations of dependence are too strong in the present case. Perhaps hylomorphic forms do not depend for their existence on being had by the appropriate compounds; rather, they depend for their existence on the mere existence of the appropriate compounds. The weaker principle can be formulated as follows:

(GD-)  $x$  generically depends on some  $F =_{\text{def}}$  necessarily, if  $x$  exists, then there is a  $y$  such that (i)  $y$  is  $F$ , and (ii)  $\langle x \text{ exists} \rangle$  is grounded in  $\langle y \text{ exists} \rangle$

(RD-)  $x$  rigidly depends on  $y =_{\text{def}}$  necessarily, if  $x$  exists, then  $\langle x \text{ exists} \rangle$  is grounded in  $\langle y \text{ exists} \rangle$

If such a dependence claim is correct, then (RF) cannot be used in the arguments above to derive a contradiction. In fact, what allows employing (RF) is the relational fact  $\langle \text{Socrates has } H \text{ as hylomorphic form} \rangle$ , which is supposed to ground the existence of  $H$ . But if the existence of forms is grounded in the mere existence of their compounds, then (RF) cannot get off the ground. In fact, neither (GD-) nor (RD-) allows the derivation of (2), but only of the weaker (8):

(8)  $\langle H \text{ exists} \rangle$  is grounded in  $\langle \text{Socrates exists} \rangle$

If (GD-) and (RD-) really adequately express the kind of dependence between forms and compounds, then they rescue hylomorphism from the previous argument. However, even if forms depended in such a weak way on compounds, hylomorphism would still be inconsistent proviso the identity dependence of compounds upon their forms. In fact, it seems that anytime there is an identity dependence relation between two entities, those same entities must also stand in a further (rather weak) dependence relation: namely, the existence of the dependent entity is at least partially grounded in the existence of its dependee(s). In other words, when  $x$  is identity dependent on the  $yy$ , then  $x$  exists at least partially because the  $yy$  exist.

This claim should reveal almost obvious and innocuous when familiar kinds of identity dependent entities are considered. For instance, take again the set  $\{\text{Plato, Aristotle}\}$ . It depends for its identity on Plato and Aristotle, in that the two philosophers, being its members, jointly fix the set that  $\{\text{Plato, Aristotle}\}$  is. Necessarily, then that set exists because there are Plato and Aristotle: Plato and Aristotle are ‘ontologically prior’ to  $\{\text{Plato, Aristotle}\}$ , and their existence explains the existence of the set. A further familiar kind of (supposedly) identity dependent entities I wish to consider are events. Particularly, events may very well be claimed to be identity dependent on their participants. Suppose this is correct: then Giacomo and Elisa’s marriage is identity dependent upon (at least) Giacomo and Elisa, the relation ‘R’ being here has  $\_$  as participant. Again, Giacomo and Elisa’s marriage exists, at least partially, because Giacomo and Elisa exist. Again, Giacomo and Elisa are

‘ontologically prior’ to their marriage and their existence at least partially explains the existence of the event.

Suppose then that identity dependence relations indeed imply the holding of such a grounding relation between the existence of the dependent entity and the existence of its dependee(s). Then, the identity dependence of Socrates upon his hylomorphic form implies that:

(9) <Socrates exists> is grounded in <H exists>

However, from (GD-) and (RD-) we still obtain (8):

(8) <H exists> is grounded in <Socrates exists>

Clearly, (8) and (9) are again inconsistent with grounding being a strict partial order. Moreover, if the correct way to characterise the dependence relation between forms and compounds is really along the lines of (GD-) and (RD-), then neither (RF) nor Moore-internal relations play any role in the argument at all. All in all, then, it is doubtful that the present weakening of the original formulations of dependence would save the Aristotelian hylomorphism.

If correct, the preceding lines of argument should put some pressure on hylomorphism. However, the argument relies on a number of assumptions that, although natural within their theory, the hylomorphists may still reject.

First, hylomorphists may claim that hylomorphic forms do not existentially depend on their bearers. In other words, they may put aside their background Aristotelianism and embrace instead some kind of Platonism about forms. Such a commitment would of course render hylomorphism theoretically more costly. If forms are construed as universals, then Platonism about forms is Platonism about universals, or transcendentism. Although it has some endorsers (e.g., Van Inwagen 2016), philosophers generally regard Platonism about universals with suspicion. One of its more controversial aspects is its acknowledgement of uninstantiated universals among what there is. If universals do not depend for their existence on their instances, then it would be arbitrary to restrain their existence to those worlds in which they are instantiated. Thus, any world ends up being overpopulated by a multitude of uninstantiated universals: however, uninstantiated universals seem to be no more than ontological danglers. If forms are instead construed as individuals, then the commitment of the corresponding version of Platonism is akin to that of Williamson’s (2013b) necessitism. If individual forms do not depend for their existence on their bearers, then it seems that the modal recombination of the former cannot be constrained by the latter in those worlds in which the latter do not exist. Hence, it is *prima facie* consistent to claim that, although my possible elder brother does not actually exist, his form does. The same goes with all my possible elder brothers, but also with all

the possible yet actually non-existent dogs, rivers, artworks, Martians, carbon dioxide molecules, and so forth. Thus, any world ends up being over-populated by a multitude of abstract forms: however, again, individual forms which are not part of any hylomorphic compound seem to be no more than ontological dangles.

The additional cost of Platonism is not the only consequence of getting rid of existential dependence. Indeed, hylomorphists may propose to avoid dependence relations and claim instead that the relation between hylomorphic forms and their bearers is just necessitation: necessarily, if there is the form, then there are the appropriate bearers. For instance, this is precisely Imaguire's (2021) understanding of the relation between Aristotelian universals and their instances. In the end, also Koslicki (2018a, 189) seems to lean towards this construction of the modal relation between forms and hylomorphic compounds. Although consistent, I take the major drawback of such a claim to be its lack of informativeness.<sup>83</sup> As Sider remarks, a tenet of contemporary metaphysics is that « [i]f a truth is necessary, there must be some reason for why this is so» (Sider 2020, 211). Consider a pacific case of mere necessitation: for instance, anything necessitates necessarily existent entities. There is an explanation for this fact, which does not involve any dependence relation at all: any necessarily existent entity  $x$  satisfies the formula  $\Box(Ex)$ , and thus any formula  $\Box(Ey \rightarrow Ex)$  as well. Cases of genuine existential dependence are different. Take tropes: they are necessitated by their bearers *because* their existence is grounded in the existence of their bearers. The necessitation is explained by non-trivial features of the relata, not by logic. As far as concerns hylomorphic forms, it seems that the weakest explanation of the necessitation is that their existence is grounded in the existence of their bearers, thus exploiting (GD-) and (RD-). However, these weak dependence claims are enough to get hylomorphism into trouble.

Second, hylomorphists may either reject the substantiveness of forms or, more conservatively, claim that forms do not account for the primary kind their compounds belong to. In both cases, the premise (3) would be rejected. However, the fortune of such a theoretical move is doubtful. The first option is really not appealing. The primary goal of hylomorphic forms is surely to account for the numerical distinction between substances and their matter. Such a distinction is construed mereologically, in full respect of Weak Supplementation principle (see especially Koslicki 2008, 180). The mereological difference between Socrates and his body, however, cannot be fully assimilated to, say, that between his body and his torso. In the former case, in fact, the difference is merely formal, no 'gross' material part playing the remainder role. And, of course, the remainder is a purely formal component of Socrates. However, if formal components just accounted for the

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<sup>83</sup> Relatedly, Fine claims that he would be «[...] decidedly uncomfortable with a conception of form whose presence could float free of the underlying facts» (2020, 432).

numerical distinction between fully coincident objects, their introduction would seem suspiciously ad hoc. After all, Socrates and his body do appear to share all of their proper parts,<sup>84</sup> at least according to a kosher conception of proper part. Still, the use hylomorphists make of forms goes beyond their role as difference-maker. First, as we have already considered, they invoke forms in order to accounts for many important features of their compounds. Second, and relatedly, hylomorphists regard forms as a useful tool to solve certain metaphysical difficulties: among these, notably, the transworld identity of substances and the grounding problem. Hence, the substantiveness of forms plays a crucial role within the theoretical framework of hylomorphists and cannot be simply dropped. Otherwise, the very introduction of forms would dangerously result ad hoc.

The ad hocness of the second option may be even more blatant, but at least it would be compatible with forms maintaining a *prima facie* good amount of their explanatory power. Hylomorphists should just drop their claim that forms also account for the primary kinds of their bearers. Given such a weaker conception of forms, however, we should ask what then explains the sortal difference between, say, Socrates and his body. Consider that, according to this impaired conception, forms would still explain the persistence conditions of compounds: hence, if sortal differences are not brute, they should be arguably grounded in the difference regarding persistence conditions. Indeed, according to the present proposal, <Socrates is human> is grounded in <Socrates has such-and-such persistence conditions>. However, such weakening of the substantiveness of forms is not satisfying. Indeed, the impaired substantiveness of forms would be still enough to grant that <Socrates has-such-and-such persistence conditions> is grounded in <Socrates has H as hylomorphic form> which, given the transitivity of grounding, thus leading to (3). For sure, it is possible to weaken the substantiveness of forms further, but the threat of ad hocness would proportionately become more serious. Moreover, consider that certain kinds of explanations the substantiveness of forms furnishes are closely related: for instance, forms cannot properly explain the range of specific behaviour of a compound without in parallel explaining the primary kind the compound belongs to. Hence, the suggested impairment of the substantiveness of forms is ad hoc at best, and definitely unpromising at worst.

Third, hylomorphists may contend that *having \_ as hylomorphic form* is not a Moore-internal relation. However, the relation indeed is a Moore-internal relation *if* hylomorphic compounds are identity-dependent on their forms. And that is a very natural thesis for hylomorphists. Both Koslicki (2018a, 99-103), and Fine (2008, 112-113),<sup>85</sup> for instance, account for transworld identity in terms of individual forms. Consequently, any hylomorphic compound would have its form necessarily.

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<sup>84</sup> Some philosophers, such as Simons (1987) and Lowe (2013a), would reject such a claim on the ground of their rejection of Strong Supplementation principle.

<sup>85</sup> Fine expresses the claim, within his theory of embodiments, in the guise of the Existence Postulate.

Moreover, since among the many theoretical roles hylomorphic forms play there are the fixing of the primary kind of their bearers, their persistence conditions, their modal profiles, and so forth, they end up accounting not only for the transworld identity of the hylomorphic compounds, but also for many fundamental features of them. Therefore, it is natural to take compounds to be identity-dependent upon their forms. And the holding of such a dependence relation grants that *having \_ as hylomorphic form* is a Moore-internal relation.

Fourth, hylomorphists may say that grounding is not a strict partial order. Hylomorphists that opted for this line may find support in the works of several philosophers (Bliss 2018, Rodriguez-Pereyra 2015, Thompson 2016). Yet, since the general consensus is still that grounding is a strict partial order (Fine 2012, Schumener 2017, Raven 2015), denying it amounts to a heterodox claim to say the least.<sup>86</sup>

Therefore, hylomorphists may very well rebut the previous argument by following one of the four lines above. However, the benefit that their theory brings to a conception of material objects would be greatly diminished, or their theory would result much weaker or gerrymandered overall. By accepting a transcendentalist hylomorphism, they would threaten their theory with the seemingly unrelated commitment to Platonism, besides offering an unintuitive and uninformative account of the relation between forms and hylomorphic compounds. By rejecting or weakening the substantiveness of forms, they impoverish the main character of hylomorphism to the point of making their theory ad hoc. By rejecting the identity-dependence of hylomorphic compounds upon their forms, not only they lose a coherent tool to account for the transworld identity of the former in terms of the latter, but also a suitable explanation of many of the essential features of hylomorphic compounds.<sup>87</sup> Lastly, by advancing a non-standard conception of grounding, they would again burden their theory with further theoretical commitment they should probably avoid.

### 2.3 Extensionality, Rigidity, Simplicity

Let us focus again on sets for a moment. We have already considered the Extensionality Axiom of set theory, according to which no two sets can have exactly the same members:

$$\forall x \forall y (x = y \leftrightarrow \forall z (z \in x \leftrightarrow z \in y))$$

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<sup>86</sup> For a more in-depth presentation of the debate, see Thompson (2021). Slightly differently, Barnes (2018) suggests that the relation of dependence may be non-symmetric. But of course, the relations of dependence and grounding are conceptually close.

<sup>87</sup> Or at least features hylomorphists plausibly wish to maintain as essential.

According to the Extensionality Axiom, for instance, the set {Imperia, Savona, Genoa, La Spezia} and the set  $\{x|x \text{ is one of the provincial capitals of Liguria}\}$  are indeed one and the same set. Moreover, inasmuch as an axiom, we can necessitate the Extensionality Axiom, thus obtaining:

$$\Box \forall x \forall y (x = y \leftrightarrow \forall z (z \in x \leftrightarrow z \in y))$$

This is a *de dicto* principle stating that in no possible world two sets can have exactly the same members. Still, the *de dicto* principle does nothing more than registering the fact that the Extensionality Axiom holds at every possible world: particularly, it is silent about the inter-world identity conditions of sets. For such conditions, we need a similar *de re* principle, specifically the following one (Cameron 2006, 102):

$$\forall x \forall z (z \in x \rightarrow \Box \forall y (x = y \rightarrow z \in y))$$

This *de re* principle states that if  $z \in x$ , then  $z \in x$  in every possible world in which  $x$  exists. Let us name this principle the Rigidity of Membership. Indeed, this *de re* principle implies that no set can vary with respect to its membership profile. Such a *de re* principle provides wholly extensional inter-world identity conditions for sets, thus establishing an interesting parallel with intra-world ones as provided by the Extensionality Axiom. Many philosophers are happy with the Rigidity of Membership.<sup>88</sup> It is almost assumed as a triviality that sets have their members essentially and thus are modally inflexible. The Rigidity of Membership also follows from the identity-dependence of sets upon their members.

$x$  depends for its identity upon  $y =_{\text{def}}$  There is a relation ' $R$ ' such that it is part of the essence of  $x$  that  $x$  is *related by  $R$*  to  $y$  (Tahko and Lowe 2020)

If it is part of the essence of the set  $x$  that it stands in the relation *having \_ as member* with  $z$ , then  $x$  cannot exist without being thus related to  $z$ : having  $z$  as member is part of what is to be  $x$ . Hence,  $x$  cannot vary with respect to its membership profile across possible worlds, that is precisely what the Rigidity of Membership states. Or to put it differently: for any set, its members are its individuator, precisely in virtue of the abovementioned identity-dependence relation. A principle of individuation for sets, that picks out the individual essence of each set, must refer to the members of sets. And principles of individuation for Ks provide corresponding criteria of identity for Ks (Lowe 2012, 217).

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<sup>88</sup> As van Inwagen states: «Many philosophers have convictions about the modal properties of sets, and the conviction that a set can neither gain nor lose members is one of the most prominent of them» (2006, 621).

Although the Rigidity of Membership is compelling, philosophers usually assume it rather than argue for it.<sup>89</sup> Nevertheless, Linnebo (2016) has recently advanced an abductive argument for the Rigidity of Membership (which he aims to extend to pluralities as well). Despite being not valid, Linnebo's argument satisfyingly explains a relevant metaphysical fact. Moreover, it relies on just the following well-endorsed principles:

Extensionality Axiom (EA): necessarily, for all sets  $x, y$ ,  $x = y$  if and only if, for all  $z$ ,  $z \in x$  if and only if  $z \in y$

Leibniz Law (LL): necessarily, if  $x = y$ , then, for all  $F$ ,  $Fx$  if and only if  $Fy$

Here is the argument. Suppose that the sets  $x$  and  $y$  have all and the same members. From (EA),  $x$  and  $y$  are identical. Consider now the property  $\Box\forall u(u \in x \leftrightarrow u \in \dots)$ , that is, the property of being such that, necessarily, for all  $u$ ,  $u \in x$  if and only if  $u \in$  the bearer. Now, clearly  $x$  has that property; however, since  $x$  and  $y$  are identical, and (LL) ensures the indiscernibility of identical,  $y$  has that property as well. It happens, then, that  $x$  and  $y$  are necessarily co-extensional. This conclusion is still compatible with systematic parallel drifting of  $x$  and  $y$ . However, why should actual co-extensionality ensure necessary co-extensionality? A claim that better makes sense of the conclusion (indeed, according to Linnebo (2016, 6), the only explanation) is the Rigidity of Membership, which Linnebo analyses as the conjunction of the following (R+) and (R-):

(R+) if  $u \in x$ , then necessarily  $u \in x$

(R-) if  $u \notin x$ , then necessarily  $u \notin x$

Since  $x$  and  $y$  actually have the same members, and (R+) and (R-) jointly impose that the members of sets do not vary across possible worlds, the conclusion is still warranted:  $x$  and  $y$  are necessarily co-extensional (and thus necessarily identical). Actual co-extensionality ensures necessary co-extensionality because sets are fixed in their actual members. Notice that Linnebo's abduction is perfectly in line with Lowe's (2012, 217) remark that principles of individuations for Ks provide criteria of identity for Ks, in that it proceeds from the evidence of a criterion of identity for sets to a corresponding principle of individuation for sets that actually make sense of it.

More broadly, according to Linnebo, any reason we have to accept an extensionality principle for any kind of collections is also a reason to accept the rigidity of the corresponding relation. Indeed, the reason for accepting the extensionality principle for a kind of collection is that those kinds of

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<sup>89</sup> Of course, the Rigidity of Membership follows from the identity-dependence of sets upon their members, but to argue for the Rigidity of Membership in this way just shifts the burden of proof to the dependence claim. Van Cleve (1986a) offers a proof of the Rigidity of Membership from further principles, but his proof is only very rarely mentioned by philosophers endorsing the Rigidity of Membership.

objects are fully specified by their respective building blocks, and when we trace an object of that kind across possible worlds we have nothing more than the respective building block to rely on (Linnebo 2016, 6). In the case of mereology, these considerations translate into the claims that mereological fusions are fully specified by their proper parts, and that such fact is what grounds our acceptance of Extensionality of Proper Parts. Indeed, Linnebo claims that

These considerations give rise to a dilemma that applies not only to sets, but to any other notion of collection: either we have to give up the principle of extensionality, or else we have to accept the rigidity principles as well. [...] There can be no ‘soft extensionalism’ concerning sets or other kinds of collection, only ‘hard extensionalism’ that incorporates the rigidity claims and the idea of transworld extensionality that they embody. (Linnebo 2016, 6).

Let us consider the mereological analogue of the Rigidity of Membership and call it the Rigidity of Proper Parthood. We may express such a principle as

- (P+) if  $PPux$ , then necessarily  $PPux$
- (P-) if  $\neg PPux$ , then necessarily  $\neg PPux$

Clearly, the considerations above hold in the present case as well: the same kind of abductive argument supports the Rigidity of Proper Parthood. Extensionality of Proper Parthood is the mereological analogue of (EA) and it delivers a parallel result for mereological fusions. Naturally (LL) still holds, since nothing in mereology speaks against it. Co-extensional fusions turn out necessarily co-extensional, and this gives the reason to abductively infer the Rigidity of Parthood.<sup>90</sup> However, unlike sets, mereological fusions seem to provide serious counterexamples to the necessary co-extensionality the above argument implies. Unsurprisingly, Linnebo’s example concerns basically our Statue-Alloy scenario.<sup>91</sup> Statue and Alloy share all of their proper parts, so they are identical by

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<sup>90</sup> How would the counterpart theorist answer Linnebo’s argument? She would regard the predicate ‘being such that, necessarily, any  $u$  is a proper part of Statue if and only if  $u$  is a proper part of  $\_$ ’ as Abelardian. Accordingly, the predicate would shift its reference depending on the subject it is attached to. When attached to ‘Statue’, the predicate refers to the property *having only statue-counterparts that have all and only the same proper parts of Statue’s statue-counterparts*; when attached to ‘Alloy’, the predicate would instead refer to the property *having only alloy-counterparts that have all and only the same proper parts of Statue’s alloy-counterparts*. Hence, Linnebo’s argument would at best conclude that Statue and Alloy share completely overlapping statue- and alloy- counterparts; such a conclusion is pretty trivial, though, inasmuch Statue *is* Alloy. Such a conclusion has no strength at all, since it does not invalidate the truth of sentences like ‘Statue may have not been constituted by Alloy’, which counterpart theorists can keep analysing as ‘There are statue-counterparts of Statue that are not constituted by alloy-counterparts of Alloy’. What matters for the truth of such sentences is that one and the same thing can have disjoint statue- and alloy- counterparts. Linnebo’s argument, then, is valid but devoid of interesting conclusions. Clearly, though, the viability of the present reply is conditional upon the viability of counterpart theory as a theory of transworld identity; yet, as the entire section 1.4 should have shown, there are good reasons for scepticism.

<sup>91</sup> Nevertheless, crucially, Linnebo’s argument works independently from such a scenario: any case of contingent identity between entities would serve it as well.

Extensionality of Proper Parthood. Moreover, since Statue clearly instantiates the property  $\Box\forall u(PPu_{Statue} \leftrightarrow PPu\dots)$ , which is the mereological counterpart of the property the original version of the argument employs, (LL) grants that Alloy instantiates such a property as well. Thus, it follows that Statue and Alloy are necessarily co-extensional, meaning here that they have necessarily the same proper parts. Again, actual co-extensionality ensures necessary co-extensionality. If this is true, though, the abduction to the Rigidity of Proper Parthood is cogent. However, instances of proper parthood relation seem to be a contingent issue: it must be the case that Statue and Alloy can diverge with respect to their mereological profile, and the same goes for many different mereological fusions. According to Linnebo, there is an important asymmetry between material objects and sets, since only the former can be tracked intensionally across possible worlds (that is, independently of their building profile). Hence, the mereological version of his argument must be ultimately invalid. Moreover, by invalidating the deductive argument to necessary co-extensionality, the abductive argument to the Rigidity of Proper Parthood would be simply dismissed.

Linnebo argues for the invalidity of the mereological version of the argument on the grounds that the Statue-Alloy example does not allow the inference to necessary co-extension. The reason is that, differently from the membership relation, it is possible to make the parthood relation sensitive to the formal aspects of material objects. In doing so, Linnebo endorses mereological hylomorphism and thus acknowledges the existence of formal parts of objects. Formal parts provide the intensional aspect to rely on when tracking objects across possible worlds; moreover, they provide a reason to accept Extensionality of Proper Parthood which is not also a reason to accept the Rigidity of Parthood. When formal parts are accepted in the ontology, in fact, Extensionality of Proper Parthood is the thesis according to which, if  $x$  and  $y$  share all of their material *and formal* proper parts, then  $x$  and  $y$  are identical. Since formal parts keep track of objects across possible worlds (as in Fine 1999, Koslicki 2018a), the fact that  $x$  and  $y$  have the same formal parts would thus explain the necessary co-extensionality of  $x$  and  $y$  without having to invoke the Rigidity of Proper Parthood.

However, if formal parts are not accepted in the ontology, the Rigidity of Proper Parthood strikes again (Linnebo 2016, fn. 19). Since our preceding argument against mereological hylomorphism is basically an argument against the very notion of formal part, or at least against a robust, non-trivial, construction of formal parts, I will avoid invoking formal parts. If formal parts are ignored, the dilemma would reappear: either we give up Extensionality of Proper Parthood or we accept the Rigidity of Proper Parthood as well. And, since we aim to preserve Extensionality of Proper Parthood, Linnebo's abduction pushes us to the acceptance of the Rigidity of Proper Parthood as well. Therefore, it seems that any metaphysical theory of material objects that wishes to accept a mereology as strong as Loss's (2021b) weakest extensional mereology is better off either accepting (some

version of) mereological hylomorphism or the Rigidity of Proper Parthood. In the next section, I will advance a metaphysical theory of material objects that makes sense of the Rigidity of Proper Parthood. Before proceeding, though, it is important to clarify a couple of points on the controversial principle.

First, the Rigidity of Proper Parthood may be conflated with similar yet different principles. For instance, it resembles Chisholm's formulation of Mereological Essentialism, that is, the thesis according to which

Chisholm-Mereological Essentialism: for all object  $x$ , and for all objects  $y$  such that  $y$  is part of  $x$  at some time, in every world in which  $x$  exists,  $y$  is part of  $x$  at all times in that world that  $x$  exists (Cameron 2017, 349)

(See Chisholm 1973, 1975; see also Plantinga 1975, and van Inwagen 1990a, sect. 8). Crucially, though, (C-ME) employs a temporal-indexed notion of parthood, which simply cannot be formulated in the standard mereological language (as Evnine 2018, fn. 5 rightly remarks). This kind of language revision is typical of philosophers endorsing a specific theory of persistence, on which we will come back in the next chapter. Indeed, the language of CEM characterises parthood as a relation that holds *simpliciter*, just like the language of set-theory characterises the membership relation. More generally, CEM's language permits a formulation of the theory in line with Mereological Semantic Simplicity:

Mereological Semantic Simplicity: any mereological sentence holds absolutely

Lacking any other theoretical tool, Mereological Semantic Simplicity characterises mereologically complex objects as unable to gain or lose parts over time. By using Fine's (2005, 322) distinction between eternal and sempiternal truth, we may that Mereological Semantic Simplicity characterises the truth (falsity) of mereological sentences as eternal, that is, true (false) regardless of time, on a par with the truth (falsity) of membership statements concerning sets. Clearly, the Rigidity of Proper Parthood and Mereological Semantic Simplicity are two different principles, and we should not conflate them.

Second, in addition to Linnebo's abductive argument, there is actually a deductive proof of the Rigidity of Proper Parthood. The proof is due to Van Cleve (1986a, 596-597), who has shown the principle to be provable from the following three mereological assumptions:

(EX):  $\Box \forall x \exists y Fyxx$

(UN):  $\forall x \forall y \forall z (Fyxx \rightarrow \Box \forall z (Fzxx \rightarrow z = y))$

(SEP):  $\forall x \forall y ((Pxy \wedge \Diamond \exists z (z = y \wedge \neg Pxz)) \rightarrow \Diamond \exists z \exists w (z = y \wedge w = x \wedge \neg Pwz))$

EX is just the necessitation of Unrestricted Composition. UN resembles Uniqueness of Composition, but is strictly stronger, since it is a *de re* principle. Lastly, SEP states that, if it is possible that an object  $y$  exists lacking one of its actual parts  $x$ , then it is possible that both  $x$  and  $y$  exist without  $x$  being part of  $y$ . The proof is as follows:

Proof: assume that there is a mereological sum  $a$  and a plurality of objects  $b, c, d$ , such that  $b, c, d$  composes  $a$  at the possible world  $w$ . By the definition of composition,  $b, c, d$  are among  $a$ 's proper parts at  $w$ . Suppose that the Rigidity of Proper Parthood is false: then, there is a possible world  $w^*$  such that  $a$  exists at  $w^*$  but it lacks one of its proper parts, let us say  $d$ . Moreover, let us say that  $d$  does not exist at  $w^*$ . By SEP, there is a further possible world  $w^{**}$  such that  $a$  exists at  $w^{**}$ ,  $d$  is not one of its proper parts, but  $d$  exists at  $w^{**}$ . By EX, there is an object at  $w^{**}$  that is composed by  $b, c$ , and  $d$ . By UN, that object is  $a$ . By the definition of composition,  $d$  is one of  $a$ 's proper parts. It follows that  $d$  is and is not a proper part of  $a$  at  $w^{**}$ . For *reductio*, it follows that the Rigidity of Proper Parthood is true.

It is no wonder that the present proof is largely ignored in the literature: the principles EX and UN are far from being uncontroversial. EX is the necessitation of Unrestricted Composition, a mereological principle that many reject. Generally, Unrestricted Composition triggers an incredulous stare towards the plurality of weird objects it countenances, and a significant number of philosophers are attracted to some sort of bare conservatism<sup>92</sup> according to which, for instance, there are trees and dogs, yet not fusions of them (or 'troggs'). Moreover, UN is a principle strictly stronger than Uniqueness of Composition, in that it comes with *de re* modal consequences for its relata. Recall from the previous section that Uniqueness of Composition is the strongest among extensionality principles. As we have seen, multi-thingist intuitions sometimes lead to the rejection of an extensionality principle as weak as antisymmetry. However, if multi-thingers reject some weaker extensionality principle, they must *a fortiori* reject UN.<sup>93</sup>

Third, the Rigidity of Proper Parthood furnishes non-trivial, crystal-clear transworld identity conditions for mereologically complex entities. This is an invaluable tool for whoever rejects counterpart theory. Consider that there are kinds of entities, such as organisms and artifacts, whose transworld identity can be plausibly accounted for in terms of qualitative essences, and other, such as spacetime points, whose transworld identity is better accounted for in terms of haecceities. However, given Unrestricted Fusion, there are many entities, such as trout-turkeys, for which transworld identity cannot undoubtedly be accounted in terms of qualitative essences. Such entities are

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<sup>92</sup> The label is due to Korman (2020, 563).

<sup>93</sup> It is surely possible to reject some of these principles while still holding mereological essentialism. Chisholm, for example, held mereological essentialism while, at the same time, rejecting Unrestricted Composition.

countenanced in the ontology, but they do not belong to any real kind: they are not artifacts, nor instances of natural kinds, and neither necessarily existent objects. Suppose that their transworld identity would be accounted for just in terms of haecceities. Chisholm (1976, 149 ff) presented the following infamous changing parts scenario. Take two utterly unnatural distinct mereological sums, such as the trout-turkey  $t$  and the salmon-hen  $s$ , both of them existing in the actual world  $w$ . Now consider a possible world  $w'$  such that  $t$  and  $a$  exist at  $w'$ , only that a molecule that was proper part of  $t$  at  $w$  is now part of  $s$ , and vice versa for a molecule of  $a$ . Indeed, it is possible to reiterate such a scenario for as many possible worlds as the molecules of  $t$  and  $s$  (indeed, for as many possible worlds as  $t$ 's and  $s$ 's proper parts). Therefore, given transitivity of identity, there is a world  $w^*$  such that  $t$  and  $s$  exist at  $w^*$ , only that their mereological profiles are inverted. Such a case is certainly logically possible, and the instantiation of the proper haecceities can fully account for it: the identity of  $t$  at  $w$  with  $t$  at  $w^*$  is grounded in their instantiation of the same haecceitistic property, no matter what proper parts they have. However, our modal intuitions point here to a different account of transworld identity. Fusions like trout-turkey and salmon-hen seem to have their proper parts essentially. That is, to be the trout-turkey  $t$  just is to have precisely the proper parts of  $t$ . Hence, the Rigidity of Proper Parts sounds like the right principle to account for their transworld identity. The real question is whether it can account for the transworld identity of natural objects as well.

#### 2.4 Hylomorphs As Extended Simples

Consider again the Troublesome Argument and Linnebo's argument, from the viewpoint of an endorser of CEM. As we have seen earlier, the traditional one-thingist way out of the Troublesome Argument comes with the adoption of an Abelardian treatment of modal predication and metalinguistic negation for non-modal ones. However, since there are reasonable doubts concerning a counterpartistic treatment of modal context, it is interesting to see how a different solution can be developed. Since the Troublesome Argument is formulated by means of Extensionality of Proper Parts, a way to avoid its conclusion is to claim that Statue and Alloy do not share all and only the same proper parts. The logical space comprises the following cases:

- (1) Statue has more proper parts than Alloy
- (2) Statue and Alloy have different proper parts
- (3) Alloy has more proper parts than Statue

Mereological hylomorphism, for example, is a Constituting Parthood extensional theory endorsing (1): Statue has more proper parts than Alloy, and precisely a formal proper part. The mereological hylomorphist can thus explain the difference between Statue and Alloy by pointing to the fact that

Statue outstrips Alloy. Varzi (2008) and Wasserman (2002, 1999) have critically hinted at (2) by suggest a theory according to which the Alloy and Statue turn out being composed by pluralities of atoms belonging to two different sorts. Clearly, however, either there is a plurality of entities that compose both or Statue and Alloy or there is not. If both Statue and Alloy are indeed composed entities, it seems that they must be composed by the same plurality of entities at a bottom level; and so the theory would be at odds with Uniqueness of Composition. If Statue and Alloy do not actually share any decomposition at all, the theory must explain away the intuition according to which they are made up of the very same particles; and such an explanation should arguably invoke a suspect systematic interpenetration of Statue's atoms with Alloy's atoms.

I want to explore the proposal (3), in the rather extreme guise according to which Statue has no proper parts at all, while Alloy is decomposable in the usual way, and every such decomposition dissects it into its parts. In other words, Statue, as well as any other hylomorph, is an extended simple. Such a proposal has very few endorsers in the literature. To my mind, it was tentatively advanced at first by Baker (2007) and then recently brought somewhat back by Canavotto and Giordani (2020). They share the multi-thingist credo that distinguishes any structured material object from its composing matter, but still grants the existence of an intimate relation between them. More on the point, these authors agree on regarding the relation between, on the one hand, a portion of matter and one of its gerrymandered sub-portions and, on the other hand, an anthropomorphic statue and its nose, as instances of two actually distinct relations. Only the former instance would be an instance of *bona fide*, CEM-theoretic parthood. The authors then disagree about the construction of the latter instance. Whereas Baker (2007) offers a reductive definition of such relation in terms of parthood and material constitution, Canavotto and Giordani (2020) regard it as primitive and then propose to axiomatize it by means of a dedicated mereology. I follow the lead of Baker and propose an alternative reductive definition of the relation at stake.

Following Koons's (2014, 161) slightly mocking label, I name the present account Aristotelian Parts-Nihilism (APN). The account is Aristotelian, at least in the broad sense of acknowledging the numerical distinction between hylomorphs and their constituting matter. The account is nihilist as well, in that it denies that hylomorphs do have proper parts. The fundamental theoretical claim of APN is thus:

(APN) Necessarily, every hylomorph is mereologically atomic

The main rationale of APN is to make sense of a multi-thingist metaphysics of material objects within the framework of CEM. Remember that these were precisely our two theoretical tenets. APN promises to be a theory of material objects that avoids the inconsistency underlying the Troublesome

Argument. Since Statue is atomic and numerically different from Alloy, it is simply false that Statue and Alloy have a decomposition in common. As a result, the premise (1) of the Troublesome Argument is defused, and the Troublesome Argument tamed.

APN is a multi-thingist theory: it acknowledges that every hylomorph is materially constituted by a suitable portion of matter at each temporal instant at which it exists. APN's approach towards material constitution is inevitably No Parthood, since both the Mutual Parthood and the Constituting Parthood approaches are incompatible with the assumption of atomicity. Moreover, we have seen that all the relevant theories endorsing one of those two approaches to material constitution must eventually give up some fragment of CEM. No Parthood is the most CEM-friendly approach to material constitution, and thus to multi-thingism itself.

I am not going to advance any definition of material constitution because nothing will depend upon such a definition. This does not mean that no definition can be given as a matter of principle, but just that the present exposition does not need any specific definition. Still, the existence of instances of material constitution relations satisfies our multi-thingist theoretical tenet. Thus, I am endorsing here the primitivist strain of No Parthood theorists, but I am open to the possibility that an appropriate definition, or at least a partial analysis, of the material constitution relation may be eventually provided. Any definition, though, should meet the following two constraints. First, the definition must avoid any claim that states or imply that hylomorphs have proper parts. Second, the definition must be asymmetric. Although not a strict requirement of the present theory, such a feature of material constitution is generally undisputed and, as Barker and Jago (2014) have pointed out, captures the idea according to which the constituted object is more informationally complex than its constituting portion of matter. Indeed, even a primitivist like Evnine (2016, 3) acknowledges that the relation of material constitution must be asymmetric.

APN makes sense of the Rigidity of Parthood: since structured entities do not have proper parts, the Rigidity principles do not have any implausible consequences. The Rigidity of Parthood implies that portions of matter have their parts necessarily, but that is indeed plausibly true. Moreover, APN can even accept Mereological Semantic Simplicity, thus dispensing with any temporal qualification of mereological predicates and sticking with the original atemporal formulation.

Of course, The Rigidity of Parthood and Mereological Semantic Simplicity suits nicely Mereological Essentialism:

Mereological Essentialism: for every  $x$ , for every  $y$ , if  $y$  is a proper part of  $x$ , then  $x$  is identity-dependent upon  $y$

Recall the notion of identity-dependence:

$x$  depends for its identity upon  $y$  =<sub>def</sub> There is a relation ‘ $R$ ’ such that it is part of the essence of  $x$  that  $x$  is *related by  $R$*  to  $y$  (Tahko and Lowe 2020)

According to Mereological Essentialism, any object is what it is partly in virtue of having its proper parts. Any alteration of the mereological profile of an object will thus lead it to cease to exist. Consequently, the mereological profile of any object must be fixed. Hence, no object can acquire, lose, or change proper parts over time. CEM’s language does not qualify mereological relations temporally and it does not need to do that. Since objects have their proper parts essentially, they have them regardless of time, and more generally regardless of any other possible parameter:<sup>94</sup> and this is Mereological Semantic Simplicity. Moreover, since any objects has its proper parts essentially, it follows that it has them necessarily,<sup>95</sup> and thus that the Rigidity of Proper Parthood is true.

It is interesting to notice that APN can indeed accept and make sense of Mereological Essentialism. APN acknowledges two sorts of material objects: hylomorphs and unstructured entities, or, to borrow Canavotto and Giordani’s (2020) expressions, non-heaplike and heaplike entities. Among the latter, it may be useful to distinguish between portions of matter and all the other genuine fusions. While portions of matter are the constituee of hylomorphs, such as Alloy with respect to Statue, genuine fusions are entities such as the fusion of Fido and Tibbles, the fusion of Fido and the matter constituting Tibbles, the fusion of Fido and its matter, and so forth. Yet I take such a distinction to have just practical value: both portions of matter and genuine fusions are in fact ontologically on a par, both being heaplike entities.<sup>96</sup> Their existence merely follows from the existence of their composing pluralities and Unrestricted Composition. Of course, Unrestricted Composition entails nothing about their naturalness, and thus about their persistence conditions and transworld identity conditions. And indeed, inasmuch heaplike, it is sensible to regard their persistence conditions and transworld identity conditions as being exhausted by Mereological Essentialism.<sup>97</sup> By using a worn-

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<sup>94</sup> Philosophers with essentialistic inclinations generally agree that objects fundamentally instantiate their essential properties *simpliciter* (see Bottani 2020, Fine 2005).

<sup>95</sup> See for instance Fine (1994a, 4).

<sup>96</sup> What about fusions such as the fusion of this top and these four legs? They do not seem to be unstructured, but rather to be ordinary objects: a table, in this case. However, consider it is true of tables that they may survive the replacement of one of their legs. Mereological Essentialism, it cannot be the case that the abovementioned fusion enjoys the same survivability. Thus, such fusion is not a table. Even seemingly *bona fide* fusions end up having persistence conditions and transworld identity conditions typical of heaplike entities.

<sup>97</sup> The present conception of heaplike entities resembles Locke’s conception of what he calls ‘masses of matter’. Locke (1690, bk. 2, ch. XXVII, §3) construes masses of matter as mereological fusions of bounded atoms, that persist as long as they maintain their mereological profile. As soon as one atom is added or removed, a mass of matter ceases to exist, and is replaced by a very similar, yet numerically different one. Hence, Locke accepted something along the lines of Mereological Semantic Simplicity, at least for portions of matter. The present conception is indeed stricter than Locke’s, in at least two ways. First, since my endorsement of Unrestricted Composition leads to the existence of scattered fusion of atoms. I thus drop the requirement of bonding among atoms and acknowledge the existence of scattered heaplike entities. Second, given the Rigidity of Proper Parts, heaplike entities not only cannot change their proper parts over time, but across possible worlds as well. Limited to portions of matter, Mereological Essentialism was advanced by Goodman (2015), Heller (1990), Markosian (2004, 2015), Van Cleve (1986a, 1986b).

out expression, we characterise heaplike entities as ‘nothing over and above their parts’. We use their parts to track them over time and across possible worlds. Heaplike entities are thus like Baker’s (2000, 2007), Elder’s (2004, 2011), Fine’s (1994b), and Lowe’s (2006) *aggregates*.<sup>98</sup>

Since hylomorphs are mereologically atomic, they have not any proper part which they depend upon for their identity. Hence, they vacuously satisfy Mereological Essentialism, as well as the associated principles Mereological Semantic Simplicity and the Rigidity of Proper Parthood. APN’s construction of hylomorphs does not contravene Mereological Essentialism nor CEM and leaves open the possibility of accounting for their transworld identity by means, for instance, of qualitative or non-qualitative individual essences. With Markosian’s (2015, 678) words, APN’s construction of hylomorphs seems fully compatible with ‘pure mereology’, that is, the conjunction of Unrestricted Fusion and Mereological Essentialism.

APN seems thus to be a catch-all theory. First, it is compatible with CEM, as for our first theoretical tenet. Second, it is a multi-thingist theory, as for our second theoretical tenet. Third, *contra* mereological hylomorphism, it does not appeal to controversial forms, and generally to any sort of ‘hidden parts’ in order to account for the distinction between hylomorphs and their constituting portions of matter. Fourth, it is compatible with the Rigidity of Proper Parthood, as Linnebo’s argument demands of all the theory endorsing Extensionality of Proper Parts which reject formal parts. Fifth, it does not contravene Mereological Semantic Simplicity, and thus does not require CEM’s language to be expanded with temporal parameters. And six, as we will see starting from the section 4.1, it is compatible with both a three-dimensionalist and a four-dimensionalist theory of persistence over time. But first, I need to clarify the nature of extended simples.

#### **2.4.1 The Nature and Qualities of Extended Simples**

Mereology is formulated through a bunch of inter-definable predicates. However, the interdefinability threatens the informativeness of such definitions. For example, the parthood relation can be taken as primitive and used to define the overlap relation as the sharing of one part. However, the opposite can be done: to take the overlap relation as primitive and define the parthood relation as inclusion of all the overlappers (as in Goodman 1951, 35). The same holds with the relation of mereological fusion too: it is usually defined through further mereological predicates, but it can also be taken as primitive and used to define the parthood relation (as in Kleinschmidt 2019). To break this circle, van Inwagen asked the General Composition Question (van Inwagen 1990a, 39), that is, the request to find a sentence necessarily extensionally equivalent to ‘the *xx* compose *y*’ that does not contain mereological terms. We can ask an analogous question for any mereological term whatsoever. Consider the

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<sup>98</sup> Lowe (2009) furtherly distinguishes between aggregates and sums. Our heaplike entities are Lowe’s (2009) sums.

mereological property of *being atomic*, or *being simple*. An entity is simple if and only if it does not have proper parts. Clearly, this is just an analysis of a mereological term into further mereological terms. It would be more informative to offer an analysis in non-mereological terms, that highlights the links of atomicity with other concepts.

When are things simple? That is, when are things devoid of any proper parts? The commonsensical view is that proper parthood and spatial (or spatiotemporal) extension come hand in hand. In other words, the commonsensical view is implicitly committed to a specific principle that intertwines mereological and locative aspects of objects. It is called Arbitrary Partition, or Doctrine of Arbitrary Undetached Parts (DAUP):<sup>99</sup>

(DAUP) if  $x$  is exactly located at a spatiotemporal region  $R$ , then, for every proper sub-region  $R^*$  of  $R$ , there is a  $y$  such that  $y$  is a proper part of  $x$  and  $y$  is exactly located at  $R^*$

Roughly, DAUP states that, for every sub-region of the exact location of  $x$ , there is a proper part of  $x$  which is exactly located there. Take any object whatsoever and its exact location: the mereological profile of the object is as fine-grained as the mereological profile of its exact location.

However, in a number of papers, Markosian (1998, 2004, 2015) argued for the possibility of objects that would falsify such a principle and attempted a characterisation of their metaphysical features. Philosophers now call these objects ‘extended simples’. An extended simple is an entity which is spatially, or spatiotemporally, extended but also devoid of any proper part. The possibility of extended simples contradicts the commonsensical view, which equates mereological simplicity with punctiform extension. Markosian’s argument for the possibility of extended simples is from conceivability:

Imagine a possible world in which there is only one physical object, a perfectly solid sphere made of some homogeneous substance, floating in otherwise empty space. If you can imagine such a world – and I think you can – then the Pointy View of Simple is false (Markosian 1998, 218)

The Pointy View of Simples would be false because, if true, it must be necessarily true, as an analysis of what mereological simplicity amounts to. The meaning of mereological simplicity must indeed be the same in every possible world. Many philosophers seem to share the same modal intuition as Markosian (e.g. McDaniel 2007, Parsons 2000, 2007). Moreover, some argue that our best scientific theories indeed require the actual existence of extended simples (see Braddon-Mitchell & Miller 2006, McDaniel 2007, Simons 2004). All in all, the metaphysical possibility of extended simples

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<sup>99</sup> For a somewhat in-depth analysis of the logic of location, the reader must wait for the section 3.3.

implies that DAUP is not a conceptual truth about locative relations. Furthermore, if physics must recognise extended simples among the fundamental entities, DAUP is not only conceptually but also empirically false.

Let us grant, then, that extended simples are indeed metaphysically possible. An interesting question concerns their qualitative heterogeneity. Consider Markosian's floating sphere again and imagine that the homogeneous substance it is made of is multi-coloured: for example, the sphere looks half red and half green. Here the very phrasing of the scenario reveals the problem: since the sphere is simple, how is it possible for the sphere to be *half* red and *half* green? On closer inspection, there are two different questions lurking here. First, how is it possible to talk about 'proper parts' of an extended simple? Maybe the case of the sphere does not trigger any specific intuition about proper parts, but it is easy to slightly alter the scenario in order to modify our modal intuition: for example, replace the sphere with the anthropomorphic statue David. If David is an extended simple, how can we make sense of the proper parthood-talk? Second, how can we make sense of the qualitative heterogeneity of extended simples, proviso it is metaphysically possible? A natural phrasing for the case above is that the sphere is partly red and partly green, but the very same adverb reveals that in such a case we would refer to red and green proper parts of the sphere.

Markosian offers a solution to both the problems through the distinction between an extended simple and the portion of stuff it is constituted by (1998, 223 ff; see also Markosian 2004, 2015). As it concerns proper parthood-talk of extended simples, he claims

[...] it seems to me that talk about the conceptual parts of an object, whenever it makes sense, can be translated into talk about the sub-regions of the region occupied by that object, along with the matter that fills those sub-regions. (Markosian 1998, 223-224)

The notion of conceptual part is here opposed to that of metaphysical part. Roughly, conceptual parts of an object can be understood along weak location: for every spatiotemporal region  $R$  an object  $x$  is weakly located at, if  $R$  is not occupied by a metaphysical part of  $x$ , then  $R$  is occupied by a conceptual part of  $x$ . Hence, although it is false to attribute metaphysical proper parts to an extended simple, it is still possible to dissect it into conceptual parts by referring to the regions it pervades and the matter that partly constitute it. Furthermore, the dualism between objects and matter can also be exploited to account for the qualitative heterogeneity of extended simples. Consider a multi-material statue, for example, an anthropomorphic statue whose head is made of bronze while the rest of the body is made of marble:

It seems to me plausible to say that we can capture what is true in the loose talk of 'parts' of the statue that are made of different types of matter in literally true talk about the relevant

sub-regions of the region occupied by the statue, and the matter filling those sub-regions.  
(Markosian 1998, 225)

Markosian's answer to the problem of qualitative heterogeneity makes use of the notion of conceptual part: the anthropomorphic statue has a conceptual proper part that is made of bronze and a distinct conceptual proper part that is made of marble. That is, there are sub-regions of the exact location of the statue such that they are filled by matter partly constituting the statue, and those portions of matter are respectively bronze and marble. Moreover, it should be noticed that the same strategy holds for any kind of qualitative heterogeneity, not only for heterogeneity of matter. The above case of the half-red half-green sphere is explained in the very same way. The sphere is constituted by some matter, and the portion of matter filling a proper sub-region of the exact location of the sphere is red, while the portion of matter filling a different proper sub-region of the exact location of the sphere is green.

A further approach deserving attention is McDaniel's (2009) extension of Ehring's (1997a) trope theory (see also Cotnoir 2013b). McDaniel's theory has a narrower scope than Markosian's one, in that it just limits to make sense of the qualitative heterogeneity of extended simples, yet it seems powerful enough to complement any theory that purports to give translation rules for sentences concerning 'parts' of extended simples.

Ehring's original aim was to offer a solution to the problem of change. Accordingly, he proposed to analyse instantiation of incompatible properties at different times in terms of instantiation of different short-lived tropes. Hence, he got that « $x$  is  $F$  at  $t$  if and only if there is an  $F$ -trope that exists at  $t$  and  $x$  exemplifies it» (McDaniel 2009, 327). McDaniel extends such an analysis to the case of instantiation of incompatible properties at different spatial regions:  $x$  is  $F$  at  $r$  iff there is an  $F$ -trope that exists at  $r$  and  $x$  exemplifies it. Consider the spatial case.<sup>100</sup> For instance, consider Markosian's simple sphere again and let it be half red and half white. Sure, the sphere does not have any coloured proper part since it is mereologically simple. However, the sphere is exactly located at a complex region, say  $r$ , which is the fusion of two equivalent subregions  $r_1$  and  $r_2$ . To say that the simple sphere is half red and half white, the Ehring-McDaniel strategy employs the parts of the spacetime regions which the objects are located at, instead that the parts of the objects. The sphere is half red and half white because it exemplifies a redness-trope and a whiteness-trope which exist, respectively, at  $r_1$  and

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<sup>100</sup> The temporal extension of the present example is obvious.

$r_2$ . Tropes are exactly located at subregions of the exact location of the sphere<sup>101</sup> and intrinsically characterise the sphere in virtue of the exemplification relation.<sup>102</sup>

Therefore, the existence of spatiotemporally extended and mereologically atomic objects is at least coherent, and some philosophers would claim that physics gives us reasons to think that there are actually some objects of that kind. Moreover, a dualistic framework is sufficient to account not only for the existence of their conceptual proper parts, but also for the qualitative heterogeneity of an extended simple in terms of the qualitative heterogeneity of its conceptual proper parts. This approach will turn out to be fruitful in the present treatment of hylomorphic objects.

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<sup>101</sup> However, notice that tropes must not be regarded as parts of their bearers. Otherwise, since tropes aim to account for intrinsic properties of *simple* objects, the present strategy would be a non-starter. Hence, there cannot be any non-trivial mereological relation between tropes and their bearers. We must rather regard the instantiation relation holding between objects and tropes as a *sui generis* relation, or perhaps as a kind of non-mereological containment relation.

<sup>102</sup> There are further available options to make sense of heterogeneity of extended simples (see Cotnoir 2013b, 229-230 for references). Among them, there is an interesting adverbial strategy. In a nutshell, the adverbial strategy paraphrases away property-talk unsuited for mereologically atomic entities by adverbially modifying an entity's aspect. An instance of the adverbial strategy appears in Schaffer's (2007) advocacy of monism. According to Schaffer, there is only one entity, the world. Nevertheless, monism would recover the existence of pluralities of objects as adverbial modification of its aspect: «When we say that there is a table, the monist holds that what exists is the world aspected table-ishly. Here talk of tables is paraphrased in terms of the world and its modes» (2007, 179).

## Chapter 3

### The Classical and Locative Debates on Persistence Over Time

#### 3.1 Persisting Hylomorphs

According to APN, we can exhaustively divide the denizens of the material worlds into structured and structureless entities or, equivalently, between non-heaplike and heaplike entities (as for Canavotto & Giordani 2020). I have borrowed Evnine's (2016) label and referred to structured entities as hylomorphs. The feature of hylomorphs that sparked our interest is their temporal and modal flexibility, i.e. their 'having a metabolism'. Hylomorphs are in fact characterised by nontrivial persistence and transworld identity conditions, that are determined by their primary kinds. Hylomorphs are thus able to survive certain alterations in their composing matter. Among the structureless entities we have listed portions of matter as well as, more generally, gerrymandered objects. Such entities, instead, seem to have much more 'neat and tidy' persistence and transworld identity conditions, that depend on them being devoid of any relevant structure. As a consequence, they are «breathtakingly fragile» (Elder 2011, 149): when a part of them ceases to exist, the whole entity ceases to exist as well. That does not mean that structureless entities are bound to live briefly. The fusion of two quarks, for instance, will arguably exist for much longer than the fusion of two pizzas. The same holds for transworld identity. Structureless entities are really nothing over and above their parts, and thus we have construed them as being identity-dependent on such parts. Hence, as identity-dependence implies, structureless entities have their parts essentially.

The modal difference between hylomorphs and structureless entities stands out in the context of the Troublesome Argument, showing there is a tension between such a modal difference and CEM, that I take to be the sound theory of parthood relation. In order to preserve both such a modal difference and CEM, I advanced APN. According to APN, hylomorphs should be construed as extended simples: they have, strictly speaking, no proper parts at all, but still occupy extended regions of spacetime. Moreover, APN is a typical multi-thingist theory inasmuch as it regards the intimate relation between hylomorphs and specific structureless entities, that serve as their matter, to be the venerable material constitution relation. APN can thus accommodate the numerical distinction between hylomorphs and their constituting matter, as grounded in a genuine account of *de re* modal properties, and CEM. Since hylomorphs are extended simples, they trivially satisfy mereological extensional theorems such as Uniqueness of Composition and Extensionality of Proper Parts. Moreover, APN is mereology-friendly in a further respect, in that it can endorse Mereological Essentialism, the thesis according to which entities are identity-dependent upon their proper parts.

Again, hylomorphs satisfy it trivially, whereas the identity dependence of structureless entities upon their proper parts accounts for their ‘neat and tidy’ persistence and transworld identity conditions. Relatedly, APN embraces both Mereological Semantic Simplicity, according to which mereological relations hold *simpliciter*, not relatively to certain parameters, and the Rigidity of Proper Part, that construes instances of parthood relation as holding necessarily. In other words, APN is compatible with a ‘pure’ version of mereology, encompassing both CEM, Mereological Essentialism, and the two cognate principles above.

To this point, we have mostly developed APN as the theory that best account for the difference between hylomorphs and structureless entities given CEM in the background, two theoretical tenets we have embraced throughout our discussion. Yet, we have hitherto dealt with modal issues for the most part. However, a metaphysical theory of material objects would be incomplete without an account of how material objects persist over time; and, of course, both hylomorphs and structureless entities seem to persist over time. Still, given their nature, it is certainly interesting to ask whether we need to account for their persistence over time differently. Perhaps surprisingly, I think that we do not. Despite being so different, it seems that whatever theory of persistence we choose to account for the hylomorphs will suit structureless entities as well, and vice versa. Hence, a single theory of persistence would be enough to serve the ontology of APN.

In what follows, I first outline the landscape of the debate concerning persistence over time. I highlight the differences between the classical and the locative debate and then show that the results of the debates are (mostly) orthogonal.

### 3.2 The Classical Debate on Persistence Over Time

‘Persistence over time’ is a technical expression aiming to capture and regiment a very familiar phenomenon indeed. According to Lewis (1986, 202), something persists over time if and only if it exists at distinct times. The following gloss should better illustrate the content of Lewis’s definition. Take a temporal instant,<sup>103</sup> say  $t_0$ , cut a slice of the world at that instant, and make a list of what there is. Then, take a numerically different temporal instant, say  $t_1$ , (with  $t_1 > t_0$ ) cut a further slice of the world at that instant, and make a further list of what there is. Next, consider the two lists: if one and

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<sup>103</sup> An appropriate definition of temporal instant relies on a certain conception of space and time. Nowadays, the two main conceptions of space and time are Separatism and Unitism (see Gilmore, Costa and Calosi 2016). According to Separatism, space is a three-dimensional entity, mereologically disjoint from time, which is instead a one-dimensional entity. Spatial regions are located at temporal instants. A temporal instant is the temporal counterpart of a spatial point: it is a mereological atom of time. According to Unitism, there is only spacetime, a four-dimensional entity, spatially three-dimensional and temporally one-dimensional. If there are temporal instants, they are maximal mereological fusions of simultaneous spacetime points. Nevertheless, what matters here is that both Separatism and Unitism allow *prima facie* for a definition of temporal instant. Hence, I will be agnostic about the issue concerning which is the right relation between space and time.

the same entity  $x$  is present in them both, then  $x$  persists from  $t_0$  to  $t_1$ . The definition can presumably be improved by adding that, if  $x$  persists from the temporal instant  $t_0$  to the temporal instant  $t_1$ ,  $x$  must also exist at every single temporal instant between  $t_0$  and  $t_1$ . This extension to Lewis's original definition allows avoiding the unintuitive claims according to which intermittent objects persist over times which they do not exist at.<sup>104</sup> Once persistence is defined as existence at different times, it becomes apparent that persisting objects make up much of the furniture of the world. Organisms normally exist at many distinct times, and so do artifacts, celestial bodies, persons, and relevant subunits of these sorts of objects, such as organs and steering wheels.

It might seem that persistence over time *per se* is unproblematic. A banana exists at  $t_0$  and successively at  $t_1$ : in the two corresponding slice-lists, there is something that is numerically identical with the banana. However, consider that persistence over time intimately interacts with a further very familiar phenomenon, that is, persistence over change. Generally, objects persist over time by persisting over change too.<sup>105</sup> Persistence over change can be defined as follows: something persists over change if and only if (i) it persists over time, and (ii) it instantiates different incompatible properties or relations at different times of its existence. For instance, the banana may be green at  $t_0$  but yellow at  $t_1$ ; however, nothing can be both green and yellow, since they are incompatible properties. Hence, it must be explained how one and the same entity can instantiate different incompatible properties at different times at which exists.

Of course, different kinds of objects can survive different kinds of change. Hence, for instance, humans can survive haircuts and organ transplant; cars can survive repaintings and tire replacements; trees can survive leaf falls; and so forth. However, the problem of change is broader than it seems, in that it does not concern just these kinds of intrinsic, relevant changes. In fact, the problem of change arises also from cases of Cambridge changes and alterations with respect to external relations, hardly regarded as 'real' changes. In other words, the notion of change at stake here is very general and indeed technical. It can be traced back to Russell's definition in the *Principles of Mathematics*, according to which:

Change is the difference, in respect of truth or falsehood, between a proposition concerning an entity and a time  $T$  and a proposition concerning the same entity and another time  $T'$ , provided

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<sup>104</sup> Classical examples of intermittent objects come from Burke (1980). The most vivid case concerns a watch that is disassembled and later reassembled. However, any endorser of Unrestricted Composition (*provisio* a B-theory of time) will be committed to the existence of temporally scattered objects (see Lando 2017, ch. 12).

<sup>105</sup> However, notice that it is not necessarily so. The two phenomena are different, in that persistence over change implies persistence over time (at least in the case of concrete entities), while the converse does not necessarily hold. For instance, it is entirely conceivable a frozen world where there is no change at all while the time still flows (like in Shoemaker's (1969) scenario). Still, these two phenomena are naturally linked in the actual world, in that persistence over time generally comes together with change, perhaps just trivial Cambridge change.

that the two propositions differ only by the fact that T occurs in the one where T' occurs in the other. (Russell 1903, 476)

Although intuitive, Russell's definition is not very clear about the nature of the concerning phenomenon. Hence, here are two provisos to improve the perspicuity of the passage above. First, the propositions must concern an entity and a time that are not (truly or falsely) related by the identity relation. For instance, the couple of propositions 'In 2020, the day of the summer solstice was May 20' and 'In 2020, the day of the summer solstice was June 20' are respectively false and true but do not capture any change at all. The problem here is that they are propositions concerning an entity that *is* a time. Second, and more generally, the propositions must say, of an entity, that it happens to instantiate the property at a time. For instance, the couple of propositions 'Maria took the plane to Milan on June 8' and 'Maria took the plane to Milan on June 9' are, say, respectively false and true but, again, they do not capture any kind of change at all. The temporal expressions qualify here the properties (*taking the plane on*), not the instantiation relation. Hence, Russell's definition of change works just in case the entity and the time are distinct and, roughly, the proposition says, of the entity, when it happens to instantiate the property. Moreover, let us notice that the properties at stake need not to be intrinsic: any property whatsoever, as abundant<sup>106</sup> as you want, can work in the problem of change. For instance, consider the following couple of propositions: 'On 2018, Maria is the owner of the best restaurant in town' and 'On 2019, Maria is the owner of the best restaurant in town'. Suppose that Maria never sold her restaurant, but simply a better one was opened in the same town in 2019: accordingly, the first proposition is true, while the second is false. Therefore, according to Russell's definition, Maria undergoes a change. Yet, the difference in truth values of those sentences hardly qualifies as a real change concerning Maria's restaurant, let alone Maria. It is an utterly extrinsic, Cambridge change. However, it suffices to generate an instance of the problem of change: at different times, Maria has and lacks one and the same property. Nevertheless, at both times, Maria is still Maria: she is numerically identical with herself. How can it be that one and the same entity has and lacks a property? Therefore, given the very broad and technical notion of change at stake, the problem of change is more appropriately regarded as the problem of incompatible properties. However, in order to avoid confusion, in what follows I stick to the traditional label.

The main trigger of the problem of change is persistence over time as numerical identity. Consider again the two instantaneous slices of the world in the example above. Consider that, in the

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<sup>106</sup> The sparse/abundant distinction is due to Lewis (1986, 59-60). Sparse properties are intrinsic, account for qualitative similarity, and carve the nature at the joints. Usual examples come from physics: charge and spin may be, and very often are, regarded as sparse properties par excellence. *Being heavier than a daisy but lighter than an elephant* is a nice example of abundant property. Abundant properties can be extrinsic, unnatural, and gerrymandered.

$t_0$ -slice there is an unripe banana, while in the  $t_1$ -slice the banana finally shows a satisfying colour yellow. The inferential structure generating the problem of change is very simple, and it is the following:

1. The banana at  $t_0$  is green all over
2. The banana at  $t_1$  is yellow all over
3. The banana at  $t_0$  is numerically identical with the banana at  $t_1$

However,

4. The banana at  $t_0$  is different from the banana at  $t_1$  (1, 2, Leibniz Law)<sup>107</sup>

Therefore,

5. Contradiction (3,4)

If the relation between the two banana-slices were considered qualitative identity, no problem of change would ever rise. As it is evident, the argument's inferential drive is Leibniz Law, and qualitative identity does not respect Leibniz Law. However, 3 makes explicit that the identity relation between these two entities is numerical identity. Hence, since the banana at  $t_0$  and the banana at  $t_1$  fail to instantiate all and only the same properties, Leibniz Law implies that the two entities cannot really be numerically identical.

Naming this inferential pattern 'the problem of change' may be misleading, though. As I said above, the present notion of change is technical and includes also Cambridge changes as well as alterations with respect to external relations. As we have already seen, it is easy to construct a structurally identical pattern of the problem of change considering no real kind of change:

- 1\* The banana at  $t_0$  is near an apple
- 2\* The banana at  $t_1$  is not near an apple
- 3\* The banana at  $t_0$  is numerically identical with the banana at  $t_1$

However,

- 4\* The banana at  $t_0$  is different from the banana at  $t_1$  (1, 2, Leibniz Law)

Therefore,

- 5\* Contradiction (8,9)

The debate on persistence over time, then, amounts to the quest for a metaphysical account of objects and properties that makes sense of two fundamental features of the world. First, the possibility, for

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<sup>107</sup> Strictly speaking, the principle that allows deriving 4 from 1 and 2 is the Indiscernibility of Identicals. Sometimes Leibniz Law is regarded as the conjunction of the Indiscernibility of Identicals and its converse, the Identity of Indiscernibles.

one and the same object, to exist at more than one temporal instant; and second, the possibility for one and the same object to instantiate different and incompatible properties at different times.

### 3.2.1 Perdurantism, Endurantism, Exdurantism

A by now classical way to frame the debate is by distinguishing, with Lewis, between endurantism and perdurantism:

Something perdures iff it persists by having different temporal parts, or stages, at different times, though no one part of it is wholly present at more than one time. Something endures iff it persists by being wholly present at more than one time (Lewis 1986, 202)

According to perdurantism, objects extend through time in the same way they extend through space that is, by having parts. More precisely, objects have a spatial part at every spatial region they pervade.<sup>108</sup> Perdurantism claims that objects occupy the temporal dimension in the same way, and thus they have a temporal part at every temporal region they pervade. Accordingly, at every instant of their career, objects have an instantaneous temporal part.<sup>109</sup> Intuitively, the instantaneous temporal part of  $x$  at  $t$  is an instantaneous snapshot of  $x$  existing at, and only at, the precise instant  $t$ . A persisting object is then constructed as the mereological fusion of its temporal parts. According to endurantism, instead, objects have spatial, but not (nontrivial) temporal, parts: a persisting object would be wholly present at every instant of its existence.<sup>110</sup> Objects do not have temporal parts, acting as ‘existential delegates’, at every instant at which they exist. Endurantism, at least as classically conceived, construes persistence over time as a sort of ‘sweeping’ through time of one and the same object, that, meanwhile, possibly endures mereological and non-mereological changes.

Unsurprisingly, sometimes authors simply define endurantism as the negation of the existence of temporal parts, and therefore as the negation of perdurantism (McCall and Lowe 2009, Wasserman 2016). Whereas perdurantism claims that objects are partly present at each instant of their existence, in that they have instantaneous temporal parts at those instants, according to endurantism objects are not partly present, but rather wholly present at each instant of their existence. Furthermore, it should be clear by now why perdurantism and endurantism are also respectively known as four-dimensionalism and three-dimensionalism. A perdurantist identifies persisting objects with mereological sums of their temporal parts, while an endurantist with a mereological sum at every

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<sup>108</sup> See Parsons’s Arbitrary Partition principle (2007, 211). We have already considered its conflict with the possibility of extended simples.

<sup>109</sup> For more on the definition of perdurantism, see Wasserman (2016, 244).

<sup>110</sup> For more on the definition of endurantism, see Donnelly (2016).

instant of its existence (these mereological sums can be disjoint, of course).<sup>111</sup> Therefore, on the one hand, perdurantists regard persisting objects as temporally extended: every perduring object is wholly present at just one single four-dimensional spatiotemporal region. In this picture, the only three-dimensional objects are instantaneous temporal parts, that, by definition, are temporally unextended and thus do not persist. On the other hand, endurantists regard persisting objects as being wholly present at three-dimensional spatial regions, one for each instant of their existence. Consider again the above scenario where we cut a slice of the world at an instant  $t$ . That slice of the world contains many everyday objects: beds, human beings, zebras, the Sun, and so forth. Both perdurantism and endurantism agree on this claim. They differ in their respective explanation of the truth of the claim. According to perdurantism, the claim is true because the list includes the  $t$ -temporal part of each of those objects. Differently, according to endurantism, the claim is true because the list includes those very objects.

Next to perdurantism and endurantism, there is exdurantism or stage view.<sup>112</sup> Exdurantists claim that objects, literally, do not persist over time. They are as short-lived as perdurantist's three-dimensional temporal parts, namely instantaneous. They abruptly come into life, last for just a temporal instant, and then cease to exist. Exdurantists come with an error theory concerning not only persistence but also semantics. In fact, a standard Kripkean metasemantical theory of naming and reference seems to come with the assumptions that (i) a singular term can, and usually does, rigidly refer to one and the same objects at different times of its career, and (ii) a singular term cannot non-ambiguously refer to two different objects. Consider again the abovementioned ripening banana. If exdurantism were true, a language should contain as many names as the instantaneous banana-stages to allow speaker to non-ambiguously refer to them. Exdurantists are ambitious and attempt to resolve both the issue in one shot by rejecting the Kripkean metasemantics and invoking a temporal counterpart relation. They claim, *contra* Kripke, that singular terms are quasi-rigid designators<sup>113</sup> that pick out genidentical entities, where two entities are genidentical iff they stand into a temporal counterpart relation with one another (Varzi 2005, 403; see also Sider 2001, 193-194). Therefore, by endorsing a theory of singular terms as quasi-rigid designators, exdurantists simply dissolve (i), while their use of genidentity allows them to make sense of (ii), that is, to explain how a singular term can non-ambiguously refer to numerically different objects. Once we baptise a stage  $s$  somehow, say 'N',

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<sup>111</sup> On pain of regarding identity as a temporal-indexed notion, endurantists generally take parthood to be a 3-places relation between two objects and an instant of time. Hence, they accept that (at least) the mereological sums that are identical with enduring objects can change their parts through time without incurring into contradictions (for more on this point, see Van Inwagen 2006).

<sup>112</sup> Hawley (2001), Parsons (2015), Sider (2001), Varzi (2003), Wilhelm (2020).

<sup>113</sup> Or, as we may call them, 'geni-rigid designators'.

the term ‘N’ will refer, at a time, at the stage that stands in a relation of temporal counterpart to *s* at that time.

Recall that theories of persistence over time must not only make sense of the existence of an object at different times but also of the possibility that it instantiates different incompatible properties at different times. In other words, an appropriate theory of persistence over time must explain what is wrong with inferences like 1-5.

Perdurantists and exdurantists agree on the falsity of 3: the relation between the banana at  $t_0$  and the banana at  $t_1$  is not numerical identity. Since 3 is false, the argument is not sound and thus it does not lead to contradiction. According to perdurantists, the banana at  $t_0$  and the banana at  $t_1$  are just temporal parts of a same four-dimensional whole, the whole banana. According to exdurantists, the banana at  $t_0$  and the banana at  $t_1$  are two distinct, genuine instantaneous objects related by a temporal counterpart relation. In neither case, the appeal to Leibniz Law is legitimate and thus the inference of 4 is not correct. Recall that the main trigger of the problem of persistence over time is numerical identity, whose instance in premise 3 legitimates the troubling inference by Leibniz Law. Perdurantists and exdurantists endorse a radical solution to the problem of persistence over time: get rid of numerical identity, and you get rid of the problem of persistence. The relations that perdurantists and exdurantists replace numerical identity with are, respectively, some version of Lewis’s I-relation<sup>114</sup> and genidentity. Since neither of these relations satisfies Leibniz Law, they do not lead to contradiction.

On the contrary, endurantists stick with numerical identity between the subjects in premises 1 and 2. Rather, they object to the qualification of the temporal element in those premises. There are at least three different theories endurantists have developed in order to properly qualify the temporal element in the premises and thus avoid the contradiction originating in 1-5.<sup>115</sup> Pseudo-adverbialism takes the predicates in 1 and 2 as referring not to monadic properties, but rather to dyadic relations in disguise (Van Inwagen 1990b, 249-250). Hence, the properties in 1 and 2 would really be the relations *being green-at-a-time* and *being yellow-at-a-time*, and they would make up a state of affairs only by relating an object and a time. An object cannot be green all over and yellow all over at the same time; but 1 and 2 just say that the same object is green all over at a time and yellow all over at a distinct time. Those properties are then no more incompatible. Hence, the inference to 4 is blocked. Strict-adverbialism regards the temporal expressions work as adverbs modifying the instantiation relation

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<sup>114</sup> Lewis (1983, 59) defines the I-relation as the relation holding between the temporal parts of a single four-dimensional whole. Notice that, given Unrestricted Composition, an instance of the I-relation holds between any two things whatsoever.

<sup>115</sup> I adopt the following taxonomy and the labels from Bottani (2020), to which I refer for an in-depth critical analysis of the three endurantist theories.

(Johnston 1987). Then, for any time  $t$ , there is a  $t$ -ly way to instantiate properties and relations: for instance, objects instantiate properties and relations  $t_1$ -ly,  $t_2$ -ly, and so forth, according to the times they instantiate those properties. Hence, the properties in 1 and 2 should be constructed as *being-at- $t_0$  green* and *being-at- $t_1$  yellow*. Again, the inference to 4 is blocked, since the properties at stake are no longer incompatible. Lastly, SOFism (State-Of-aFair-ism) shifts the focus from the referents of the predicates, i.e. properties, to those of sentences, i.e. states of affairs tokens (Haslanger 2003). Consider a sentence such as ‘The banana is green all over’. The corresponding state of affairs token exists at  $t_0$  if and only if (i) there is a banana at  $t_0$ , and (ii) the banana is green all over at  $t_0$ . The state of affair type exists if and only if it has at least an instance, that is, a state of affair token. Hence, ‘The banana is green all over’ and ‘The banana is yellow all over’ are both true of the very same object. However, the truthmakers of the two sentences exist at distinct times: different states of affairs tokens make the two sentences true at distinct times. Therefore, the inference to 4 is blocked because 1 and 2 are not true at the same time, since their truthmaker, the two states of affairs types, have instances at different times.

All in all, the difference between perdurantism and exdurantism on the one hand, and endurantism on the other hand, amounts to what they ‘build’ the temporal expressions into. Perdurantism and exdurantism construe objects in such a way to build time into them: respectively, by endorsing instantaneous temporal parts or identifying ordinary objects with instantaneous stages. In other words, objects are as fine-grained as time itself. Differently, endurantism’s objects are ‘timeless’. Then, various endurantists have advanced different options to account for the problem of change. Accordingly, they proposed to build temporal expressions into properties, instantiation relations, or state of affairs tokens.

### 3.2.2 More on the Formulations of Perdurantism and Endurantism

Let us come back to the very formulations of perdurantism and endurantism.<sup>116</sup> Perdurantism claims that objects persist by having an instantaneous temporal part at each instant of their existence. Endurantism claims that objects persist by being wholly present at each instant of their existence. These phrasings inevitably sound slightly obscure and the culprits are the notions of ‘temporal part’ and ‘whole presence’. These are technical notions that philosophers have attempted to define accurately. In what follows, I introduce their most widespread mereological definitions. We will later see that there are also locative definition of these very expressions.

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<sup>116</sup> In what follows, I will ignore exdurantism. In doing so, I join metaphysicians who regard persistence as a genuine phenomenon. They customarily leave exdurantism aside in favour of a wider discussion of perdurantism and endurantism.

### 3.2.2.1 What Is a Temporal Part?

Let us begin with ‘temporal part’. The core formulation of perdurantism features the notion of temporal part. We said above, as an informal gloss, that the temporal parts of objects are like instantaneous snapshots of those objects. But how does a temporal part look like from an ontological point of view? Consider the banana again, together with one of its temporal parts. First, and trivially, the temporal part is a part of the banana: after all, temporal parts are still parts *tout court*. Moreover, the temporal part is instantaneous: its lifespan is just a temporal instant.<sup>117</sup> Lastly, «temporal parts have spatial parts and spatial parts have temporal parts» (Sider 2008, 243). Each spatial part of temporal parts of the banana is also a (spatial) part of the banana, given Transitivity of parthood. Also, for every spatial part of the banana existing at the instant  $t$ , for instance the peel, that part overlaps the  $t$ -temporal part of the banana. Hence, a part of the  $t$ -temporal part of the banana is a temporal part of the peel. Given these three features of temporal parts, we can follow Sider (2001, 60) and offer the following, by now classic, definition:

- $x$  is an instantaneous temporal part of  $y$  at instant  $t =_{\text{def}}$  (i)  $x$  is a part of  $y$ , (ii)  $x$  exists at, but only at,  $t$ , (iii)  $x$  overlaps every part of  $y$  that exists at  $t$

This definition is right to the point and virtuous. It is right to the point because it precisely captures and substantiates the idea that temporal parts are snapshots of objects by defining them as maximal instantaneous parts of their objects. It is virtuous because the definiens just employs two predicates, (atemporal) parthood and existence at a time, whose acceptance is rather unproblematic, given their pivotal role in the formulation of mereology and the very notion of persistence over time. The parthood predicate is unmysterious, and it enjoys an entire formal theory, namely mereology, devoted to study the inferential patterns among principles featuring the parthood predicate and other cognate ones. The predicate of existence at a time may not enjoy a likewise theory, but it is not a new entry either, since it has a pivotal role in the very notion of persistence over time, as for Lewis’s definition. Moreover, endurantists surely understand both the notions of parthood and existence at a time since they use it as well in formulating their theory of persistence.<sup>118</sup> Therefore, it is not surprising that

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<sup>117</sup> At least, the temporal parts that are relevant for the debate on change and persistence over time. Indeed, modulo considerations on the temporal simplicity of persisting objects, perdurantists generally accept that (DAUP) holds for temporal regions as well. Accordingly, every temporally extended object has temporal parts of different lengths, the longer being as long as the career of the object itself (indeed, the longer temporal part of any persisting object is identical with the object itself). There are two main reasons why the temporal parts relevant for the present debate are instantaneous. First, their instantaneity qualifies them as three-dimensional as well, and three-dimensional objects seem to be required to instantiate predicate such as *being spherical*, which no four-dimensional object can possibly instantiate (Hawley 2001, 38). Second, since temporal parts are supposed to ultimately account for the phenomenon of change of persisting objects and change can be instantaneous (consider, for instance, a variation in temperature), they better be instantaneous as well.

<sup>118</sup> Actually, some endurantists may claim that Sider’s definition is still unintelligible because it employs the notion of atemporal parthood, whereas the only legitimate notion of parthood, and indeed the notion of parthood used by endurantists in formulating their theory of persistence, is parthood-at-a-time. However, this rejoinder is quite dubious.

every perdurantist does, to my mind, accept Sider's definition, and endurantists no longer regard the notion to be unintelligible.<sup>119</sup>

### 3.2.2.2 What Is Whole Presence?

Perduring objects are partly present at each instant of their existence by having a proper temporal part at every instant of their existence. Sider's definition substantiates the informal gloss that characterises temporal part as instantaneous snapshot of their wholes. What about enduring objects? Since they are wholly present at each instant of their existence, they do not have temporal parts at all, let alone a temporal part at each instant of their existence. The next section will deal with a reframing of the debate on persistence over time that allows to make better sense of endurantist notion of whole presence at a time. Indeed, offering a mereological definition of 'whole presence' has revealed to be much more difficult than defining the perdurantist notion of temporal parthood. For example, Costa (forthcoming), Donnelly (2016), and originally Sider (2001, 64) consider and reject the following two mereological definitions:<sup>120</sup>

- $D_{\text{TIMER-WP}}$ :  $x$  is wholly present at  $t =_{\text{def}}$   $x$  is present at  $t$  and, for any object  $y$ , if  $y$  is part of  $x$  at  $t$ , then  $y$  is present at  $t$
- $D_{\text{AMER-WP}}$ :  $x$  is wholly present at  $t =_{\text{def}}$  for any object  $y$  and time  $t^*$ , if  $y$  is part of  $x$  at  $t^*$ , then  $y$  is present at  $t$

'To be present at  $t$ ' just means here 'to exist at  $t$ '.<sup>121</sup> Consider again the scenario in which we chop off some instantaneous slices of the world. Any object that is present at a slice is an object that exists at that very slice. Since these slices informally capture the idea of temporal instants,<sup>122</sup> any object existing at the instantaneous slice  $t$  is an object existing at the temporal instant  $t$ . Notice that nothing

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Sattig (2015, fn. 38) notices that endurantists commonly adopt both the atemporal and temporally-indexed versions of different notions, such as existence, shape, as well as parthood, in order to express instances of those relations when the relata are, respectively, *abstracta* or *concreta*. Since endurantists will usually regard a sentence such as 'The keyboard solo is the most elaborate part of Deep Purple's *Highway Star*' as perfectly significant, we should not take this rejoinder seriously.

<sup>119</sup> The unintelligibility objection was early raised by many endurantists (Chisholm 1976, Geach 1972, Lowe 1987, Thomson 1983, Van Inwagen 1981, 1990b). However, just notice that «[...] most enemies of temporal parts firmly believe that events and processes, such as wars and tennis matches, have proper temporal parts» (Bottani 2002, 414). Of course, if the notion of temporal part is intelligible as far as occurrents are concerned, the unintelligibility objection must ultimately fade.

<sup>120</sup> Donnelly (2016) considers two further ways of defining endurantism that avoid the expression 'wholly present'. First, the negative definition I hinted at in the previous section, that defines endurantism just as the negation of perdurantism. Second, Hawley's (2001) definition, that simply regards endurantism as the conjunction of the claims that (i) objects persist over time, and (ii) statements about the parts of objects must be temporally qualified. In what follows, I will largely leave these definitions aside. Nevertheless, I will later show that the first definition follows from a richer one, while the second definition fails at capturing a relevant brand of endurantism.

<sup>121</sup> While discussing Donnelly's (2016) very same definitions, Costa (forthcoming) simply uses 'to exist at  $t$ '.

<sup>122</sup> Nevertheless, the very idea of temporal slices can be modelled with an instant-based temporal logic. In such a case, roughly,  $x$  will be said to exist at  $t$  if and only if the couple  $\langle 'x$  exists',  $t \rangle$  will be true.

requires  $t$  to be instantaneous:  $t$  may be an extended temporal interval as well. Considering instantaneous temporal interval just allows to regard persistence as fine grained as time itself.<sup>123</sup> Furthermore, notice also that ‘to be present at  $t$ ’ should differ from ‘to be wholly present at  $t$ ’, on pain of triviality. Since ‘to be present at  $t$ ’ is equivalent with ‘to exist at  $t$ ’, ‘to be wholly present at  $t$ ’ is a richer notion. Indeed, it must be a richer notion: otherwise, to say that objects persist by enduring would be tantamount to say that objects exist at various times by existing at various times. These two mereological definition of whole presence, however, do not fare very well. They both fail at capturing the intuition of persistence as a ‘sweeping’ through time that motivates endurantism.

Consider  $D_{\text{TMER-WP}}$ . It aims to capture the idea according to which when there is an object at a time there are also all the parts it has at that time. My scooter existed in 2015 and also exists today. Take an instant in 2015: my scooter was wholly present there in that it existed at that instant together with all the parts it had at that time. It is now wholly present too: it exists at the present instant together with all its actual parts. In the meantime, I had to replace its windshield, so that its actual mereological profile differs from its mereological profile in 2015. The problem with  $D_{\text{TMER-WP}}$  is that it is perfectly consistent with perdurantism. Indeed, a perdurantist may accept the definition as well and claim that her persisting objects are wholly present at each instant of their careers. Consider Sider’s (2001, 57) definition of parthood-at-a-time in terms of temporal parthood:

- $x$  is part of  $y$  at  $t =_{\text{def}}$   $x$  and  $y$  each exist at  $t$  and  $x$ ’s instantaneous temporal part at  $t$  is part of  $y$ ’s instantaneous temporal part at  $t$ .

Consider now a persisting perduring object  $x$  at  $t$ . Since it perdures, it has an instantaneous  $t$ -temporal part. Of course, given the definition of persistence,  $x$  exists at  $t$ . Moreover, given the first conjunct of Sider’s perdurantist definition of parthood-at-a-time, any object  $y$  that is part-at- $t$  of  $x$  exists at  $t$ . Therefore, it follows that, at every instant  $t$  at which the perduring  $x$  exists,  $x$  is wholly present. Hence,  $D_{\text{TMER-WP}}$  is not strong enough to distinguish between endurantism and perdurantism, and thus it is not a notion of whole presence allowing for a satisfying set up of the debate.

Next, consider  $D_{\text{AMER-WP}}$ . First of all, notice that, if presentism were true,  $D_{\text{AMER-WP}}$  would be equivalent with  $D_{\text{TMER-WP}}$ , given the assumption that  $x$  exists (at the present time). Second, notice that  $D_{\text{AMER-WP}}$  does distinguish between endurantism and perdurantism, or, at least, it is unsuited for perdurantism. Suppose that  $x$  exists both at distinct  $t$  and  $t^*$ , and thus is wholly present at those instants. Accordingly, all the parts  $x$  has at  $t$  and at  $t^*$  are present at  $t$  (as well as  $t^*$ ). If  $x$  had temporal parts,  $x$  would have a  $t$ - and a  $t^*$ - temporal part. If  $x$  were wholly present at  $t$ , then, its  $t^*$ -temporal

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<sup>123</sup> On the assumption that there are instantaneous temporal intervals. Of course, it may turn out that time is ultimately decomposable only in extended simple intervals, analogously as what Braddon-Mitchell and Miller (2005) suggest to be the case with spatial regions.

part should exist at  $t$ : temporal parts are still parts. However, the  $t^*$ -temporal part exists only at  $t^*$  by definition of temporal part. Therefore, perduring objects would not be wholly present at every time of their existence.

Yet,  $D_{\text{AMER-WP}}$  is far from unproblematic, and the following example should make clear why. I have recently replaced, say at  $t_0$ , the windshield of my scooter and then broke the old one in a bunch of pieces, so that they fit in the blue bin. My scooter persisted through the change, and it is now, say at  $t_1$ , parked in the box. Since the scooter persisted through the windshield replacement, it was wholly present at  $t_0$  as well as it is wholly present right now at  $t_1$ , or so the endurantist would like to claim. However,  $D_{\text{AMER-WP}}$  delivers the unfortunate result that my scooter is not wholly present at  $t_1$ , given that the old windshield does not exist at  $t_1$ . Moreover, consider that the variable  $t^*$  in  $D_{\text{AMER-WP}}$  ranges over every temporal instant, present and past ones as well as future ones. Accordingly, my scooter was not wholly present even at the first instant of its existence, in that its new windshield did not exist at that time (or so we may assume). Therefore,  $D_{\text{AMER-WP}}$  fails at accounting for endurantist intuition of persistence as ‘sweeping’ of whole present objects through time. At least, it fails to account for the standard endurantist intuition: indeed, endurantists holding that objects cannot change their parts over time can still endorse  $D_{\text{AMER-WP}}$ . Classically, such a brand of endurantism was defended by Chisholm (1976), but any philosopher holding that objects cannot change their parts over time will find  $D_{\text{AMER-WP}}$  a useful formulation to distinguish her take on persistence over time from perdurantism. However, since this is certainly not at all the default endurantist position, and it does not really capture endurantist’s idea that persisting objects ‘sweep’ through their career,  $D_{\text{AMER-WP}}$  fails again at providing a satisfying set up of the debate between perdurantism and endurantism.

There are further mereological definitions for the notion of whole presence at a time available for the endurantists. Recently, Costa (forthcoming) proposed the following promising mereological definition of endurantism:<sup>124</sup>

- $D_{\text{FMER-WP}}$ :  $x$  is wholly present at time  $t \stackrel{\text{def}}{=} x$  exists at  $t$  and if  $x$  is complex at  $t$ , then  $x$  is identical with the fusion-at- $t$  of its proper parts-at- $t$

To be complex at  $t$  just means to have proper parts at  $t$ . The notion of fusion-at- $t$  is constructed by simply replacing any instance of timeless parthood predicate with an instance of parthood-at-a-time predicate in the following (classical) definition of fusion:<sup>125</sup>

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<sup>124</sup> Costa’s paper actually advances many definitions of ‘wholly present at  $t$ ’, suited for different kinds of endurantist theorists. For instance, it presents definitions for constitution and non-extensionalist theorists as well. I will not discuss them here. See Loss (2021a) for a criticism of Costa’s overall proposal.

<sup>125</sup> I have previously defined the notion of fusion differently. Regardless of the temporal indexes, the present definition is strictly weaker than the previous one. However, as already stated in section 1.2, the two definitions are provably equivalent given Strong Supplementation Principle in the background.

- Fusion-at-a-time:  $F_{ty}xx =_{\text{def}} \forall z(O_tzy \leftrightarrow \exists x(x <_t z \wedge O_txz))$

This definition fares better than the previous two. On the one hand, it rightly implies that perduring objects are not wholly present at each instant of their existence, and it does so by requiring  $x$  to be identical with the fusion-at- $t$  of its *proper* parts-at- $t$ . Since proper parthood is irreflexive,  $x$  itself cannot be among its proper parts-at- $t$ , and thus it does not end up trivially wholly present at  $t$ . Second, perdurantists accept the existence of something identical with the fusion-at- $t$  of  $x$ 's proper parts-at- $t$ , namely  $x$ 's instantaneous  $t$ -temporal part. Such a temporal part, and not the entire four-dimensional object, rightly comes out to be wholly present at  $t$ . On the other hand, Costa's definition is fully compatible with the possibility for enduring objects to change their proper parts over time, while it is still fully compatible with the negation of such possibility.

The intuition driving endurantism depicts persisting objects as 'sweeping' through all the times of their existence. Persisting objects retain their individuality despite the changes they undergo in their careers. Philosophers have recently tried to put flesh on the same intuition in different terms. A suggestion is:  $x$  is present at  $t$  if and only if  $t$  is not completely free of  $x$ . Interestingly, by building on such a suggestion, it is possible to regiment a formal theory of spatiotemporal occupation. Hence, endurantism can be reconstrued as a claim concerning how material objects occupy spacetime, and the same goes with perdurantism. The next section aims to expose the (classical) theory of location and the resultant rephrasing of the debate on persistence over time.

### 3.3 The Locative Debate

We said above that four-dimensionalism and three-dimensionalism are alternative labels for perdurantism and endurantism, respectively. Temporal parts of perduring objects are three-dimensional entities, in that they occupy temporally unextended regions, while perduring objects occupy four-dimensional spatiotemporal regions, insofar as they are identical with mereological fusions of temporal parts. Like perdurantist's instantaneous temporal parts, enduring objects are temporally unextended. Differently from them, though, they exist at many distinct temporal instants, in that they persist over time. For decades, philosophers have been regarding the debate between perdurantists and endurantists as a mereological issue concerning which proper parts of a persisting object are present at every instant of the object's career. On the one hand, perdurantists claim that objects are partly present at every instant of their existence, by having an instantaneous temporal part that is wholly present at each very instant. On the other hand, endurantists claim that persisting objects are wholly present at every instant of their existence, an expression aiming to state that what there is at every instant at which an object  $x$  exists is the whole  $x$  itself, as opposed to some part of it. However, perduring and enduring objects differ not only with respect to their mereological behaviour, but also

for what concerns their existence in time. Metaphorically, we may say that three-dimensional, enduring objects are ‘small enough’ to be fully contained into single temporal instants, whereas this is not the case for four-dimensional, perduring ones, that overfill temporal instants instead. Yet, even whether it is intuitively correct to claim that perduring and enduring objects exist in time in different ways, it is obscure what the claim amounts to. The source of unclearness is the very notion of existence at a time. It is far more graspable what it means for an object to exist at a region of space: for an object to exist at a region of space just means to occupy the region, to be located at the region. Hence, a promising way to analyse the notion of existence at a time draws from its spatial counterpart and assumes that to exist at a time just means to occupy the time, to be located at the time. Starting from the works of Donnelly (2010, 2011), Gilmore (2006, 2008), Hawthorne and Sider (2002), Parsons (2000, 2007) and Sattig (2006), the debate on persistence over time was revised and expanded into a debate on spatiotemporal location of objects.<sup>126</sup> More carefully, these works provided the tools for understanding that the traditional endurantism/three-dimensionalism vs perdurantism/four-dimensionalism debate was actually conflating two different questions: a mereological one and a locative one. On the one hand, the mereological question concerns the existence of temporal proper parts: perdurantists claim that persisting objects have temporal proper parts, whereas endurantists disagree. On the other hand, the locative question concerns how objects are located in time: perdurantists claim that each persisting  $n$ -dimensional object occupies a single  $n+1$ -dimensional region, whereas endurantists maintain each enduring object occupies many distinct instantaneous three-dimensional regions. In light of the present distinction, thus, the endurantist notion of ‘whole presence at a time’ displays all its ambiguity between a mereological and a locative reading.

However, the predicate ‘to be located at’ is utterly ambiguous too. For instance, consider the following couple of sentences:<sup>127</sup>

- Since Aristotle is now in Athens, he is not now in Thebes
- Since Aristotle is now in his house, he is not now in the garden

The two sentences are respectively true and false (suppose the second sentence is uttered while Aristotle is leaving his house and his right leg is already past the door). At first sight, though, their superficial structure is the same: both the antecedents and the consequents picture an object that is spatially located somewhere. The predicate ‘to be in’ has clearly a locative meaning here and refers to the occupation relation between an object and a region of space. However, the logical forms of the

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<sup>126</sup> Some philosophers, such as Costa (2017, 2018) and Eagle (2019), have named this shift in the debate the ‘locative turn’.

<sup>127</sup> If you believe in the possibility of time travel, then add to the next two sentences an antecedent like ‘If right now there is no instance of time traveling all over the world’.

two sentences must be different. For sure, it could be objected that those sentences concern spatial location, whereas we are interested here in temporal location. Therefore, despite riddles of spatial location being a topic that surely deserves attention on itself, philosophers interested in persistence over time should just focus on the notion of temporal location. However, this objection misfires for two reasons. First, it is immediate to recreate temporal analogues of the previous two sentences.<sup>128</sup> Just consider:

- Since Aristotle exists at the temporal interval between 384 B.C. and 322 B.C., then Aristotle does not exist at the temporal interval between 321 B.C. and 300 B.C.
- Since Aristotle exists at the first weekend of 383 B.C., then Aristotle does not exist at the first weekend of 382 B.C.

Again, the sentences are respectively true and false, despite their identical grammatical structure. Hence, the problem here does not lie with the notion of spatial location, but rather with the notion of location itself. Second, and most importantly, it runs afoul of the rationale behind the ‘locative turn’. Nowadays, most philosophers involved in the debate on persistence over time equate existence at a time with location at a time.<sup>129, 130</sup> Moreover, the hard core of the locative turn is precisely that the notions of spatial and locative relations have the same formal features and logical behaviours. What varies among philosophers, though, is why they believe they do so. We can roughly distinguish between three positions, here sketched in order of decreasing theoretical commitment. According to some philosophers, there is just one locative relation. It is a two-place relation such that a material object and a region of spacetime must respectively occupy the first and the second place. This is a quite natural position for orthodox substantivalists,<sup>131</sup> according to which both material objects and regions of spacetime are fundamental existent and irreducible to one another, and more generally for anyone endorsing a unitist conception of space and time. For instance, Donnelly (2011, 31) simply claims that «the occupation relation holds between objects and spatiotemporal regions of the same shape and size», whereas Calosi (2014, 124), more carefully, considers that to be a «simplifying assumption». These philosophers would say that the two couples of sentences above are just incomplete. They all would refer to the occupation of spacetime regions by material objects, and

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<sup>128</sup> Notice, though, that A-theorists would contend that the genuineness of such an analysis. Indeed, a core claim of A-theory is that time is not a dimension at all, or at least is a completely different kind of dimension from the spatial dimension (see Emery, Markosian, and Sullivan (2020)).

<sup>129</sup> Slightly different is the position of Costa (2017, 2018), according to which persisting objects do not exist at times by being located at those times, but rather by participating in events that are located at those times. Again, however, objects may be rightfully said to occupy times, albeit in a mediate way (or ‘transcendently’).

<sup>130</sup> However, it is interesting to notice that, although an absolute notion of existence is certainly available, a parallel absolute notion of location is not forthcoming.

<sup>131</sup> I draw the label from Eagle (2019).

avoid an explicit talk for pragmatic reasons. Other philosophers, such as Costa (2017) and Giordani and Costa (2013), agree on the existence of a single locative relation. However, they endorse a laxer conception of location and allow regions of any dimension, be it space, time, or spacetime, to occupy the second place of the relation. Hence, there is a true difference between two couples of sentences above: the first one concerns material objects located in space, whereas the second one material objects located in time. Nevertheless, the locative relation at stake is one and the same: what changes is just the kind of dimension under consideration. Lastly, some philosophers may want to follow Parsons (2007, 215) and claim that «[t]hough temporal location has the same formal structure as spatial location, it is not the same relation». Parsons' position is the least committing, since he does not make any assumption concerning the relata of the location relation. There are just two locative relations that relate material objects with two different kinds of entities, namely regions of space and instants of time. Perhaps there is also a notion of spatiotemporal location: plausibly, it would sit among the other two. This way, any tension with competing conceptions of space and time is *ab ovo* avoided. However, Parsons's position is clearly the least parsimonious. For any way in which material objects can be said to occupy a dimension, there is a corresponding primitive locative relation. I already mentioned spacetime, but there could be further dimensions too. For instance, Giordani and Costa (2013, 214) characterise the existence of objects at possible worlds through a locative relation. Accordingly, we should introduce a further primitive locative relation. The issue here is not so much the multiplication of primitive relations as rather that they all would end up having the same formal structure. As a matter of fact, Parsons's account leaves as a mystery why every locative relation has certain formal features, and this is at least suspicious.

All in all, then, the ambiguity does not spring from spatial or temporal location, but rather from the very notion of location. Material objects can be said to be located in various ways, and these ways license certain sort of inferences. For instance, by knowing that I occupy a spatial region  $x$ , you can infer that I thereby occupy any spatial region  $y$  that has  $x$  as subregion, but you cannot infer that I do not occupy a spatial region  $z$  which overlaps  $x$ . Analogous inferential patterns hold with temporal location. In order to highlight the relations between the various ways in which material objects may occupy regions of some dimensions, philosophers have developed formal theories of location. In the next section, I will introduce the locative predicates and principles that allow reframing the debate on persistence over time.

### **3.3.1 Parsons's Theories of Location**

Theories of location are formal theories, formulated in the regimented language of first order predicative logic, just like mereology. They consist of a number of definitions, axioms, and of course

the theorems they imply. A crucial aspect for the formulation of a theory of location, and indeed any formal theory, is the choice of the primitive predicate(s). Different primitive predicates allow the formulation of equivalent theories of location. Another central aspect of theories of location is their interaction with mereology. The hard core of the locative turn is the equation of existence at a time with location at a time; a further quite standard claim is that regions of space, time, spacetime, and maybe other dimensions as well, display mereological structure. Importantly, this allows defining non-primitive locative predicates through the primitive one together with mereological predicates.<sup>132</sup> Furthermore, theories of location end up being extensions of mereological theories. Since both material objects and regions, regardless of the dimension they belong to, are constructed as having mereological structure, the mereological axioms range freely and need not be restricted to just the first kind of entities.

I now follow Parsons (2007) and introduce a number of locative predicates, together with a couple of principles. However, despite its simplicity, Parsons's theory of location is far from undisputed. Indeed, whilst philosophers largely regard it as the starting point for the formulation of theories of location, many have criticised Parsons's theory on the grounds of its inadequacy to deal with some exotic scenarios (Kleinschmidt 2016, Leonard 2014, Loss 2019a, forthcoming-a). I will largely ignore these issues, and just focus on the intertwining between persistence of objects over time and their location. Moreover, Parsons's theory of location is also consistent with supersubstantivalism, that is, the metaphysical thesis according to which, necessarily, objects are literally identical with spatiotemporal regions (see Lehmkuhl 2018, Leonard 2021, Nolan 2014).<sup>133</sup> Parsons's theory of location can be equivalently formulated by adopting either the predicate of exact location or that of weak location and define the other locative notions accordingly, through it and mereological predicates.<sup>134</sup> To get a grip on the notion of exact location, Gilmore informally qualifies the relation as follows:

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<sup>132</sup> It should be noticed, though, that mereology does not impose constrictions of any sort on the existence of ultimate elements from which everything is made up. It is a feature of mereology that it is compatible with both atomic and non-atomic scenarios. In the present discussion, this feature leads to the silence concerning the existence of atomic regions. Interestingly, theories of location are compatible with the possibility that there are no temporal instants, that is, with the gunkiness of times.

<sup>133</sup> However, as Parsons himself notices (2007, 228), the conjunction of supersubstantivalism and his theory of location implies the controversial principle of Arbitrary Partition.

<sup>134</sup> Further non-classical theories of location may assume more or different primitive predicates. For instance, Leonard (2014) argues that we should assume both exact and weak location as primitive; Loss (2019a, forthcoming-a) defines 'to collectively fill' as a new primitive plural predicate; and Correia (2022) develops a theory of location that is neutral with respect to Functionality, Exactness, and (DAUP) by using entire location as primitive.

[A]n entity  $x$  is exactly located at a region  $[r]$  if and only if  $x$  has (or has-at- $[r]$ ) exactly the same shape and size as  $[r]$  and stands (or stands-at- $[r]$ ) in all the same spatial or spatiotemporal relations to other entities as does  $[r]$ . (Gilmore 2018)

In other words, the exact location of an object is its ‘shadow’ in the spacetime. To say that  $x$  is exactly located at the spatiotemporal region  $r$ , we write  $x@r$ . It is then possible to define the other locative predicates, with the assumption that the regions objects can be located at have a mereological structure.

The weaker locative relation is weak location. Generally,  $x$  is weakly located at  $r$  when  $r$  is not completely free of  $x$  (Parsons 2007, 203). For instance, Niagara Falls are weakly located at both Canada and USA. The relation is defined as follows:

$$x \text{ is weakly located at } r: x@_or \stackrel{\text{def}}{=} \exists s(x@s \wedge Ors)$$

Successively, consider that there is a sense in which objects are said to be located where some of its parts are. For instance, I am someway located where my nose is; only there is not the whole of me. This sort of locative relation is called pervasive location, and we say that  $x$  pervades  $r$  when  $r$  is the exact location of a part of  $x$ :

$$x \text{ pervades } r: x@>r \stackrel{\text{def}}{=} \exists y(y@r \wedge Pyx)$$

A locative notion we employ very much is entire location. For instance, if someone asked me to say where I am now, I would answer that I am home. However, I am surely not exactly located at the exact location of my home. Of course, I am weakly located at the exact location of my home, but I am weakly located at my home also when I just extend one arm over the door while the rest of my body is still inside the building. The locative relation relevant in such cases, though, is entire location:  $x$  is entirely located at  $r$  when  $x$  is exactly located at a subregion of  $r$ :

$$x \text{ is entirely located at } r: x@<r \stackrel{\text{def}}{=} \exists s(x@s \wedge Psr)$$

Consider now these two following principles:

$$\text{Functionality: } (x@r \wedge x@s) \rightarrow r = s$$

$$\text{Exactness: } \exists r x@_or \rightarrow \exists r x@r$$

Functionality is an axiom of the theory. Indeed, Parsons seems to regard it like a meaning postulate for the notion of exact location, in that he claims: «if someone doesn’t believe Functionality is true, I begin to suspect they aren’t talking about exact location – what part of ‘exact’ don’t they understand?» (2007, 219). Functionality ensures that exact location is a functional relation. Exactness immediately

follows from the definition of weak location: thus, it is a theorem of the present theory. It says that if a material object  $x$  is weakly located at some region, then  $x$  is exactly located at some region too (perhaps the very same region). The theory is provably equivalent with the following one, which instead takes Exactness as an axiom and the predicate  $@_o$  of weak location as primitive, thereby defining the other locative predicates as follows:

$x$  is exactly located at  $r$ :  $x@r =_{\text{def}} \forall s(\text{Ors} \leftrightarrow x@_os)$

$x$  pervades  $r$ :  $x@>r =_{\text{def}} \forall s(\text{Ors} \rightarrow x@_os)$

$x$  is entirely located at  $r$ :  $x@<r =_{\text{def}} x@_or \wedge \forall s(x@_os \rightarrow \text{Ors})$

By taking the predicate of weak location as primitive, Exactness acts now as a meaning postulate for the notion of weak location, while Functionality is a theorem of the theory, and is derived as follows:

1.  $x@r \wedge x@s$  (assumption)
2.  $x@r$  (from 1 and logic)
3.  $\forall t(\text{Ort} \leftrightarrow x@_ot)$  (from 2, definition of  $@$ )
4.  $x@s$  (from 1 and logic)
5.  $\forall t(\text{Ost} \leftrightarrow x@_ot)$  (from 4, definition of  $@$ )
6.  $\forall t(\text{Ort} \leftrightarrow \text{Ost})$  (from 3, 5)
7.  $r = s$  (from 6, Extensionality of Overlap)
8.  $(x@r \wedge x@s) \rightarrow r = s$  (from 1, 6, and logic)

The proof uses Extensionality of Overlaps, which is a strong extensionality principle, requiring a mereology at least as strong as to include the lexical axioms together with Weak Supplementation Principle, and Uniqueness of Fusion (Loss 2021b, 3457-3458; see also Varzi 2008). Hence, the present theory of location is indeed an extension of a strong mereology. And of course, the present theory of location is fully compatible with CEM.

### 3.4 Persistence Over Time as Location Over (Space)Time

The traditional debate on persistence over time conflates mereological and locative issues. On the one hand, the mereological issue concerns the existence of temporal parts. Perdurantist claim that objects persist by having a temporal part at every instant of their existence, while endurantist deny it and claim instead that objects persist by being wholly present at every instant of their existence. On the other hand, the locative issue concerns the way persisting material objects occupy spatiotemporal regions. Particularly, the definition of the locative predicates and the formulation of a theory of location allow understanding that what is really at stake between the four- and three- dimensional claims, respectively associated with perdurantism and endurantism, is a disagreement over the exact

location of persisting objects. According to four-dimensionalism, each persisting object is exactly located at a single temporally extended, four-dimensional region. Differently, three-dimensionalism is the thesis that each persisting object is exactly located at many temporally unextended, three-dimensional regions. In other words, three-dimensional persisting objects would be multi-located, *contra* Functionality. Thus, the difference between the locative and the mereological debates should be now clear. We can be even more precise in circumscribing the matter of disagreement. Let us define the predicate of total location as follows:

$$x \text{ is totally located at } r: x@_{\text{Tr}} =_{\text{def}} \exists yy(\forall z(z < yy \leftrightarrow x@z) \wedge \text{Fryy})$$

$x$  is totally located at a region  $r$  if and only if  $r$  is the fusion of the plurality of regions which  $x$  is exactly located at. The region  $r$  which  $x$  is totally located at is often called  $x$ 's path (Calosi 2014, Costa 2018, Donnelly 2011, Gilmore 2006). Every persisting object has a non-instantaneous path. According to four-dimensionalists, the total location and the exact location of any persisting objects are identical: every persisting object is exactly located at its path. Three-dimensionalists claim instead that persisting objects are exactly located at every instantaneous regions at which they exist. The following two definitions are nearly undisputed ways to phrase four- and three- dimensionalism through locational predicates (Calosi 2014, Costa 2018, 2020, Gilmore 2006):

$$4\text{D}: \forall x(\text{Persist}(x) \rightarrow \forall r(x@r \leftrightarrow x@_{\text{Tr}}))$$

$$3\text{D}: \forall x(\text{Persist}(x) \wedge \forall r(x@r \rightarrow \text{Instantaneous}(r)))$$

These two definitions allow proving that four-dimensional objects are singly located, whereas three-dimensional objects are multi-located.

Suppose, for *reductio*, that 4D objects are multi-located. Then, there is a 4D object  $x$  that is exactly located at two distinct instantaneous regions, say  $r$  and  $s$ . By definition of 4D,  $x$  is totally located at  $r$  and  $x$  is totally located at  $s$ . Now consider  $r$ . By definition of total location,  $r$  is the mereological fusion of  $x$ 's exact locations. Hence, by definition of fusion,  $s$  is part of  $r$ . Then, consider  $s$ . By definition of total location,  $s$  is the mereological fusion of  $x$ 's exact locations. Hence, by definition of fusion,  $r$  is part of  $s$ . Therefore,  $r$  and  $s$  are mutual parts: by Antisimmetry,  $r = s$ . However,  $r$  and  $s$  are distinct by assumption. By *reductio*, 4D objects are not multi-located.

Suppose, for *reductio*, that 3D objects are not multi-located.<sup>135</sup> Then, there is a 3D object such that it is exactly located at a single region  $r$ . By definition of 3D,  $r$  is instantaneous. By definition of total location,  $r$  is the total location of  $x$ . But  $r$  is instantaneous. Since, by assumption,  $x$  is a persisting object, its total location cannot be instantaneous. It follows that 3D objects are multi-located.

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<sup>135</sup> The present proof is due to Calosi (2014, 135-136).

As a corollary, these two proofs jointly imply that no persisting object can be both 4D and 3D: otherwise, such an object would turn out to be both singly and multi-located. Therefore, the two definitions really set up a genuine dispute between the two theoretical positions.

More generally, one can trace the incompatibility between four- and three- dimensionalism back to Functionality, which four- and three- dimensionalists respectively endorse and reject. However, recall Parsons's complaint that denying Functionality just amounts to a bad understanding of the very notion of exact location. Should then we reject three-dimensionalism as unintelligible on mere semantic grounds? The vast majority of three-dimensionalists and philosophers who discuss three-dimensionalism disagree with Parsons's scepticism (see, *inter alia*, Donnelly 2011, Eagle 2016a, 2016b, Leonard 2018, Sattig 2006). Interestingly, though, we will see in a moment how Parsons's position can be nonetheless substantiated through a *sui generis* theory of persistence.

The introduction of locative predicates and a theory of location allow then to prove that, given appropriate definitions, four- and three- dimensionalism have been proved to be incompatible. Let us come back to the mereological issue concerning the existence of temporal parts. Recall Sider's definition of instantaneous temporal part:

$x$  is an instantaneous temporal part of  $y$  at instant  $t =_{\text{def}}$  (i)  $x$  is a part of  $y$ , (ii)  $x$  exists at, but only at,  $t$ , (iii)  $x$  overlaps every part of  $y$  that exists at  $t$

The definition makes use of the ambiguous notion of existence at a time. An insight from the theories of location is that things exist at times in different ways. Interestingly, it is possible to give a non-ambiguous formulation of the notion through locative predicates (Costa 2018, 77):

$x$  is a temporal part of  $y =_{\text{def}} \text{PP}xy \wedge \exists t(x@t) \wedge \forall z(\text{P}zy \wedge z@_o t \rightarrow \text{O}zx)$

Still, the mereological debate between perdurantism and endurantism does not rely on such a definition, and it can be simply framed as follows (with 'TP' standing for temporal parthood):

Perd:  $\forall x(\text{Persist}(x) \rightarrow \exists y\text{TP}yx)$

End:  $\forall x(\text{Persist}(x) \rightarrow \neg\exists y\text{TP}yx)^{136}$

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<sup>136</sup> Still, notice that several endurantists acknowledge a fundamental ontological distinction between occurrents and continuants (e.g., Costa (2017, 2018), Simons (2000b), (2013), Wiggins (2001)). The main difference between the two kinds of entities precisely amounts to the way in which they persist over time: occurrents persist by perduring, while continuants persist by enduring. Roughly, events and processes are occurrents, while substances are continuants. An event is temporally heterogeneous in virtue of its heterogeneous temporal parts. In other words, an event is temporally heterogeneous because two temporal proper parts of it instantiate different properties at different times. Differently, a continuant changes in a genuine way: the continuant itself, not its mereological delegates, instantiates different properties at different times. Hence, Perd and End may very well be both accepted, modulo a slight reformulation of the antecedent, by endurantists acknowledging the existence of occurrents and continuants and their present characterisation.

The two formulations are plainly contradictory, given the existence of persisting objects. Consequently, no persisting object can both endure and perdure. Of course, End is just a bare statement of genuine endurantism. As we have seen above, endurantism is the richer thesis according to which persisting objects are wholly present at each instant of their existence (whatever it means). Nevertheless, the whole presence of  $x$  at each instant of its existence should rule out its partial existence at those very instants, that is, it should imply that  $x$  has not proper temporal parts at any instant of its existence, and therefore that  $x$  has not proper temporal parts at all. Hence, an interesting statement of endurantism should be strictly stronger than End. For instance, recall Costa's definition of whole presence:

$D_{\text{FMER-WP}}$ :  $x$  is wholly present at time  $t \stackrel{\text{def}}{=} x$  exists at  $t$  and if  $x$  is complex at  $t$ , then  $x$  is identical with the fusion-at- $t$  of its proper parts-at- $t$

Recall also that to persist over time just means to exist at distinct times. Hence, the corresponding predicate can be unpacked as follows:

$\text{Persist}(x) \stackrel{\text{def}}{=} \exists t \exists t' (t \neq t' \wedge \text{Ext } t \wedge \text{Ext } t')$

Where  $\text{Ext } t$  means that  $x$  exists at the time  $t$ . Then consider the respective formulation of endurantism:

$\text{End}_{\text{Costa}}$ :  $\forall x (\text{Persist}(x) \rightarrow (\text{Whole-present}(x, t) \wedge \text{Whole-present}(x, t') \wedge t \neq t'))$

$\text{End}_{\text{Costa}}$  is strictly stronger than End. Given Costa's definition of whole presence, we can prove that  $\text{End}_{\text{Costa}}$  actually implies End. Assume, for *reductio*, that  $x$  is whole present at  $t$  and at  $t'$  but still  $x$  has temporal proper parts. Let us further standardly assume that  $x$  has a temporal part at each instant of its existence. Consider now the time  $t$ .  $x$  is wholly present at  $t$  and  $y$  is the  $t$ -temporal part of  $x$ . Either  $y$  is a proper part-at- $t$  of  $x$  or is identical with  $x$ . Obviously,  $y$  cannot be identical with  $x$ . Since  $y$  is a temporal part, it exists at, and only at,  $t$ , whereas  $x$  is wholly present both at  $t$  and at  $t'$ , with  $t \neq t'$ . Hence,  $x$  exists both at  $t$  and  $t'$ , but  $y$  does not.  $y$  cannot be a proper part-at- $t$  of  $x$  either. If  $y$  were a proper part-at- $t$  of  $x$ , then, by (a temporally-indexed version of) Weak Supplementation Principle, there should be a part-at- $t$  of  $x$ ,  $z$ , disjoint-at- $t$  from  $y$ . Moreover,  $z$  should exist at a time  $t' \neq t$ : otherwise,  $z$  and  $y$  would overlap-at- $t$ , given the definition of temporal parthood. However,  $x$  is wholly present at  $t$  and complex-at- $t$  by assumption since it has a proper temporal part. Hence,  $x$  is the fusion-at- $t$  of all its proper parts-at- $t$ , given  $D_{\text{FMER-WP}}$ . It would turn out that  $x$  is the fusion-at- $t$  of  $y$  alone:  $y$  is a part-at- $t$  of  $x$  and every part-at- $t$  of  $x$  overlaps-at- $t$   $y$ . The fusion, as well as the fusion-at- $t$ , of any improper plurality is identical with its only member, given Weak Supplementation Principle.<sup>137</sup>

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<sup>137</sup> Suppose that  $x$  is the fusion of the improper plurality having only  $y$  as a member and still  $x \neq y$ . By definition of Fusion,  $y$  is part of  $x$ ; and since  $x \neq y$  by assumption, it follows that  $y$  is a proper part of  $x$ . By Weak Supplementation Principle, it

Therefore, it would follow that  $x = y$ , *contra* the assumption that  $y$  is a proper (temporal) part of  $x$ . Therefore,  $\text{End}_{\text{Costa}}$  implies End.

Therefore, Costa's definition of whole presence allows defining a version of endurantism that is strictly stronger than End. It is indeed correct to state that endurantists share an opposition towards the existence of temporal parts. However, endurantism is not simply the negation of perdurantism, or at least it should not be. Rather, it is a substantive mereological thesis, concerning the persistence of material objects, that implies the negation of perdurantism.

All in all, the locative turn allows discerning the existence of two debates concerning the persistence of material objects over time. On the one hand, there is a mereological debate concerning the existence of temporal parts. Perdurantists claim there are temporal proper parts of persisting objects, while endurantists deny it. On the other hand, there is a locative debate concerning the Functionality of exact location. Four-dimensionalists accept Functionality and claim that each persisting material object is exactly located at a single four-dimensional spatiotemporal region, while three-dimensionalists deny Functionality and claim instead that each material object is exactly located at distinct three-dimensional spatiotemporal regions. Interestingly, the two debates are not only distinct: they are also orthogonal. Therefore, the locative turn eventually allows expanding the debate on persistence over time along a nowadays well-known pattern (see Costa 2018, Gilmore 2008, 2018):

	4D	3D
Perd	4D-Perd	3D-Perd
End	4D-End	3D-End

4D-Perd and 3D-End are the theoretical positions that better capture the theses featured in the classical debate on persistence over time. For instance, Lewis (1971, 1986) endorses 4D-Perd, while van Inwagen (1981, 1990a, 1990b) endorses 3D-End.

What about the other two combinations? Let us consider 3D-Perd first. It affirms that material objects persist by having a temporal part at each instant of their existence, and that they are exactly located at three-dimensional spatiotemporal region. However, there seems to be a tension between these claims. 3D-Perd objects should be exactly multi-located at each of the very three-dimensional spatiotemporal regions that are occupied by their proper temporal parts. But how can ever a whole complex object and just one of its proper parts be exactly located at the very same spatiotemporal

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follows that  $x$  has some part that is disjoint from  $y$ . However, by definition of Fusion, every part of  $x$  overlaps  $y$ . *Contradiction!* Hence, given Weak Supplementation Principle, if  $x$  is the fusion of the improper plurality having only  $y$  as member, then  $x = y$ .

region? By pushing on this point, Costa (2018, 83) argues that 3D-Perd is incoherent. Suppose that a 3D object  $x$  persists by having proper temporal parts and call one of these  $y$ .  $y$  is either temporal extended or unextended. If  $y$  is temporally extended, then  $x$  would be temporally extended too, *contra* 3D. If  $y$  is temporally unextended, and it is a proper part of  $x$ , then consider again Weak Supplementation. Since  $y$  is a temporal part of  $x$ , it overlaps every part of  $x$  that exists at the instant  $t$  at which  $y$  exists. Hence, the remainder  $z$  must exist at an instant  $t' \neq t$ . Consequently,  $x$  would have two parts at two distinct temporal instants, and therefore it would not be exactly located at a three-dimensional spatiotemporal region. It follows that 3D implies the negation of Perd, that is, End.

I will discuss 4D-End at great length in the following section.

### 3.5 Transdurantism

4D-End turns out to be far more interesting than 3D-Perd and a real alternative to the two traditional views on persistence over time. From a locative point of view, it is a four-dimensionalist theory: each persisting object is exactly located at the four-dimensional spatiotemporal region that is identical with its path. From a mereological point of view, it is an endurantist theory, at least in the minimalistic sense of rejecting the existence of temporal parts and claiming that objects persist by being wholly present at each time of their existence. In other words, 4D-End objects extend in the temporal dimension without having proper temporal parts at all. Hence, they are temporal extended simples: they exactly occupy complex temporal regions without having a proper temporal part at each temporal instant they are weakly located at.

The theory does not enjoy many endorsers. Among them, the most famous is surely Parsons (2000, 2007, 2008), while Daniels (2019) has recently illustrated and explored the theory, which he labels transdurantism. Parsons upheld 4D-End with the purpose of advancing a four-dimensionalist conception of persisting objects that was not committed to temporal proper parts. The theory is endurantist in the minimalistic sense of rejecting temporal parthood. There are two main reasons why endurantists should like 4D-End. First, differently from standard multi-locationist 3D-End, it is compatible with Functionality. If, like Parsons, one is tempted to regard Functionality as a meaning postulate for the notion of exact location, then 3D-End's commitment to multi-location would be puzzling, since multi-location is the straightforward negation of Functionality. Moreover, since Functionality is a meaning postulate of the predicate of exact location, any theory at odds with it would risk rendering the notion outright unintelligible. Notice that this concern is not idiosyncratic for transdurantists, since every philosopher with 4D-Perd inclinations would share it.<sup>138</sup> 4D-End

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<sup>138</sup> However, multi-locational endurantism is alive and well, and several philosophers still endorse it or at least regard it as conceptually possible (e.g., Bittner et al. 2004, Correia 2022, Gilmore 2007, Sattig 2006, Van Inwagen 1990a, 1990b).

offers a temporal spanning, as opposed to a temporal multi-locational, version of endurantism (Daniels 2019, 90-91).<sup>139</sup> Second, 4D-End can make literal sense of the mereological notion of whole presence. By stating that persisting objects are wholly present at each temporal instant of their existence, endurantists are rejecting the existence of temporal parts. Specifically, they are rejecting the mereological claim according to which persisting objects are partly present at those very temporal instants. According to Parsons, if being partly present at a temporal instant means to have some parts at that temporal instant, then being wholly present at a temporal instant means to have all the parts at that temporal instant. Moreover, being wholly present at a temporal instant means to be wholly located at that temporal instant. Therefore, the claim that an object is wholly located at a temporal instant amounts to the claim that all the parts of the object are present at that temporal instant. He defines the following locative notion:

$x$  is wholly located at  $r$ :  $x@ \blacktriangleleft r =_{\text{def}} \forall y (Pyx \rightarrow y@_or)$

$x$  is wholly located at  $r$  when all the parts of  $x$  are weakly located at  $r$ . The relation of whole location usually reduces to that of entire location. However, the two relations can diverge in the case of extended simples. Parsons's example concerns an extended simple sphere hovering over the sill of a window (2007, 212). In such a case, the sphere would be wholly located at the appropriate regions on both sides; still, it would be entirely located only at the fusion of those regions.

Costa (2017, 2020) labels 4D-End as Simplism and qualifies it as the thesis according to which ordinary persisting objects are mereologically simple and exactly located at the temporally extended region of their persistence only. Why should 4D-End affirm that persisting objects are mereologically simple *tout court*? Costa explains this point by stating that «the persisting object has no proper temporal parts because it has no proper parts at all» (2017, 8). Of course, if  $x$  has no proper parts at all,  $x$  has no proper temporal parts too. Still, such a reason seems alien to the rationale for 4D-End. Consider Daniels's distinction between spatial, temporal, and proper simples (2019, 89-90). An object is spatially simple if and only if it has no proper spatial parts. An object is temporally simple if and only if it has no proper temporal parts. Lastly, an object is a proper simple if and only if it has no proper parts at all. Proper simples are indeed temporal simples. However, in order to accommodate transdurantism's rejection of temporal parts, persisting objects just need to be *temporally* simples (see also Eagle 2019, 178). Accordingly, Daniels (2019, 98) suggests that the commitment of transdurantism to proper simples is a further theoretical question.

I suspect that the *rationale* behind Costa's definition of 4D-End relies on considerations pertaining to temporal flexibility of ordinary objects (see also Miller 2009, 632). Suppose a 4D-End

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<sup>139</sup> The labels come from McDaniel (2007), though he uses them slightly differently.

wants to claim that my scooter is wholly present, hence wholly located, at the temporal instant  $t$ . According to the definition of whole location, the temporal instant  $t$  is not free of any of my scooter's parts. Since 4D-End rejects temporal proper parts, the focus must be thereby on spatial proper parts of objects. Suppose then that at  $t$  I have already replaced my scooter's windshield and completely destroyed the old one. It follows that not all of my scooter's spatial parts are weakly located at  $t$  (notice that 4D-End does not use a temporally-indexed mereology). Since persisting ordinary objects can, and customarily do, undergo mereological alteration and survive through them, they would not be wholly located at every temporal instant of their existence. However, if persisting objects are proper simples, then, for every persisting object  $x$ , only one part of it needs to be weakly located at every instant of the existence of  $x$ , and that is its improper part, namely  $x$  itself.

That is not the only way in which objects can transdure, though. Indeed, any object that never undergoes mereological alteration happens to be wholly located at each instant of its existence, regardless of being spatially complex or not. Remarkably, APN acknowledges the existence of objects of this kind, given its commitment to heaplike entities. Portions of matter and gerrymandered objects do have spatial parts, but they are also structureless entities and so, as in accordance with Mereological Essentialism, depend on their mereological profiles for their own identity. Consequently, they cannot lose any of their parts on pain of ceasing to exist. Indeed, the notion of whole location allows precisely defining this aspect of their structureless nature through a timeless notion of parthood: heaplike entities, inasmuch structureless, are wholly located at every instant of their existence. Since heaplike entities turn out identity-dependent upon their proper parts, for every  $x$ , if  $x$  is a proper part of a heaplike entity  $y$ , then  $x$  must be weakly located at every region  $y$  is wholly located. If any proper part of a heaplike entity was not thus located, the heaplike entity would not persist over that region, because the heaplike entity itself would have *ipso facto* ceased to exist.

However, if spatially extended portions of matter are suitable candidates for transdurance, then the label Simplism is clearly too narrow as an appropriate characterisation of transdurantism. The single constraint transdurantism imposes over persisting object concerns their temporal simplicity. More precisely, transdurantism characterises persisting objects as temporally simple, mereologically unchanging, and exactly located at the single spatiotemporal region that identifies their paths.<sup>140</sup> Hence, transdurantism does not need to construe every persisting object as simple, but merely as mereologically unchanging. Such a construction nicely suits what we have called Mereological Semantic Simplicity - the principle stating that mereological sentences hold *simpliciter*. Given Mereological Semantic Simplicity, times does not have any role in the context of mereological sentences; and clearly this must be so, if objects are mereologically unchanging. Instances of parthood

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<sup>140</sup> The first conjunct allows distinguishing between transdurantism and perdurantism.

relation are as fix as instances of membership relations. Moreover, the fixity over time of mereological profiles of objects indeed follows from Mereological Essentialism. According to Mereological Essentialism, complex objects are identity-dependent upon their proper parts: hence, they cannot change their mereological profile without ceasing to exist.<sup>141</sup> The two principles are still distinct (even though they are often confused: see Cameron 2017, 349). Mereological Essentialism is a modal principle, whereas the claim that objects do not change with respect to their mereological profiles over time is just an intra-world one. Transdurantism suits Mereological Essentialism well, but it does not need to endorse it: a weaker temporal intra-world principle would suffice for its coherence.

Let us now examine how transdurantism can deal with the problem of change. Consider Socrates: he is sitting at  $t_0$  but standing at  $t_1$ . Hence, he has two different shapes at two different times, despite being one and the same object. Clearly, an object may have such shapes only if it is three-dimensional. Remarkably, both 3D-End and 4D-Perd offer an ontology that can accommodate the existence of the proper three-dimensional entities. For 3D-End, Socrates himself is the proper three-dimensional entity sitting at  $t_0$ . For 4D-Perd, the proper three-dimensional entity sitting at  $t_0$  is instead an instantaneous temporal part of Socrates. Yet, none of these answers is compatible with transdurantism. On the one hand, transdurantism regards Socrates as a four-dimensional entity; on the other hand, it denies the existence of temporal proper parts. Recall that, according to transdurantism, persisting objects are temporally extended simples. Hence, the problem of change is nothing but an instance of the problem concerning the correct account of the qualitative heterogeneity of extended simples.

In order to account for the qualitative heterogeneity of persisting objects, Parsons introduced the concept of distributional property (Parsons 2000, 2004). Distributional properties qualitatively characterise objects throughout their dimensions. Particularly, such properties characterise objects with respect to their distribution of qualities. Consider first the spatial case. An example of spatial distributional property is *being polka-dotted*. Inasmuch as it specifies the chromatic profile of an object, it is a qualitative property. Specifically, it characterises objects with respect to the distribution of chromatic properties to, say, the smallest colourable part of the objects. Further instances of spatial distributional properties are *being hot at one end and cold at the other* and *being uniformly dense*. Again, these properties qualitatively characterise objects throughout their spatial dimension. Nevertheless, the scope of distributional properties extends to the temporal dimension as well. Consider, for instance, the colour distribution throughout the career of an apple. The apple starts its career as green; later, it ripens and gets red; lastly, it perishes and turns brownish. Hence, the apple

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<sup>141</sup> In other words, if  $x$  is essentially  $P$ , then  $x$  is permanently  $P$ . See Parsons (2005).

instantiates a non-uniform chromatic distributional property that characterises its colour distribution throughout its career. As far as concerns Socrates and his changes of shape, the trandurantist claims that Socrates is a temporal simple, heterogeneous along the temporal dimension. As such, he instantiates a shape-characterising temporal non-uniform distributional property. It is easy to generalise: «[a]n object *changes* iff it has a non-uniform temporal distributional property» (Parsons 2004, 178).

Recall that the persistence of an object through change requires that the object instantiates different incompatible properties at different times. *Prima facie*, trandurantist's ontology of properties is not rich enough. Persisting objects are temporally extended simples that instantiate distributional properties. They do not, literally, instantiate different incompatible properties at different times: rather, they instantiate different compatible properties at the very same times: the non-punctiform region of spacetime they are wholly located at and every proper part of it. Nevertheless, the machinery of distributional properties is strong enough to allow simulating, and actually improving, the pseudo-adverbialist strategy due to Van Inwagen (1990b). For many<sup>142</sup> n-adic predicates expressing a property or a relation, pseudo-adverbialism takes it to refer not to a n-adic property, but rather to an n+1-adic relation in disguise. Lewis famously objected to pseudo-adverbialism that it turns intrinsic properties, such as shapes, into extrinsic relations to times or regions of spacetime. However, «if we know what shape is, we know that it is a property, not a relation» (Lewis 1986, 204).

Parsons (2000, 410-411) claims that it is indeed possible to recover temporally-indexed properties by analysing them in terms of distributional properties. A property such as *having the shape s at t* is analysed as the disjunction of the appropriate plurality of distributional properties. What does 'appropriate' mean in this context? Parsons just says that the members of the plurality must be 'compatible' with *having the shape s at t*. Intuitively, the property is analysed in terms of those distributive properties that have a proper 'phase at *t*', so to speak. However, since distributional properties are fundamental, such a talk must stay metaphorical. Interestingly, though, the analysis of temporally-indexed intrinsic properties through distributional properties ensures their intrinsicity. Fundamental distributional properties are intrinsic: if *x* instantiates a distributional property, any duplicate of *x* will instantiate it as well. And disjoining intrinsic properties does not give back any extrinsic property. Therefore, Parsons's analysis promises to achieve the same results as the pseudo-

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<sup>142</sup> Pseudo-adverbialism arguably does not extend to properties necessarily instantiated by everything, such as *being identical with itself* or *being identical with the number 1* or *different from the number 1*.

adverbialist strategy, while, at the same time, getting rid of the gratuitous relational structure pseudo-adverbialism imposes on intrinsic properties.<sup>143</sup>

A theory of distributional properties is not the only way in which transdurantism may account for the change in transduring objects. Recall that the problem here is accounting for the heterogeneity of simples; and as we have already considered in the section 2.4.1, further theories aim to provide the result. Markosian (1998) purposes to construe sentences stating the heterogeneity of an extended simple as sentences about the heterogeneity of the complex portion of matter constituting it. For instance, an extended simple would be half white and half black because it is constituted by a portion of matter that is composed by a black part and a white part. An immediate problem for such an account of heterogeneity of extended simples is that, if heterogeneous extended simples are conceivable, then it seems conceivable as well that a heterogeneous extended simple statue is made up of a heterogeneous extended simple portion of matter. For instance, suppose the shape of a heterogeneous extended simple portion of matter has been intentionally modified so as to bring a statue into existence at the end of the process. In such a case, though, Markosian's strategy is clearly unable to help accounting for the heterogeneity of the two objects; and the extension from the spatial to the temporal case is straightforward.

It seems to me that the most promising theory to the present end is the Ehring-McDaniel strategy (McDaniel 2009). Recall that McDaniel proposes, by building on Ehring's (1997) characterisation of tropes as momentary, to switch to a spatiotemporally-indexed trope talk to deal with property ascriptions for heterogeneous extended simples. The schema he proposes is: « $x$  is  $F$  at  $t$  if and only if there is an  $F$ -trope that exists at  $t$  and  $x$  exemplifies it» (McDaniel 2009, 327), and an extension of this schema to spatiotemporal regions is straightforward. Consider again the transduring Socrates, sitting at  $t_0$  and standing at  $t_1$ . We can take ' $t_0$ ' and ' $t_1$ ' as referring, in a unitistic fashion, to instantaneous slices of the world, and thus to the corresponding spatiotemporal regions.<sup>144</sup> Socrates is exactly located at a single spacetime region, namely his path. Still, he has different shapes at  $t_0$  and  $t_1$ . According to the Ehring-McDaniel treatment of properties, Socrates is sitting at  $t_0$  because he exemplifies an appropriate shape-trope existing at  $t_0$ . The strategy offers a way to characterise the intrinsic features of objects with no appeal to relations different from the exemplification relations between objects and their tropes. In so doing, the present strategy allows intrinsically characterising objects as finely as the spatiotemporal regions they are exactly located at.

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<sup>143</sup> Notice, though, that McDaniel (2009) vigorously criticises such reductive ambitions.

<sup>144</sup> See again Gilmore, Costa and Calosi (2016).

## Chapter 4

### More on Hylomorphs as Extended Simples

#### 4.1 Towards Endurantist APN

I think perdurance is not the theory of persistence that best suits APN. What I take to be one of APN's main selling points is its compatibility with 'pure' mereology, that is, the conjunction of CEM and Mereological Essentialism. It does so because it accepts and makes sense of the intuition that portions of matter and gerrymandered entities such as trout-turkeys are, by using a worn-out expression, nothing over and above their proper parts. It seems to me, though, that such an intuition just suggests that those entities are nothing over and above their *material* proper parts, on the grounds that they are utterly devoid of any structure. However, if perdurantism were true, Mereological Essentialism would imply that entities are identity-dependent on their *temporal* proper parts as well – far beyond what the intuition about the lack of structure suggests. With some revision of the principle we have hitherto considered, perdurantism may indeed turn out compatible with APN. For instance, Mereological Essentialism should be weakened in such a way to express identity-dependence of entities on just their *material* proper parts; and, by appealing to Daniels's (2019) terminology, hylomorphs should be characterised as *spatial* simples instead of simples *tout court*. However, in what follows, I will leave it aside in order to minimise technicalities and stick instead with the two versions of endurantism; it is important though to notice that we can possibly make perdurantism serviceable as well.

Baker (2007, 2008) actually pairs up her seminal theory of atomic hylomorphs with endurantism. Although she does not properly distinguish between the two versions of endurantism that the locative turn in the debate on persistence over time allows delineating, the theory of persistence she endorses is definitely the classical 3D-End. Nevertheless, it is interesting to notice that the core metaphysical assumptions of APN seem compatible with both 3D-End and 4D-End, and I consider this *prima facie* compatibility with both three- and four-dimensional endurantism (as well as with perdurantism, proviso some adjustments to the principles we have been using) an advantage of APN. Philosophers having serious reservations against the rejection of Functionality would not thus be compelled to reject APN, since they could still appreciate its transdurantist or perdurantist formulations; vice versa, whoever is attracted to a multi-locationist account of persistence over time may enjoy the 3D-End formulation. In what follows, I will parallelly develop both a 3D-End and a 4D-End formulation, with a specific emphasis on underlying the suitable accounts of properties. Moreover, it is important to discuss three general issues for the present theory.

First, APN is committed to strong forms of interpenetration: not only every hylomorph and its constituting portion of matter interpenetrate but also every hylomorph and its ‘hylomorphic parts’, such as Statue and Head, interpenetrate despite sharing no parts. Hence, we should check whether interpenetration is actually a threat to the theory. We will also consider whether there is some compelling principle leading from interpenetration to mereological consequences at odds with CEM.

Second, and crucially, APN must develop a further theory that accounts for the seeming mereological talk concerning hylomorphs. By following other APN theorists’s thoughts, and by expanding on certain robust intuitions concerning the ‘real’, or ‘natural’, parts of material objects, I introduce the relation *real parthood at a time*. I advance a reductive definition of such relation in terms of essence, grounding, and parthood – *bona fide* CEM-theoretic parthood. Although partially defined in terms of parthood, *real parthood at a time* is not a mereological relation between hylomorphs and their ‘parts’, but rather a relation capturing the fact that, *modulo* the satisfaction of further conditions, the existence of certain kinds of entities contribute to bring about the existence of certain kinds of other entities. How the contribution is provided varies according to the kinds of the relata.

Third, I show that Baker’s theory of derivativeness can make sense of the fact that hylomorphs and their constituting portions of matter share many properties. The theory of derivativeness must be slightly modified depending on the endorsed theory of persistence, but the core of the theory stands still. The theory of derivativeness also furnishes APN with an answer to the charge of causal overdetermination and the related infamous double weight argument. The appropriate answer depends on the theory of properties the APN theorist ends up with, which in turn depends again on the chosen theory of persistence over time.

## 4.2 Interpenetrating Material Objects

Let us distinguish between Coincidence and Colocation. Coincidence is a mereological notion and can be defined in the following two ways (Smid 2021):

$$(O\text{-Coincidence}) \text{OC}_{xy} =_{\text{def}} x \neq y \wedge \forall z(\text{O}zx \leftrightarrow \text{O}zy)$$

$$(PP\text{-Coincidence}) \text{PC}_{xy} =_{\text{def}} \neg Ax \wedge \neg Ay \wedge x \neq y \wedge \forall z(\text{PP}zx \leftrightarrow \text{PP}zy)$$

$x$  and  $y$  O-coincide if and only if  $x$  and  $y$  share all of their overlappers and  $x$  is different from  $y$ .  $x$  and  $y$  PP-coincide if and only if  $x$  and  $y$  are two different non-atomic entities that share all of their proper parts. Of course, CEM prevents any  $x$  and  $y$  from satisfying the two definitions, since sharing all the overlappers or being complex and sharing all the proper parts are sufficient conditions for identity. Some multi-thingers endorse Coincidence (e.g., Baker 2000, Burke 1994, Doepke 1982, Rea 2000,

Simons 1987) at the cost of rejecting some extensionality principles of mereology. Clearly, our theoretical framework does not allow any sort of coincidence.

Differently, Colocation is a locative notion and is defined as follows:

$$\text{(Colocation) } CO_{xy} =_{\text{def}} \exists R(\text{ExL}(x, R) \wedge \text{ExL}(y, R) \wedge x \neq y)$$

$x$  and  $y$  are colocated iff  $x$  and  $y$  are different and each of them is exactly located at the same region.

APN's worldview acknowledges colocation. Suppose God creates Statue at a time and later annihilates it. Statue would have been constituted by Alloy the whole time. In such a case, Statue and Alloy would be colocated objects. There are two reasons why Colocation may be a problem for APN. First, many philosophers are reluctant to accept the possibility of two objects satisfying the definition; particularly, all those philosophers accepting some version of mereological harmony. Second, and more specifically, there is an argument showing that Colocation implies Coincidence: and whereas APN does endorse the former, it cannot accept the latter, on pain of giving up CEM.

Mereological harmony is a theory according to which there is some mirroring between parthood and location (see, inter alia, Casati & Varzi 1999, Leonard 2016, Saucedo 2011, Uzquiano 2011). It is constructed as a number of distinct principles relating mereological and locative notions. Although there are different systems of mereological harmony, many of them include the following No Colocation principle:

$$\text{(NC) No-Colocation: } \text{ExL}(x, R) \wedge \text{ExL}(y, R) \rightarrow x = y$$

Clearly, (NC) is in plain contradiction with the possibility of Colocation. However, (NC) is already entailed by the following minimal principle of mereological harmony (see Leonard 2016):

$$\text{(MH}_P\text{) } Pfxfy \leftrightarrow Pxy$$

The function  $f$  takes material objects as arguments and returns their exact locations as values.<sup>145</sup> (MH<sub>P</sub>) thus states that the exact location of  $x$  is part of the exact location of  $y$  iff  $x$  is part of  $y$ , and, together with some lexical axioms, implies (NC). Assume (MH<sub>P</sub>) and the antecedent of (NC). Since  $x$  and  $y$  are exactly located at the same spatiotemporal region  $R$ , and Reflexivity grants that  $R$  is part of itself, it follows, by the left-to-right direction of (MH<sub>P</sub>), that  $x$  is part of  $y$  and  $y$  is part of  $x$ . By Antisymmetry, it follows then that  $x = y$ , and thus (MH<sub>P</sub>) implies (NC), at least given Reflexivity and Antisymmetry.

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<sup>145</sup> The assumption is that exact location is functional. As we have considered in section 3.3.1, Functionality is indeed an axiom in Parsons's classical theory of location. Yet, functionality is by no means a pacific principle.

As we have said, there is then a further difficulty for colocationism, in the guise of an argument which leads from Colocation to Coincidence. The argument has been discussed by Smid (2021) and employs some mereological theorems together with the following locative principles:

(NI) No-Interpenetration:  $\text{ExL}(x, R) \wedge \text{ExL}(y, S) \wedge \text{O}(R, S) \rightarrow \text{O}xy$

(EXP) Expansivity:  $(\text{P}xy \wedge \text{ExL}(x, R)) \rightarrow \exists S(\text{ExL}(y, S) \wedge \text{P}(R, S))$

(TOT) Totality:  $\exists R \text{ExL}(x, R)$

(FUN) Functionality:  $\text{ExL}(x, R) \wedge \text{ExL}(x, S) \rightarrow R = S$

The argument proceeds differently when  $x$  and  $y$  are simple or complex. Let us begin with the supposition that  $x$  and  $y$  are simples. Suppose Colocation holds for  $x$  and  $y$ :  $x$  and  $y$  are different and yet there is a region  $R$  such that  $\text{ExL}(x, R)$  and  $\text{ExL}(y, R)$ . From the reflexivity of overlap and (NI), it follows that  $x$  and  $y$  overlap. Since  $x$  and  $y$  are simples, they overlap if and only if they are mutual parts; given Antisimmetry, however, it follows that  $x$  and  $y$  are identical. Contradiction!

Suppose now that  $x$  and  $y$  are complex. Suppose Colocation holds for  $x$  and  $y$ :  $x$  and  $y$  are different and yet there is a region  $R$  such that  $\text{ExL}(x, R)$  and  $\text{ExL}(y, R)$ . From Extensionality of Proper Parts, it follows that  $x$  has a proper part  $z$  that  $y$  lacks. Two cases are possible: either (i)  $z$  is not a part of  $y$ , or (ii)  $z$  is identical with  $y$ . Suppose (i). From Strong Supplementation, it follows that  $z$  has a part, say  $w$ , that does not overlap with  $y$ . From (TOT), it follows that  $w$  has an exact location, say  $S$ . From (EXP) and Transitivity, it follows that  $S$  is part of a region  $T$  at which  $x$  is exactly located and, given (FUN),  $T = Y$ . From the assumption of Colocation, and (NI), it follows that  $w$  and  $y$  overlap. Contradiction! Suppose now (ii). Since  $y$  is now a proper part of  $x$ , it follows from the asymmetry of proper parthood that  $x$  is not a part of  $y$ . From Strong Supplementation, it follows that  $x$  has a part, say  $u$ , that does not overlap with  $y$ . From (TOT), it follows that  $u$  has an exact location, say  $U$ . From (EXP), it follows that there is a region  $V$ , at which  $x$  is exactly located, such that  $\text{P}(U, V)$ . From (FUN), it follows that  $V = R$ . From the assumption of Colocation, and (NI), it follows that  $u$  and  $y$  overlap. Contradiction!

The two proofs show how Colocation interacts with mereology. The first proof actually shows that Antisimmetry suffices to rule out collocated atoms, given (NI). The second proof shows instead that Colocation implies Coincidence, and thus instances of Colocation are incompatible with extensional mereology, given (NI), (TOT), (EXP), and (FUN).<sup>146</sup> Whoever wishes to endorse the possibility of Colocation together with extensional mereology must therefore reject at least one of the abovementioned locative principles. Of course, APN demands the rejection; however, mereological

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<sup>146</sup> A slight modification of the second proof would show the incompatibility of Colocation between a simple and a complex proviso extensional mereology and the abovementioned locative principles.

hylomorphism must do that as well. It is interesting to compare the two theories and see the respective incompatibilities with locative principles.

Let us first consider (NC). According to mereological hylomorphism, Statue and Alloy (may) share their exactly location, since Statue's formal part is abstract and thus devoid of any location at all. And of course, APN agrees on this point. Consequently, the two theses must reject the principle of mereological harmony ( $MH_P$ ). Particularly, they must reject a specific direction of the principle:

$$(MH_{P \rightarrow}) Pfxfy \rightarrow Pxy$$

$$(MH_{P \leftarrow}) Pxy \rightarrow Pfxfy$$

Both APN and mereological hylomorphism must reject ( $MH_{P \rightarrow}$ ). The two theories are committed to the possibility of a hylomorph and its constituting piece of matter to be wholly spatiotemporally coincident. Consequently, they would turn out being mutual parts, and thus identical given Antisymmetry. Moreover, the commitment to abstract formal proper parts of material objects does not actually provide any help to mereological hylomorphism in this respect. Inasmuch abstract, hylomorphic forms lack spatiotemporal location, and thus the exact location of the hylomorph is not a proper extension of the exact location of its constituting portion of matter. Still, mereological hylomorphists are better off denying that forms have an exact location. Suppose particular hylomorphic forms have an exact location: arguably, they would be exactly located where their bearers are. But then, according to ( $MH_{P \rightarrow}$ ) and Antisymmetry, the form, the hylomorph, and its constituting portion of matter would turn out being identical. Suppose then universal hylomorphic forms have an exact location: arguably, they would be exactly located at the fusion of the exact location of their bearers. For instance, the hylomorphic form for human being would be exactly located at the fusion of the exact locations of Socrates, Plato, Aristotle, and all the other human beings. But then, according to ( $MH_{P \rightarrow}$ ), the hylomorphs would turn out being parts of their forms. Moreover, according to ( $MH_{P \leftarrow}$ ), it would follow that the exact location of the form is part of the exact locations of its bearers, while it is the case, according to the current hypothesis, that the exact locations of its bearers are proper parts of the exact location of the form when there are at least two hylomorphs of the appropriate kind.

Relatedly, as far as Smid's (2021) argument is concerned, mereological hylomorphism must reject (TOT). The role of (TOT) within Smid's argument is precisely to infer that some part of a material object has an exact location. APN must instead reject (NI): even though a hylomorph and its constituting matter may be exactly located at overlapping regions, they can never overlap.

Smid (2021, 66) actually points out (NI) as the culprit behind the argument from Colocation to Coincidence, to the point that he regards (NI) as an anti-Colocation principle. The fundamental reason

is that if one wishes to make room for Colocation, she better accepts that Colocation can relate objects regardless of their mereological profile, on pain of ad hocness; and (NI) is crucial to avoid the implication from Colocation to Coincidence in every case. First, we have seen that (NI) plays a part in the argument from Colocation to Coincidence for complex entities. Second, we have seen that (NI) alone prevents the possibility of colocated simples, when conjoined with Antisimmetry. Someone may then make a case for colocated simples by rejecting Antisimmetry while still maintaining (NI). However, third, (NI) would still prevent the possibility of a simple and a complex to be colocated, proviso the endorsement of the other locative principles and a supplementation principle as weak as Quasi-Supplementation (that, crucially, does not imply Antisimmetry even granting Transitivity). Thus, according to Smid, philosophers willing to accept Colocation should deny (NI).

Moreover, there are further reasons to be sceptic of (NI), and such reasons extend to  $(MH_{P \rightarrow})$  as well. For instance, some philosophers have argued that some modal principles of recombinations allow for colocated entities, and thus we should acknowledge the possibility of Colocation (McDaniel 2007, Saucedo 2011, Sider 2000). Another sort of examples comes from bosons. Differently from fermions, this kind of particles do not obey Pauli's exclusion principle: some have interpreted this fact as the possibility for bosons to be colocated (Hawthorne and Uzquiano 2011; see Schaffer 2009 for a different interpretation). An interesting source of scepticism about (NI) and  $(MH_{P \rightarrow})$  comes also from bio-ontologies. Following Jansen and Schultz's (2014, 169 ss) we can distinguish between the notions of *inclusion* and *containment*.  $x$  includes  $y$  just in case  $y$  is exactly located at a region which is part of the region  $x$  is exactly located at;<sup>147</sup>  $x$  contains  $y$  just in case  $x$  includes  $y$ , but  $y$  is not a part of  $x$ . Clearly, the possibility of containment is at odds with the two locative principles. However, examples from biology lead to consider containment as quite widespread in the world. Consider Mary, a girl who happens to swallow a glass marble. The situation is as follows: a glass marble is in the stomach of Mary. Is it part of Mary's stomach? There are plenty of reasons to answer negatively: by mentioning just a few, it does not play any role in the digestive function of the stomach; it originated elsewhere; it is supposed to be expelled; it is inorganic; it is not in genealogical continuity with any of the cell of the stomach. If these suggestions are correct, then the glass marble is just contained in Mary: its exact location of the glass marble is part of her exact location; however, it should not be regarded as one of her parts.<sup>148</sup>

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<sup>147</sup> Jensen and Schultz actually employ a set-theoretic treatment of spatiotemporal regions. Anyway, a mereological treatment would not modify their theory in any relevant respect.

<sup>148</sup> The example assumes that Mary's exact location encompasses her digestive cavity's exact location. The assumption may seem strange: after all, Mary's digestive cavity is a sort of hole, and it is rather questionable that the exact location of a piece of Emmenthal encompasses the exact locations of its typical holes. However, there is an important difference between the two cases. Particularly, there is an intimate functional relation between the digestive cavity and Mary's digestive organs; and in turn an intimate functional relation between Mary's digestive organs and Mary herself. On the contrary, there is no relevant functional relation between the piece of Emmenthal and its holes.

All in all, then, scepticism towards (NI) and  $(MH_{P\rightarrow})$  is not so absurd and has actually different independent sources. Moreover, all the relevant counterexamples in the literature concern interpenetrating entities and provide reasons to think that interpenetration is possible. In other words, all the counterexamples to the principles are of a kind. Lastly, it is worth to notice (NI) and  $(MH_{P\rightarrow})$  share the same counterexamples because the two principles are conceptually very akin.<sup>149</sup> Hence, by rejecting (NI) and  $(MH_{P\rightarrow})$ , APN is basically rejecting just one principle, and on the very same grounds.

What about mereological hylomorphism? It does not just need to reject  $(MH_{P\rightarrow})$ , but (TOT) as well. Still, there is an obvious reason to get rid of (TOT), namely that abstract entities lack an exact location. (TOT) should thus be restricted so that it holds for concrete entities alone. However, consider that Smid's argument from Colocation to Coincidence would still work if we replace (TOT) with a weaker principle, such as:

$$(TOT^*) \quad (\exists SExL(y, S) \wedge Pxy) \rightarrow \exists RExL(x, R)$$

(TOT\*) is clearly compatible with abstract entities lacking an exact location (given Reflexivity), but it is still too strong to accommodate abstract formal proper parts of material objects (indeed, of every object having an exact location).

There is actually a kind of counterexample in the literature to (TOT\*), and thus to (TOT), and it comes from Stoic theory of mixtures (Nolan 2006, Leonard 2014, Loss 2019a, Parsons 2007). Let us say that an object is gunky iff each of its proper parts has in turn proper parts:

$$(Gunky) \quad Gx =_{def} \forall y(Pyx \rightarrow \exists zPPzy)$$

Take then two homogeneous gunky substances, say  $S_1$  and  $S_2$ , and mix them together to obtain the gunky substance  $S_3$ . If we suppose that the mixture is such that every part of  $S_3$  contains both (and only)  $S_1$  and  $S_2$ , and thus that  $S_1$  and  $S_2$  are mixed through and through, then  $S_3$  is a Stoic mixture. If Stoic mixtures are possible, and thus  $S_3$  is possible, it follows that the composing substances  $S_1$  and  $S_2$  have a weak location, yet not an exact one.  $S_1$  and  $S_2$  are too scattered and discontinuous to have an exact location (Parsons 2007, 208). In other words, Stoic mixtures are purported counterexample to Exactness.

But clearly, the Stoic mixtures provide a counterexample to (TOT\*) for wholly different reasons than formal proper parts of material objects. While Stoic mixtures falsify (TOT\*) and because they are composed by substances that have a weak location but lack an exact one, hylomorphic forms

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<sup>149</sup> Gilmore (2018) even states that « $[(MH_{P\rightarrow})]$  may seem to say basically the same thing as  $[(NI)]$ , but to say it more simply». He still sticks to (NI) just because  $(MH_{P\rightarrow})$  would be independently rejected by many philosophers who already reject Strong Supplementation Principle.

contravene the principle because they lack a location altogether despite being parts of material objects. Hence, the hylomorphic case against (TOT\*) does not enjoy any real support. In other words, if we furtherly restricted (TOT\*) to non-gunky objects, the only reason to doubt them would be provided by non-located parts of material objects. The most relevant theory recognising such abstract parts, as we know well, is mereological hylomorphism.<sup>150</sup> On top of that, not only the theory is the only relevant exception to non-gunky formulations of (TOT\*), but also its dialectical position has been seriously undermined by the argument in section 2.2. Moreover, as Smid remarks, any theory endorsing both Colocation and (NI) must endorse the suspiciously ad hoc rejection of some kinds of colocation.

To sum up, any multi-thingist theory that wishes to accept a mereology at least as strong as extensional mereology must block the inference from Colocation to Coincidence. Mereological hylomorphism achieves the result by giving up the two locative principles (TOT) and (MH<sub>P→</sub>), while APN through the rejection of two, but almost one, locative principles (NI) and (MH<sub>P→</sub>). The contemporary literature on location and mereology furnishes various independent reasons to give up the latter two, counterexamples coming both from conceivability and actual scientific scenarios. On the contrary, the main counterexample to more refined formulations of (TOT) is a very specific one, and it falsifies it for completely different reasons than those mereological hylomorphism provides. Moreover, while the rejection of (NI) allows one to endorse Colocation at full, the rejection of (TOT) commits one to reject some kinds of collocational scenarios anyway, thus raising the further question about what motivates such a selection.

### 4.3 Real Parts of Hylomorphs

An obvious issue for APN is that hylomorphs usually seem to have proper parts. After all, one of the main intuitions driving the present account is that Statue has a torso and a head among its parts, but not their fusion; and that Tibbles the cat has a tail and a heart among its parts, but not their fusion; and so forth. In other words, the intuition suggests that hylomorphs cannot be dissected arbitrarily into proper parts, but still they can be dissected in appropriate, natural, ways. However, since APN construes hylomorphs as extended *simples*, it seems it must concede that hylomorphs cannot even be dissected in such appropriate ways. But then, if Statue is a simple, any sentence like ‘Statue’s head is made of marble’ would be strictly false. Clearly, APN prevents *any* mereological talk regarding hylomorphs, and thus seems to throw the baby out with the bathwater. In what follows, I will discuss two different accounts that try to make sense of such mereological intuition. Even if none of them

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<sup>150</sup> To be fair, there are other theory of material objects acknowledging abstract parts (McDaniel 2001, Longenecker 2018, Paul 2002, 2006, 2017, 2018). However, not only those theories are far less relevant than hylomorphism, but generally construe abstract parts as having an exact location.

will result adequate to APN, they will furnish two important cues for the definition of a new relation that should precisely capture the phenomenon we are interested in. Lastly, I will discuss a recent theory due to Sattig and show that some minor tweaks make it so that it implements precisely those cues.

Let us consider first that several philosophers take proper parts to be carved out of material objects according to the Doctrine of Arbitrary Undetached Parts (DAUP):

(DAUP) if  $x$  is exactly located at a spatiotemporal region  $R$ , then, for every proper sub-region  $R^*$  of  $R$ , there is a  $y$  such that  $y$  is a proper part of  $x$  and  $y$  is exactly located at  $R^*$

(DAUP) is a liberal principle of dissection which basically acknowledges a mirroring between the mereological profile of the region an object exactly occupies and the mereological profile of the object itself. We have already considered that (DAUP) is conceptually incompatible with the possibility of extended simples. Still, some philosophers would reject (DAUP) on the grounds that it commits to acknowledge as *real* parts of objects some dubious entities. Intuitively, while the head and the left lung of Maxima the horse are two of her parts, the fusion of the head and the lung is not a part of her. As Simons states, «An arbitrarily jerrymandered subregion of the region occupied by a real whole, whether natural or artificial, continuant or occurrent, may be a genuine region, but it will not in general be occupied by a part of the whole» (Simons 2006, 608). Is it possible to develop an account of real parts that avoids the unnatural dissections of wholes?

Simons (2006) advances a proposal to construe wholes as fusion of their real parts alone. Its core is the notion of ‘welding relation’, that Simons logically characterises as a class of equivalence relations taking disjoint objects as relata. According to Simons, an instance of welding relations accompanies any instance of composition. The accompanying must be taken in the serious sense of satisfaction of necessary and sufficient conditions: for any plurality  $xx$  and object  $y$ , the  $xx$  compose  $y$  if and only if the  $xx$  are jointly related by a welding relation. Although Simons does not profusely explain what welding relations are, and mostly defers to a scientifically informed image of the world, his idea is nonetheless pretty clear: there is a new whole  $y$  if and only if there is a suitable welding relation among certain objects  $xx$ , which then qualify as the only *real* parts of  $y$ , and it is fundamentally up to science to identify welding relations. Every plurality of objects standing in a welding relation composes a natural whole. Consider one example he proposes: a helium-4 nucleus. There is a plurality of disjoint objects, namely two protons and two neutrons. Such objects are the relata of the welding relation *exchanging gluons with*. Hence, they compose something, a helium-4 nucleus, and are its only real (proper) parts. Generally, a real part of an individual is «something

which plays a distinct, unified and identifiable causal or, more broadly, functional role within the individual or its life» (Simons 2006, 609), and welding relations hold exclusively among real parts.

A further account of real parthood and composition can be found in the works of Gillett (2013, 2016) and Glennan (2021). The two authors stress the role that parts have in implementing the processes their wholes undergo, particularly all of their typical behaviours, functions, and capacities (henceforth TBCFs). For every whole, its parts participate to processes that implement the processes the whole participate to, and they do that in virtue of their own TBCFs. A plurality of carbon atoms within a diamond, for instance, by manifesting the typical bonding behaviours of each of its members, implements the typical capacity of breaking the bond between glass molecule of the diamond (Gillett 2016, 67). Generally, true parts of material objects are tracked down on causal grounds: the parts of a material object must causally contribute to the manifestation of the object's TBCFs. The causal considerations actually stretch to the very identity of the whole, since Glennan claims that TBCFs identify wholes: «A composite is the composite it is, not just because of what it characteristically does, but because of what it characteristically can do» (Glennan 2021, 11447). In other words, every individual depends, for its identity, on its CBCs. Since TBCFs of a whole ultimately depend on actions of the whole's parts for their manifestation, the present causal account preserves the intimacy of parthood relation, inasmuch the causal effects of parts ground its whole's TBCFs, which in turn are featured in the essence of the whole itself. Of course, the TBCFs of a whole are determined by the kind the individual belongs to. Both Glennan (2021, 11447) and Gillett (2016, 85) explicitly acknowledge that, as indeed many other philosophers (e.g., Kaiser 2018, Koslicki 2018, 63). Leaving a precise characterisation of the relation aside, the present account surely satisfies the sustaining condition as well. Moreover, the present causal account of parthood seems to maintain the existence of grounding relations between parts and wholes: as Gillett clearly puts it, «the existence of these lower-level entities, under the conditions at this time, non-productively determines that we also have the composed entity at this time» (Gillett 2016, 84). Lastly, Glennan claims that the real parts of a whole must show some degree of cohesion with each other during the life of the whole, and argues that this conditions alternative captures the otherwise trivial condition of spatial containment (Glennan 2021, 11448-9). Parts of a whole's environment do not, in fact, satisfy Glennan's condition, and thus are not included among the whole's parts too.

How do the two proposals fare within the background of CEM? First of all, they come with a rejection of Unrestricted Composition. Take Simons' one. Given that a plurality of objects composes something if and only if those objects stand in a welding relation, clearly not all the pluralities would

be compositionally fertile, so to speak.<sup>151</sup> Take the Gillett-Glennan account. It surely acknowledges a car  $c$  and a duck  $d$  as complex wholes. Unrestricted Composition acknowledges the fusion of  $c$  and  $d$  too, say  $e$ . Clearly,  $e$  does not belong to any real kind, being it a wholly gerrymandered mereological fusion. However, an object's TBCFs are determined by the real kind the object belongs to, and  $e$  does not belong to any real kind at all, being neither an artifact nor a natural whole. But then, even if the existence of  $e$  is granted, it arguably does not have proper parts, according to the Gillett-Glennan account. Proper parts of material objects causally brought about the manifestation of their whole's TBCFs, and since  $e$  does not have TBCFs, it follows that  $e$  has not proper parts, *contra* the assumption that it is the mereological fusion of  $c$  and  $d$  (proviso that  $c \neq d$ ).

Moreover, the two proposals must reject Strong Supplementation Principle. Consider Simons' claim that «[...] even if we can identify a collection of parts of some individual, they do not compose a further part unless they compose under a welding relation» (Simons 2006, 608). Intuitively, the quote expresses a sound point. Take again Maxima the horse. We are reticent to claim that the mereological fusion of her head and her left lung, call it  $m$ , is part of her. Simons explains our reticence towards such a mereological claim by saying that  $m$  is really not a part of Maxima. Whereas some biologically relevant relation, no matter how complex, welds together the head and the left lung,  $m$  does not enter any such relation: indeed, no book of physiology will ever mention an object like  $m$  to play any role in the events sustaining the life of organisms. In other words, the head and the left lung do not compose under any welding relation. Thus,  $m$  does not exist, and *a fortiori*  $m$  is not a part of Maxima. Of course, Simon' account is in contrast with CEM since it comes with a principle of restricted composition. Yet, suppose that the account is slightly modified by replacing such a principle with Unrestricted Composition. Simons would thus say that, although  $m$  indeed exists, it is not a part of Maxima. Suppose that is true. Given Strong Supplementation Principle, it follows that  $m$  has some part that is disjoint from Maxima. Of course, such a part cannot be either the head or the left lung. More generally, such a part cannot be a real part, for instance a cell or a protein. Arguably, any such part is included into a suitable plurality of objects standing in a welding biologically relevant relation, which ensures those objects compose some direct or indirect part of Maxima. Then, the part we are searching for must be unnatural or unstructured, for instance an arbitrarily carved piece of nervous tissue, call it  $p$ . After all,  $m$  is an unnatural entity as well (it is just the fusion of two structured entities), and there seems to be no problem in claiming that unstructured entities can be arbitrarily decomposed into unstructured parts. However, is  $p$  really disjoint from Maxima? Notice that  $p$  has in turn parts: it has, of course, many unstructured parts, such as its top and bottom halves. However, there is no

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<sup>151</sup> Just consider that any plurality including two or more overlapping objects would be excluded from the composing ones due to the conditions imposed on the relata of welding relations.

reason why  $p$  should not be regarded as the fusion of a certain plurality of natural mereological atoms. But then, consider Maxima again. According to Simons, her parts are those entities which are ‘welded’ together by her vital processes. Among such parts, there is her head. Maxima’s head is of course a natural whole on its own. Thus, it has in turn parts, which are again entities standing in the appropriate welding relation. By repeating this pattern, we must finally arrive at a bottom level, which arguably consists of a plurality of mereological atoms welded such-and-such. By transitivity of parthood and the definition of composition, it follows that these atoms are parts of Maxima as well. But then,  $p$  and Maxima overlap, thus *a fortiori*  $m$  and Maxima, *contra* Strong Supplementation.<sup>152</sup>

Hence, the present proposals fail to deliver an account of real parthood that is compatible with CEM, and thus they are unfit for carving out parts of hylomorphs in the context of APN. Let us now consider the reductive account proposed by Baker (2007, 2008). Differently from the authors above, Baker explicitly accepts CEM in its entirety. Also, she claims her theory to be compatible with Mereological Essentialism. She rejects the more subtle ideological claim according to which there is just one legitimate notion of parthood. She regards the parthood relation coming from CEM as abstract and largely detached from the ordinary world, to the point that she claims «when mereologists utter what sounds like the English word ‘part’, they are not referring to parts of ordinary things» (Baker 2007, 187). Consequently, she distinguishes between a philosophical and a real notion of parthood. While the philosophical notion obeys the axioms of CEM, there is not a formal theory regulating the real notion of parthood. Still, there is an intimate relation between them, in that real parthood is defined by means of philosophical parthood.

The real notion of parthood captures the genuine articulations of ordinary objects and, relatedly, the true way in which the word ‘part’ is used in English. Like Simons, Baker wishes to distinguish natural wholes from gerrymandered ones. Differently from him, though, she does not delimit the scope of mereology to the former (by rejecting Unrestricted Composition): quite the contrary, she claims the relations between natural whole and their ‘parts’ to be no instances of the mereological parthood relation. Her definition reduces genuine parthood to mereological parthood and material constitution:

$x$  is a real part of  $y$  at  $t$  =<sub>def</sub>  $\exists z(x \neq z \wedge Pxz \wedge Czyt)$  (Baker 2007, 187)

According to the present definition,  $x$  is a real part of  $y$  at  $t$  if and only if  $x$  is part of the fusion that constitutes  $y$  at  $t$ . Take a table  $y$  at time  $t$ . The table is constituted (thus not identical with) at  $t$  by the fusion  $z$  of four legs and a tabletop. Since the leg  $x$  is a (timeless, mereological, proper) part of the

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<sup>152</sup> The same argument, with a slight modification to highlights the causal factors, show that the same incompatibility strikes the Gillett-Glennan account as well.

fusion  $z$ , it follows that  $x$  is part of  $y$  at  $t$ . Baker's definition of real parthood is interesting. First, her definition introduces a temporally-indexed parthood predicate without altering the language of mereology: the philosophical parthood predicate is still 'pure'. Such a choice makes Mereological Essentialism much more natural and appealing. Second, since her definition is reductive, the introduction of the real notion of parthood does not expand the ideology of Baker's theory.<sup>153</sup>

As a first remark, it is at the very least curious that Baker's definition cannot offer a transitive relation (as she herself acknowledges: Baker 2007, 189). She really wishes to define a 'pure' parthood predicate, but the vast majority of philosophers generally agree on taking philosophical parthood as a relation strictly stronger than a partial order.<sup>154</sup> Particularly, the violation of transitivity may open up very controversial and unintuitive metaphysical scenarios (see the discussions in Lando 2017, Varzi 2016, and Varzi and Cotnoir forthcoming). If transitivity is really a basic property of parthood relation, then Baker's definition may be either regarded as a definition of (some kind of) selective parthood, or as a definition of a relation that is ultimately not a parthood relation, or simply as unacceptable. In any case, Baker may simply reply that the ordinary use speakers make of 'part' is strictly incorrect, and thus advancing an error theory for ordinary mereological claims.

More seriously, it seems that Baker's theory straightforwardly fails to account for real parts of ordinary objects in the way she means. Consider again the table and the tabletop, which is a real part of the table at  $t$ . By Baker's definition of real parthood, it follows that the tabletop is a proper part of the fusion which constitutes the table at  $t$ . Let us call such a fusion  $f_1$ : it is the fusion, say, of the tabletop and the legs. Take now the fusion of all the atoms constituting the legs and the tabletop and call it  $f_2$ .  $f_2$  constitutes the table at  $t$  as well: indeed, Baker remarks that «an object with parts is constituted by the sum of all the sums that constitute the parts of that object» (Baker 2007, 190). Now it must be the case that either (i)  $f_1 = f_2$ , or (ii)  $f_1 \neq f_2$ . Suppose (i). Given Extensionality of Proper Parts,  $f_1$  and  $f_2$  must have the same proper parts, which is clearly not the case. Just consider that atoms are not part of the tabletop, but rather part of a fusion that constitutes, at a time, the tabletop. Then (ii) must be true. In such a case, the table would result to be constituted by two (indeed, by a much higher number of) different aggregates at the same time.<sup>155</sup> Moreover, all such aggregates would ultimately consist of the very same atoms. What is worse for Baker's theory, however, is the following problem. Consider the half left of  $f_2$ , call it  $h$ .  $h$  is a part of  $f_2$ . Suppose otherwise: given Strong Supplementation Principle, it follows that  $h$  has some part disjoint from  $f_2$ , which clearly is not the

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<sup>153</sup> For the distinction between ontology and ideology, the classical reference is Quine (1951).

<sup>154</sup> The substantive discussion rather concerns composition and decomposition principles. As Simons claims, «there are many partial orderings which we should never call part-whole systems» (Simons 1987, 26).

<sup>155</sup> The most charitable interpretation of Evnine (2011, 232) is that he takes such a claim to be false: at every time at which it exists, exactly one fusion must materially constitute the table.

case. Since the table is also constituted by  $f_2$  at  $t$ , and  $h$  is different from  $f_2$ , it follows that  $h$  is a real part of the table at  $t$ : but this is false. Since the main aim of Baker's theory is precisely to avoid such claims of real parthood, we must conclude that not only her account ends up multiplying constituting aggregates without necessity but also carving out real parts of ordinary objects in precisely the way it was meant to avoid.

The two kinds of approaches we have considered point to interesting features for the real parthood relation to have. The first approach aims to individuate, given an individual, which entities can be regarded as its (proper) parts on specific grounds (particularly, causal-functional considerations), and then construe such an individual as the mereological fusion of those entities. The rationale of the second approach is instead to carve out real parts of objects by introducing a new parthood relation, that only those real parts should be able to satisfy. This way, the 'pure' mereological predicate is preserved, while the relevant intuitions about the mereology of hylomorphs satisfied. However, the first approach is provably at odds with CEM, thus unsuitable for APN, while the second one just does not manage to provide a satisfactory definition of real parthood. I will now advance a further approach, by revising a definition provided by Sattig (2021). With some slight revisions, Sattig's approach seems to provide the best of both worlds. Like the first one, it constraints real parts to objects that satisfy specific conditions. Like the second one, it allows retaining the fundamental mereological parthood predicate, and the consistency of CEM.

Sattig aims to provide a characterisation of the structure of objects in terms of slots. Like hylomorphists, he takes the primary kind an object belongs to as determining which kinds of parts it can have as well as which relations can hold between its parts. The primary kind of an object determines a number of slots. There are both monadic and polyadic slots, that can be occupied by the object's parts; and polyadic slots represent the relations that can hold between the object's parts. Each monadic slot encodes a kind; each polyadic slot encodes a relation. Accordingly, he defines parthood relation, which he takes to be temporally-indexed, as slot-filling (at a time). Next, Sattig further reduces slot filling in terms of essences, grounding relations, and subregionhood. Let us just focus on his definition of *filling a monadic slot at a time*:

$x$  fills a K-slot of  $y$ , at  $t$  =<sub>def</sub>

- (i)  $x$  is a K, at some region  $p$ , at  $t$ ,
- (ii) there is a kind  $K^*$ , such that  $y$  is a  $K^*$ , at some region  $p^*$ , at  $t$ ,
- (iii)  $x$  is essentially a K, while  $y$  is essentially a  $K^*$ ,
- (iv) the fact that some object is a K, at  $p$  at  $t$ , partially grounds the fact that some object is a  $K^*$ , at  $p^*$ , at  $t$ ,

(v)  $p$  is a subregion of  $p^*$

Such a relation is then used to reduce proper parthood (at a time):

$x$  is a proper part of  $y$ , at  $t =_{\text{def}} x$  fills one of  $y$ 's slots, at  $t$

Sattig's account assumes that kinds are instantiated relatively to spatial regions and times. For every  $x$ , if  $x$  instantiates  $K$ , at the region  $p$ , at  $t$ , the region  $p$  will be the exact location of  $x$ .<sup>156</sup> Moreover, the subregionhood relation at clause (v) must obviously not be parthood. Lastly, proper parthood inherits the temporal index from slot filling, and thus allows things to change with respect to their proper parts over time.

Let us begin by noticing that Sattig's definition is at odds with Unrestricted Composition in a way that resembles Gillett's and Glennan's account: both the accounts indeed fail to adequately manage the parts of unnatural fusions. Surely Sattig countenances cars and ducks, inasmuch as objects belonging to real kinds. Now take a car  $c$  and a duck  $d$ . Unrestricted Composition would commit him to the existence of the fusion of  $c$  and  $d$  too, say  $e$ . Clearly,  $e$  does not belong to any real kind. First problem: given clause (i) in Sattig's definition,  $e$  could not be a proper part, at a time, of anything, contravening Unrestricted Composition in any domain in which there is an object disjoint from  $e$ . Second problem: to belong to a real kind is a minimal requirement for any whole to have a proper part, at a time, according to clause (ii) in Sattig's definition. It would thus follow that  $e$  has not proper parts (at any time). However,  $c$  and  $d$  are proper parts of  $e$ , by the very definition of mereological fusion (proviso that  $c \neq d$ ). Therefore, Sattig's definition is incompatible with CEM on the grounds that Unrestricted Composition implies the existence of unnatural objects.

Although Sattig's definition does not pick out the meaning of proper parthood as axiomatized by CEM, it is certainly promising as a definition of *real* parthood, at a time. In fact, it features a number of conditions that seem to deliver the intended meaning of real parthood. First, instances of real parthood are sensitive to the kinds of the relata. As Sattig remarks, this principle captures the mereological intuition that whether a thing,  $x$ , is a proper part of a given material object depends on what kind of thing  $x$  is (Sattig 2021). Not everything 'contained' in a whole has to be a part of it. For instance, although all four the tyres are parts of the car, their fusion is not; similarly, the matter constituting a tyre is not a part of the car, even though the tyre is.<sup>157</sup> Wholes are dissected into real parts belonging to the right kinds rather than arbitrarily. Second, such an intuition is substantiated by a clause expressing a clear way in which parts are not 'just there' but actually contribute to the realisation of the whole. Particularly, the interaction lies in taking such a contribution to be kind-

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<sup>156</sup> Sattig's account thus rejects Functionality.

<sup>157</sup> See also Fine (1999, 73).

relative: given an object  $x$ , its real parts, inasmuch as belonging the appropriate kinds and being appropriately located, ground the fact that  $x$  is of the kind it is and appropriately located where it is. Notice that also Simons must end up taking the contribution as kind-relative, at least partly. Simons carves real parts out of material objects by pointing to their causal-functional roles within the individuals (Simons 2006, 609). Those parts compose a whole by collectively instantiating the appropriate welding relations. Moreover, since the causal-functional role of an individual arguably depends, at least partially, on the kind the individual belongs to,<sup>158</sup> the kind of real parts becomes relevant for their carving, and thus their contribution to the whole kind-relative. Still, the present grounding condition is more general than Simons's, in that it does not require any causal-functional contribution from the real parts to their whole: it just requires that the instantiation of a certain kind at a region partly explains the instantiation of a certain kind at a nearby (appropriate) region.<sup>159</sup> Third, the last clause grants that real parts must be located within the whole. That the location of parts does not outstrip the location of their whole, proviso that both parts and wholes have a location, is surely a basic desideratum of any theory of real parthood. Fourth, by distinguishing between *mediate* and *immediate* grounding<sup>160</sup> in clause (iii) it can make sense of the distinction between mediate and immediate proper parts of objects. For instance, my heart is an immediate part of mine, while a specific heart cell is a mediate part of mine, inasmuch as an immediate part of my heart. Sattig's definition captures this distinction by saying that, while the fact that there is a heart, at a certain region, at a time, immediately grounds the fact that there is a human being, at a nearby region, at the same time, the fact that there is a heart cell, at a region, at the same time, immediately grounds the former fact, and only mediately the latter.

I endorse Sattig's definition of proper parthood at a time, but I take it to be a definition of *real parthood at a time*. I still consider the fundamental parthood relation to be the one CEM axiomatizes, and I take it as a primitive relation. Still, I think we should get rid of Sattig's assumption that objects instantiate kinds relatively to spatial regions and times. Indeed, such an assumption contrasts with the

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<sup>158</sup> We have already considered that several philosophers agree on this claim (e.g., Gillett 2016, Glennan 2021, Kaiser 2018, Koslicki 2018). And indeed, when Simons explains, for instance, why the heart is a real part of an organism, he does so by pointing out many properties and behaviours that are typical of hearts.

<sup>159</sup> Simons's account may very well say something substantive about what grounds the holding of particular instances of clause (iv). Take again the case of the helium nucleus. According to the present account, the electron is a real part (at a time) of the helium nucleus also because the fact that there is an electron at a certain spatiotemporal region partly grounds the fact that there is a helium nucleus at a nearby (appropriate) spatiotemporal region. Facts concerning causal-functional considerations or perhaps the welding relations at stake can then be pointed out as what ground the grounding fact itself. For instance, the whole grounding fact <the fact that there is an electron at a certain spatiotemporal region partly grounds the fact that there is a helium nucleus at a nearby (appropriate) spatiotemporal region> would be at least partially grounded in a fact like <an electron at a certain spatiotemporal region exchanges gluons with other specific particles at some spatiotemporal regions nearby>. In other words, the truth of Simons's claim that «there is no formal recipe for delimiting the [real] parts of a whole» (Simons 2006, 609) would be recovered if we took Simons as claiming that there is no formal recipe for stating what grounds the grounding claim in (iv), for any kind of whole.

<sup>160</sup> See Fine (2012).

claim, widely endorsed by philosophers with essentialistic inclinations, that objects fundamentally instantiate their essential properties *simpliciter* (see Bottani 2020, Fine 2005). The fact that an object  $x$  instantiates one of its essential properties  $P$  relatively to a spatial region  $r$  (arguably its exact location) and a time  $t$  follows from the fact that  $x$  is  $P$  *simpliciter* and the fact that  $x$  is exactly located at  $r$  and exists at  $t$ . Thus, I will modify clauses (i) – (iv) accordingly. Moreover, since we are no longer defining it, we can use parthood relation to account for subregionhood relations between regions, as it is indeed customary among contemporary metaphysicians (e.g., Calosi 2014, Casati and Varzi 1999, Gilmore 2018, Loss 2019a, forthcoming-a, Parsons 2007). Of course, since APN is compatible with both 3D-End and 4D-End, the very same definition must be differently formulated with a particular care on the locative notions at stake. The following definition is suitable for For 3D-End APN:

$x$  is a real part of  $y$ , at  $t =_{\text{def}}$

- (i)  $x$  is a  $K$ , at  $t$ , and is Exactly located at  $p$
- (ii) there is a kind  $K^*$ , such that  $y$  is a  $K^*$ , at  $t$ , and  $y$  is Exactly located at  $p^*$
- (iii)  $x$  is essentially a  $K$ , while  $y$  is essentially a  $K^*$ ,
- (iv) the fact that some object is a  $K$ , at  $t$ , and is Exactly located at  $p$  partially grounds the fact that some object is a  $K^*$ , at  $t$ , and is exactly located at  $p^*$
- (v)  $p$  is a part of  $p^*$

As for the 4D-End formulation, let us define the notion of Instantaneous Location: the  $t$ -instantaneous location  $r$  of  $x$  is the mereological product of  $x$ 's exact location  $s$  and temporal instant  $t$ , where  $t$  is construed, in a unitistic fashion, as an instantaneous slice of the world:<sup>161</sup>

$$IL_t(x, r) =_{\text{def}} \text{ExL}(x, s) \wedge \forall z(\text{Pz}r \leftrightarrow \text{Pz}t \wedge \text{Pz}s)$$

In other words,  $x$  is  $t$ -instantaneously located at the  $t$ -slice of its four-dimensional exact location.

$x$  is a real part of  $y$ , at  $t =_{\text{def}}$

- (i)  $x$  is a  $K$  and is  $t$ -instantaneously located at  $p$ ,
- (ii) there is a kind  $K^*$ , such that  $y$  is a  $K^*$  and  $y$  is  $t$ -instantaneously located at  $p^*$ ,
- (iii)  $x$  is essentially a  $K$ , while  $y$  is essentially a  $K^*$ ,
- (iv) the fact that some object is a  $K$  and is  $t$ -instantaneously located at  $p$ , partially grounds the fact that some object is a  $K^*$  and is  $t$ -instantaneously located at  $p^*$ ,

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<sup>161</sup> See again Gilmore, Costa and Calosi (2016). The instantaneous slice of the world is a maximal collection of simultaneous spacetime points.

(v)  $p$  is a part of  $p^*$

While 3D-APN supports the possibility multi-location, and thus allows one object to have more than one exact location, 4D-APN endorses Functionality, and therefore denies the possibility of multi-location. Still, any theory endorsing Functionality of exact location can accept that persisting objects are instantaneously located at every temporal instant they span over.<sup>162</sup> Both the versions of the definition turn out appropriately indexed with respect to times, thus providing a notion of real parthood that leaves room for contingency and indeed is straightforwardly compatible with objects changing their real parts over time (and *a fortiori* across possible worlds). Recall instead that, according to Mereological Semantic Simplicity, mereological relations hold *simpliciter*. Moreover, both the versions retain the possibility to account for mediate and immediate proper parts of objects in terms of the mediateness of grounding relations, in accordance with clause (iv). Let us go back to the previous example of my heart. Both the versions manage to say that whereas the heart is an immediate real part of mine, at a time, the heart cell is merely a mediate real part of me, at a time. Parallely, both the versions manage to say that the left half of the heart is neither an immediate nor a mediate real part of me, at any time. That is so because such an entity does not belong to any real kind, being a mere portion of matter. Still, there is a clear relation between me and the left half of my heart, since it is a part *tout court* of the portion of matter that materially constitutes me at a time.

All in all, then, by taking Sattig's definition as a definition of real parthood at a time, we get a precise way to formally individuate real parts, at a time, of objects. Still, the definition employs the standard parthood predicate; moreover, inasmuch reductive, the real parthood at a time does not qualify as a fundamental mereological predicate. Hence, there is just one fundamental parthood relation, that relates objects *simpliciter*, and whose instances hold notwithstanding considerations on essential kinds, grounding, and location. While the former relation relates objects belonging to real kinds, thus hylomorphs, the latter one enjoys an absolute scope that makes it suitable to relate portions of matter and other unstructured entities. Hence, claims of real parthood concerning hylomorphs do not contravene APN's core claim that hylomorphs are atomic. Hylomorphs do not have parts, but they may have real parts at times.

#### 4.4 Double Weight? APN's Way Out of Overdetermination

Any multi-thingist account of material objects must also avoid a sneaky way of double counting property instances. Consider Lewis' complaint:

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<sup>162</sup> A perdurantist would say that  $x$  is  $t$ -instantaneously located at a region  $r$  iff  $x$ 's  $t$ -temporal part is exactly located at  $r$ .

It reeks of double counting to say that here we have a dishpan, and we also have a dishpan-shaped bit of plastic that is just where the dishpan is, weighs just what the dishpan weighs (why don't the two together weigh twice as much?), and so on. (Lewis 1986, 252).

(see also Zimmerman 1995, 87-88). A bit of plastic weighs, say, 5 kilos and the dishpan it constitutes weighs 5 kilos as well; however, in a relevant sense, there are not really *two* things weighing 5 kilos. Any multi-thingist account of material objects must say how hylomorphs and their matter can instantiate certain properties without redundancy, so to speak.

The double weight argument is indeed an instance of the more general issue of multi-thingism with overdetermination (as suggested by Árnadóttir 2015, 495-496). A (in)famous version of the overdetermination argument is due to Merricks (2001, 2017) and Korman (2015, 191) reconstructs it as follows:

1. Every event caused by a baseball is caused by atoms arranged baseballwise
2. No events caused by atoms arranged baseballwise is caused by a baseball
3. So, no events are caused by baseballs
4. If no events are caused by baseballs, then baseballs do not exist
5. So, baseballs do not exist

The main inferential drive of the present argument is premise 2, which is justified by overdetermination concerns. Given the very plausible premise 1, baseballs and pluralities of atoms cannot jointly co-cause any event on pain of overdetermining it. Since overdetermination is undesirable, either baseballs or pluralities of atoms must go; and the choice falls on baseballs, since their existence rests on more shaky grounds than that of their composing atoms, at least from a metaphysical point of view.

It is easy to revise the previous argument to make it an argument against multi-thingism. Consider the following version of the argument:

- 1\*. Every event caused by an hylomorph is caused by its constituting portion of matter
- 2\*. No events caused by a portion of matter is also caused by the hylomorphic it constitutes
- 3\*. So, no events are caused by hylomorphs
- 4\*. If no events are caused by hylomorphs, then hylomorphs do not exist
- 5\*. So, hylomorphs do not exist

Clearly, Lewis's double weight argument is an instance of 1\*-5\*, in that mass properties are powerful properties that bestow on their bearers the power to participate in certain events, such as indeed pressing a balance. Consider again the dishpan and the bit of plastic constituting it. A popular multi-

thingist answer to Lewis’s argument appeals to their mereological structure. The dishpan and the bit of plastic have the same weight because they have a common decomposition: for instance, they are composed by the same plurality of fundamental particles. Consequently, the facts about their mass properties would be fully reducible to the very same plurality of facts about the mass properties of those particles. Multi-thingers may very well accept such an explanation while simply rejecting Uniqueness of Composition (e.g., Lowe 2001, 2003).

Enter the argument 1\*-5\*. The dishpan and the bit of plastic do not weight twice as much because they share a decomposition, and thus 1\* is very plausibly true: they can causally bring about all and the same events (among which there are events of pressure on balances). But then, on pain of overdetermination, either the dishpan or the bit of plastic should result causally inefficacious, and thus non-existent by 2\*. At this point, one-thingers may remark that the identification of the two objects would solve the overdetermination problem, including the double weight problem, without giving up the existence of any of them.<sup>163</sup> In other words, the one-thinger would reject 2\* on the grounds of the identity between the dishpan and the bit of plastic. On the contrary, multi-thingers cannot reject 2\* without ending up endorsing widespread causal overdeterminacy. At the very least, any multi-thingist account of material objects must *illustrate* why the resulting kind of overdetermination is not unacceptable.

#### 4.4.1 Transdurantist APN and Baker’s Theory of Derivativeness

I think the best strategy for APN to satisfactorily answer the overdetermination argument is by introducing a derivative way for objects to instantiate some of their properties. Such a theory was first developed by Baker (2000, 2007, 2008), who applied it to her 3D-End version of APN. According to her theory, there are many kinds of properties that constituted entities instantiate *derivatively* because that their constituting portions of matter instantiate *nonderivatively*, and vice versa. In other words, Particularly, a constituted entity and its constituting portion of matter share every property with the exclusion of those belonging to the following categories:

- i. alethic properties and their variants. This category includes properties expressed by the operators ‘necessarily’, ‘essentially’, as well as properties featuring the expression ‘primary-kind’,<sup>164</sup>
- ii. identity, constitution, and existence properties

<sup>163</sup> Despite definitely unpopular, further monistic strategies are available. For instance, the dominant kind theory of Burke (1992, 1994) would reject the existence of the bit of plastic, inasmuch it is ‘dominated’ by the dishpan. For a criticism of Burke’s theory, though, see Barker and Jago (2014, 4-5).

<sup>164</sup> «For any *x*, we can ask: What most fundamentally is *x*? The answer will be what I call *x*’s ‘‘primary kind.’’ Everything that exists is of exactly one primary kind – e.g., a horse or a passport or a cabbage» (Baker 2007, 33).

iii. properties rooted outside the time that they are had.<sup>165</sup>

iv. conjunctive properties whose at least one conjunct belongs to i, ii, or iii.

She names the properties belonging to these kinds *excluded properties*. Of course, since hylomorphs must be atomic while their constituting portions of matter need not, mereological properties must be included among the excluded properties. This should not be concerning, since the very relation of identity is reducible to mereological relations in CEM (Smid 2017b). Thus, given CEM, mereological properties belong to the second category above, and therefore figure among excluded properties. Then, she defines the notion of ‘having a property at  $t$  independently of constitution relations at  $t$ ’:

$y$  has  $H$  at  $t$  independently of  $y$ ’s constitution relations to  $x$  at  $t$   $\equiv_{\text{def}}$

a)  $H$  is not an excluded property; and

b)  $y$  has  $H$  at  $t$ ; and

c) Either

1. (i)  $y$  constitutes  $x$  at  $t$ , and (ii)  $y$ ’s having  $H$  at  $t$  (in the given background) does not entail that  $y$  constitutes anything at  $t$ ; or
2. (i)  $x$  constitutes  $y$  at  $t$ , and (ii)  $y$ ’s having  $H$  at  $t$  (in the given background) does not entail that  $y$  is constituted by something that could have had  $H$  at  $t$  without constituting anything at  $t$

This notion allows Baker defining two ways for objects to have properties at a time: derivatively and nonderivatively. Property instantiation always turns out adverbially typed:

$x$  has  $H$  at  $t$  derivatively  $\equiv_{\text{def}}$

a)  $H$  is not an excluded property; and

b) There is some  $y$  such that:

1.  $y$  has  $H$  at  $t$  independently of  $y$ ’s constitution relations to  $x$  at  $t$ ; and
2. it is not the case that:  $x$  has  $H$  at  $t$  independently of  $x$ ’s constitution relations to  $y$  at  $t$

$x$  has  $H$  at  $t$  nonderivatively  $\equiv_{\text{def}}$

a)  $x$  has  $H$  at  $t$ ; and

b) Either

1.  $H$  is an excluded property; or

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<sup>165</sup> Baker’s own example of such properties is *was in the quarry yesterday*. On such properties see Chisholm (1976, 100).

2. There is no  $y$  such that (i)  $y$  has  $H$  at  $t$  independently of  $y$ 's constitution relations to  $x$  at  $t$ , and (ii) it is not the case that:  $x$  has  $H$  at  $t$  independently of  $x$ 's constitution relations to  $y$  at  $t$

Notice that every excluded property is instantiated nonderivatively. In other words, the fact that any object instantiates an excluded property is never a matter of material constitution. As far as non-excluded properties are concerned, the fact that an object exemplifies a property derivatively will depend on the fact that it is constitutionally related to some other object that happens to exemplify that property nonderivatively; otherwise, it will exemplify that property nonderivatively. Alloy, for instance, has certain mass and chromatic properties nonderivatively, since Alloy, say, weighs 100 kilos and is white arguably in virtue of a plurality of facts concerning the mass and chromatic properties of its parts, together with the fact that those entities together compose Alloy. Differently, Statue has such mass and chromatic property derivatively, in virtue of being materially constituted by Alloy.

The present theory of instantiation allows Baker offering a solution to the overdetermination problem (Baker 2000, 176-177). Let us consider again the overdetermination argument against multi-thingism:

- 1\*. Every event caused by an hylomorph is caused by its constituting portion of matter
- 2\*. No events caused by a portion of matter is also caused by the hylomorphic it constitutes
- 3\*. So, no events are caused by hylomorphs
- 4\*. If no events are caused by hylomorphs, then hylomorphs do not exist
- 5\*. So, hylomorphs do not exist

In the case of a baseball shattering a window, its constituting matter shatters the window because it has the right causal property  $H$ . She claims the fact that the baseball shatters the window just *is* the fact that its constituting matter shatters the window *and* that the baseball is materially constituted by the portion of matter (at the relevant times) (Baker 2000, 177). In other words:

If  $x$  has  $H$  derivatively, then there are not two independent instances of  $H$ : for  $x$ 's having  $H$  is entirely a matter of  $x$ 's having constitution relations to something that has  $H$  nonderivatively (Baker 2000, 177)

Given Baker's theory of property instantiation, then, 2\* turns out false. However, it is not clear what the relation between the facts at stake is meant to be. It cannot be identity: it seems to me that is simply wrong to identify the facts <the portion of matter  $y$  has  $H$  at  $t$ > and <the baseball  $x$  has  $H$  at  $t$  and  $x$  is materially constituted by  $y$  at  $t$ >. For instance, suppose that two facts are identical iff they

exist in all and the same possible worlds.<sup>166</sup> Since  $y$  can surely be  $H$  at  $t$  without constituting anything, the two facts end up being different. Still, we may save Baker's narrative by construing the relevant relation between the relevant facts as grounding relations. For instance, we may say that, for every causal property  $H$  of the portion of matter, the fact the portion of matter has  $H$  at a time is fully grounded in a plurality of facts concerning the simples composing the portion of matter and their causal properties at that time. Then, we come to baseball: for every causal property of the baseball, the fact the baseball has that causal property at a time is fully grounded in the plurality of facts {<the portion of matter has that causal property at that time>, <the portion of matter materially constitutes the baseball at that time>}. Hence, the fact that the baseball is  $H$  at  $t$  is fully grounded in the plurality of facts consisting in (i) the fact that the portion of matter has  $H$  at  $t$ , and (ii) the fact that the portion of matter materially constitutes the baseball at  $t$ . Moreover, the fact (i) would be fully grounded in a plurality of facts concerning the simple composing the portion of matter; and the transitivity of grounding would ensure that such facts would partly explain why the baseball is  $H$  at  $t$ .<sup>167</sup> Baker's claim that there are not two independent instances of  $H$ , where  $H$  is the causal property an object has derivatively at a time, would be thus substantiated by such a grounding chain between facts concerning the simples composing the portion of matter and their properties, and facts concerning relations of material constitution. Therefore, the supposed overdetermination fades away if we look at the causal process more deeply.

Baker's theory of derivativeness thus ensures that the 3D-End version of APN has an answer to the argument from overdetermination. Moreover, it also explains, at least partially, why a hylomorph and its constituting portion of matter are so alike in many respects. Interestingly, though, APN is compatible with four-dimensional endurantism too: both extensional portions of matter and hylomorphs are *wholly present*, in the relevant, mereological-locative sense, at every instant of their existence. Of course, the transdurantist version of APN still retains the same two problems of its 3D-End counterpart: it must make sense of property inheritance between hylomorphs and their constituting portions of matter and also tell a story about causal overdetermination. Two main theories attempt to make sense of the heterogeneity of extended simples: Parsons's distributional properties and Ehring-McDaniel's spatiotemporally-indexed tropes.<sup>168</sup> In the present case, a straightforward endorsement of these strategies is not enough, though. APN is a multi-thinger theory of material objects: hence, it also needs a theory stating which properties hylomorphs and their matter share. In what follows, I first show how an endorsement of distributional properties should be supplemented

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<sup>166</sup> As for the Modal Criterion for the identity of facts. See Correia (2020).

<sup>167</sup> A full explanation would still need the fact (ii) concerning the relation of material constitution at the relevant time.

<sup>168</sup> We have already considered and put aside Markosian's (1998) theory in section 2.4.1, inasmuch unable to deliver a result in specific scenarios concerning material constitution.

in order to make sense of property inheritance between hylomorphs and their matter. Secondly, I do the same with spatiotemporally-indexed tropes, by developing a slight variation of Baker's theory of derivativeness. Thirdly, I will show how spatiotemporally-indexed tropes can get rid of charges of causal overdetermination, when a (nowadays rampant) metaphysics of causation is in the background.

Any scenario in which the relevant portions of matter and the hylomorphs have non-fully overlapping careers illustrates the inadequacy of distributional properties with regard to the tasks they should fulfil for APN. Consider, for instance, the following scenario. On Monday, there is a spheric portion of clay C in the study of an artist. On Tuesday, the artist carves a statue S of a cat out of it. Hence, it happens that C constitutes S at a spatiotemporal region *r*. On Wednesday, the artist notices that she forgot to mold the whiskers: she removes a tiny piece of S, let us say from the tail, creates some whiskers from it, and attach them to the muzzle of the statue. S clearly survives this change of shape, as well as C (suppose no particle at all is lost in the process). On Sunday, though, the artist, unsatisfied by the result, chooses to squash S. This time, S does not survive the change in shape. Nevertheless, C surely does.

By endorsing distributional properties, together with Baker's idea of derivative instantiation of properties, an APNist should say that S instantiates many temporally non-uniform distributional properties derivatively, that is, in virtue of its constitution relation with C at the relevant times. Accordingly, C should instantiate such properties nonderivatively.

However, the theory of distributional properties, as it is, simply lacks the equipment to furnish such an explanation of property inheritance. Consider the shape property of S. It would be something like *having the shape of a cat without whiskers on Tuesday and having the shape of a cat with whiskers on Sunday*. Intuitively, on any account of property inheritance, C should turn out to have such a distributional property nonderivatively. The issue here is that C does not have that property at all! In the mentioned scenario, C pre-exists and outlives S: C existed on Monday and presumably will exist the subsequent Monday too, whereas S' career spans from Tuesday to Sunday.

Hence, C has a temporally non-uniform shape distributional property different from that of S. Intuitively, the shape distributional property of S is 'contained' within the shape distributional property of C. However, recall that distributional properties qualitatively characterise objects throughout their dimensions and are also fundamental. Distributional properties lack any kind of structure altogether: they are not conjunctions of simpler properties (but rather the contrary). If distributional properties were conjunctions of simpler properties, then we could capture the intuition of containment by stating that the shape property of C is a conjunction of all the conjuncts defining S, plus further properties. This is illegitimate, though, given the fundamental and not-conjunctive

nature of distributional properties. In our scenario, C has a distributional property that S simply lacks and vice versa, and we can say nothing more about them.

Nevertheless, the theory of distributional properties can be supplemented by considerations that allow recovering a meaningful way to regard some material objects as having some of their properties derivatively. Consider again the example above concerning C and S. Let us call the distributional property characterising C's shape throughout its career  $D_1$ , and the distributional property *having the shape of a cat without whiskers on Tuesday and having the shape of a cat with whiskers on Sunday*, which characterises instead S's shape throughout its career,  $D_2$ . It seems intuitively true to claim that the two facts  $\langle C \text{ has } D_1 \rangle$  and  $\langle C \text{ is the matter of } S \text{ (at the relevant times)} \rangle$  jointly ground the fact  $\langle S \text{ has } D_2 \rangle$ . In other words, the fact that S has the distributional shape property it has depends on the fact that C has an appropriate distributional shape property and materially constitutes S throughout the relevant temporal interval. Hence, S has its particular distributional shape property derivatively, in virtue of being materially constituted by something which has a (eventually different) distributional shape property. Of course, the present sense of 'derivatively' would differ from Baker's original one. Baker's theory basically explains facts concerning having a property derivatively by stating that either the constituted inherits the property by the constituee or vice versa. In the present case, though, having a property derivatively is accounted in terms of a fundamental relation between distributional properties (together with an appropriate instance of material constitution relation). Logically, the number of such fundamental relations must be enormous. Suppose you scratch a bronze statue with some sandpaper. During the process, many different portions of matter would suddenly replace one other, due to the continuous loss of parts. However, each of those portions of matter would instantiate some distributional shape property, and the statue would happen to have its specific distributional shape property also in virtue of the fact that each of those portions of matter has the distributional shape property it has.

Hence, although it may still be possible to account for materially constituted objects having some of their properties derivatively, the systematic appeal to fundamental relations between distributional properties would burden the theory with notable ideological costs. Notice that the issue arises as a tension between two theoretical tenets. On the one hand, the fundamentality of distributional properties and therefore their lack of internal structure. On the other hand, the multi-thingist desideratum according to which constituting and constituted objects' careers do not need to be always perfectly overlapping. Therefore, multi-thingers may be looking forward to a more malleable account of properties in order to make sense of property inheritance between portions of matter and hylomorphs.

In contrast, the Ehring-McDaniel account of heterogeneity of extended simples by means of exemplification of spatiotemporally-indexed tropes proves much more promising for APN. Recall that the idea is exploiting an analysis such as « $x$  is  $F$  at  $t$  if and only if there is an  $F$ -trope that exists at  $t$  and  $x$  exemplifies it» (McDaniel 2009, 327), where the temporal parameter is replaced by a spatiotemporal parameter. Spatiotemporally-indexed tropes can be exemplified by extended simples as well as extended complexes. Thus, an analysis of property ascriptions in terms of exemplification of spatiotemporally-indexed tropes suits well the ontological worldview of APN.<sup>169</sup>

Hylomorphs and portions of matter exemplify spatiotemporally-indexed tropes. Nevertheless, hylomorphs exemplify many of their tropes derivatively, *because* their constituting portions of matter exemplify them nonderivatively. In other words, hylomorphs inherit many of their tropes from the portions of matter that constitute them. A tuned version of Baker's theory of derivativeness can account for property inheritance:

$y$  exemplifies  $H$  independently of  $y$ 's constitution relations to  $x$  at  $t =_{\text{def}}$

- a)  $H$  is not an excluded property; and
- b)  $y$  exemplifies  $H$ ; and
- c) Either

1. (i)  $y$  constitutes  $x$  at  $t$ , and (ii)  $y$ 's exemplifying  $H$  (in the given background) does not entail that  $y$  constitutes anything at  $t$ ; or
2. (i)  $x$  constitutes  $y$  at  $t$ , and (ii)  $y$ 's exemplifying  $H$  (in the given background) does not entail that  $y$  is constituted by something that could have exemplified  $H$  without constituting anything at  $t$

$x$  exemplifies  $H$  derivatively  $=_{\text{def}}$

- a)  $H$  is not an excluded property; and
- b) There is some  $y$  such that:

1.  $y$  exemplifies  $H$  independently of  $y$ 's constitution relations to  $x$  at  $t$ ; and
2. it is not the case that:  $x$  exemplified  $H$  independently of  $x$ 's constitution relations to  $y$  at  $t$

$x$  exemplifies  $H$  nonderivatively  $=_{\text{def}}$

- a)  $x$  exemplifies  $H$ ; and
- b) Either

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<sup>169</sup> Notice that, according to the present view, trope exemplification is primitive. Thus, it contrasts with the reduction of trope exemplification to parthood, customary for many bundle theorists (see Ehring 2011, Maurin 2002, Williams 1953, 1953b). Nevertheless, consider that, given Mereological Essentialism, the reduction of trope exemplification to parthood is utterly implausible (on pain of taking objects to be, to the very least, qualitatively unchanging).

1. H is an excluded property; or
2. There is no  $y$  such that (i)  $y$  exemplifies H independently of  $y$ 's constitution relations to  $x$  at  $t$ , and (ii) it is not the case that:  $x$  exemplifies H independently of  $x$ 's constitution relations to  $y$  at  $t$

Since tropes themselves are, inasmuch as ways things are, spatiotemporally-indexed, trope exemplification obtains *simpliciter*. Indeed, the fact that exemplification obtains *simpliciter* is coherent with McDaniel's characterisation. Still, a temporal parameter remains with regards to the relation of material constitution: of course, if relations can be construed as tropes as well, and particularly as tropes according to McDaniel's characterisation, then the temporal parameter would be redundant here as well. Moreover, I maintain the clause concerning excluded properties. However, it would arguably be dropped by anyone who endorses a sparse theory of tropes, such as Campbell (1990) and Heil (2003). Since nothing relevant for APN seems to depend on this aspect of the underlying theory of tropes, I will leave the issue aside.

Consider again C: it has certain mass, chromatic, volume properties, and so forth. Spatiotemporally-indexed tropes intrinsically fully characterise C. Suppose C is half black and half white: particularly, C is white at  $r_1$  and black at  $r_2$ . Given the present account of properties, there is a whiteness trope at  $r_1$ , a black trope at  $r_2$ , and C exemplifies them. Moreover, C exemplifies them independently of its constitution relation to S at  $t$ . First, those tropes do not fall within the category of excluded properties: they are plain qualitative and intrinsic properties. Second, in our scenario C exemplifies them by assumption. Third, C constitutes S at  $t$ , but the fact that C is half white and half black does not entail it: C may very well not constitute anything at that time. On the contrary, S does not exemplify them independently of its constitution relation to C at  $t$ : S's having certain chromatic properties entails S being constituted by a coloured portion of matter, which of course may be thus coloured and still not constitute anything at that time. Therefore, S is half black and half white derivatively. The same explanation holds, *mutatis mutandis*, in the former case of shape-changing objects. At every instant at which S exists, C has a particular shape. At each of those instants, C nonderivatively exemplifies an appropriate spatiotemporally-indexed trope. At each of those instants, S derivatively exemplifies the very same tropes exemplified by C. All in all, the Ehring-McDaniel trope-theoretical account of heterogeneous simples seems suitable to account for property sharing between portions of matter and hylomorphs, at least as well as Baker's original account in terms of properties.

However, there may be a problem lurking here. According to the primitivist trope theory here endorsed, tropes are better regarded as ways things are, Aristotelian individual accidents.<sup>170</sup> As such, they are often regarded as non-transferable: this condition is sometimes spelled out as the claim that tropes are rigidly existentially dependent on their bearers (Simons 1994, 2000a, though see Heil 2003, 141-142). *This whiteness here and now* is a way which C is, and differs from *this whiteness here\* and now\** of, for instance, a distinct portion of matter C\*. However, C materially constitutes S at some times, and S ends up having *this whiteness here and now* as well: how can this be the case, given that  $C \neq S$  and tropes are non-transferable? Given their non-transferability, Heil (2018, 2369) argues that tropes are unsuited for any brand of multi-thingism.

Nevertheless, APN offers a narrative that is compatible with the core of Heil's complaint. Tropes, inasmuch as ways things are, can be had derivatively or nonderivatively. Certain kinds of tropes, such as mass, volume, charge, spin, modify nonderivatively fundamental elements of reality, such as fundamental particles. Unrestricted Composition ensures the existence of many amorphous things, aggregates that I very generally regard as portions of matter or gerrymandered entities. These aggregates exemplify those tropes nonderivatively, in virtue of their parts exemplifying those tropes nonderivatively; still, only the appropriate parts exemplify those tropes *primarily*.<sup>171</sup> A portion of matter may then materially constitute a hylomorph: in such a case, the hylomorph will have the aforementioned tropes derivatively. Still, such a construction allows retaining the dependency of tropes on their bearers with just a minor revision. Tropes will be said to rigidly existentially depend on the objects they modify *nonderivatively* and *primarily*.

The present considerations suit well the claims that material constitution is unity without identity, sameness without identity, and a sort of third way between identity and numerical distinctness (Baker 2000, 2007, Rea 2011, Zangwill 2012). The colour of S is strictly identical with the colour of C; the weight of S is strictly identical with the weight of C; and the same goes for any non-excluded trope. In this respect, the intimacy of material constitution relation and its vicinity to identity stands out: constituting and constituted objects are identical in many respects, in the very literal sense that they have numerically the same tropes. The difference between S and C, thus, does not amount to *which* (non-excluded) tropes they instantiate, but rather to *how* they exemplify them. Particularly, it amounts to whether they instantiate them nonderivatively or derivatively. For instance, C exemplifies the

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<sup>170</sup> Among the philosophers embracing a primitivist theory of tropes there are Heil (2003, 2012, forthcoming), Husserl (1900), Jaworski (2016), Lowe (2006), Martin (1980), Mulligan, Simons and Smith (1984), Simons (1994, 2000a, 2016).

<sup>171</sup> Consider, for instance, Cameron's (2006, fn. 3) example of a sharp knife: the knife is sharp clearly in virtue of having a blade which is sharp, that is, in virtue of having a blade characterised by the *sharpness* trope. In such a case, we would say that the knife is sharp, yet non primarily, while the blade exemplifies *sharpness* primarily. Moreover, objects having tropes in virtue of their parts having such tropes do not contravene non-transferability. The same, arguably, holds for real parts.

colour trope T nonderivatively, whereas S exemplifies T derivatively. C and S both exemplify T: however, the fact that C exemplifies T is more fundamental than the fact that S exemplifies T.<sup>172</sup>

According to the present view, the existential dependence of tropes may still be achieved through rigid existential dependency. Particularly, tropes are rigidly existentially dependent on the objects that exemplify them nonderivatively and primarily. Accordingly, it is necessarily the case that, if T exists, then it exists in virtue of being exemplified nonderivatively and primarily by C; and that is perfectly consistent with the non-existence of S. As a consequence, the existence of the greyness of C implies the existence of C, but not that of S. C may have that greyness on Monday, when it does not materially constitute anything. The present view also rescues the non-transferability of tropes between distinct objects: tropes cannot be transferred among *completely distinct* entities, that means, among numerically distinct *and* compositionally unrelated entities.

#### **4.4.2 Multi-Thingism, Tropes, and Causal Overdetermination**

Tropes offer thus an efficient way to intrinsically characterise heterogeneous simples and make sense of property inheritance under material constitution. Let us now turn to the issue with causal overdetermination. Interestingly, it seems that tropes could prove useful here too. The issue of causal overdetermination arises given specific considerations on causal relations and their relata. Tropes enter the picture because many trope theorists claim tropes to be the proper relata of causal relations (Ehring 1997b, 2011, Garcia-Encinas 2009, Heil 2003, Molnar 2003). For instance, suppose I inadvertently touch a hot stove and thus I burn my hand. We are surely facing a causal relation: but what are its relata? According to the aforementioned trope theorists, the causal relata are two tropes, two ways things are: the hotness of this stove and the alteration of this hand. APN already employs tropes in order to qualitative describe hylomorphs. Recall that the problem with causal overdetermination concerns the excess of causing entities: if atoms arranged baseball-wise break the window, then baseballs would be causally redundant. However, if tropes were also the fundamental relata of causal relations, the issues of overdetermination would immediately dissolve. This stove is materially constituted by a portion of cast iron. Consequently, according to APN, they share all their (non-excluded) tropes at any time they stand in the material constitution relation. The hotness of this stove is numerically identical with the hotness of this portion of cast iron. Therefore, there is no causal overdetermination at all: there is not any excess of causes.

The issue turns out thornier, though. Recall that APN conceives tropes as spatiotemporally-indexed particularised properties that are exemplified by objects. Thus, it does not offer a reduction

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<sup>172</sup> The fundamentality order is reversed in all the (allegedly putative) cases in which S nonderivatively exemplifies some tropes. Among such cases, we may consider, for instance, S's powers of causing aesthetics experiences. Baker's own example is «a flag may have the effect of bringing tears to your eyes» (Baker 2003, 597).

of tropes exemplification in terms of more fundamental relations, for instance, parthood. However, according to Garcia (2015b, 2016), such a conception of tropes makes them unsuitable to play the role of causal relata. APN must regard tropes as modifiers: they are ways things are and cannot be detached from the objects they characterise.<sup>173</sup> Moreover, modifier tropes do not have the character they deliver to their bearers. The redness of this apple is not red itself: rather, the apple is red because it exemplifies its redness. Next, Garcia offers two necessary conditions for entities to be suitable to serve as causes in causal relations:

Let  $c$  stand for whatever it is that is directly causally responsible for the burn mark on my hand. Presumably, a candidate entity  $e$  is eligible to play the role of  $c$  only if (C1)  $e$  is something unique to Stove<sub>1</sub> (as Maurin says, the ‘mark is left by the particular temperature had by this particular stove now’) and (C2)  $e$  is itself hot. (Garcia 2015b, 643)

Modifier tropes are at least at odds with (C2). A hotness trope modifies a substance so that the substance turns out to be hot; the trope itself, though, is not hot. Hence, Garcia concludes, modifier tropes are unable to play a direct role in causal relations. At the very least, they cannot be causes: which is unfortunate, since their role as causes in causal relations is precisely what would have solved the issue of overdetermination.

Must APN therefore accept systematic causal overdetermination? I think APN comes with at least a couple of rejoinders available. First, APN may reject the metaphysics of causation that Garcia presupposes, namely some version of substance causation. Second, APN may indeed endorse Garcia’s metaphysics of causation and concede the existence of a sort of causal overdetermination. However, it would be, so to speak, a cheap sort of overdetermination, in that there still would not be overdetermination at the level of the deep causal structure of the world. Tropes and the theory of derivativeness play a major role in both the rejoinders.

In his criticism, Garcia clearly presupposes a substance theory of causation, according to which causal agents are just substances (see Lowe 2008, 2013b, Whittle 2016). Given condition (C2), causal agents cannot be events, for instance, since no event is itself hot.<sup>174</sup> However, such a metaphysics of

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<sup>173</sup> Garcia contrasts modifier tropes with module tropes (2015a, 2015b). The contrast parallels the distinction between tropes as properties and tropes as ‘junior substances’ (in the words of Armstrong 1989, 115). The most salient difference between the two characterisations is that modules, but not modifiers, tropes have the features they bestow on their bearers. Accordingly, module tropes are better suited as parts of their bearers. Again, APN cannot endorse a theory of tropes that constructs them as parts of objects. Otherwise, hylomorphs would not be extended *simples* anymore.

<sup>174</sup> Furthermore, notice that it is not uncontroversial that events may still have hot proper parts. According to Lewis (1987, 245), for instance, events are classes of spatiotemporal regions. Since classes have not proper parts (or, at least, they have not proper parts that are not in turn classes as for Lewis (1991)), the claim that events in themselves are not hot, but some proper parts of them are hot, would turn out false. Analogously, according to Costa’s (2017, 2018) view, events have temporal parts but not spatial parts. As a result, objects cannot be carved out from the mereological profiles of events. Hence, again, events would end up lacking proper parts that may be appropriately considered hot.

causation is not uncontested. Particularly, there is a theory of causation that suits trope theory well and can also rebut Garcia's criticism: power-based theory of causation (Heil 2012, 2016, Ingthorsson 2021, Marmodoro 2017, Mumford and Anjum 2011, Williams 2019). According to the power-based view of causation, causation just is manifestation of powers. Powers are properties of objects and manifest themselves when arranged in the right 'constellation' of powers (Williams 2019, 49).<sup>175</sup> A simple model for power-based causation is repulsion between electrons. Electrons repel each other in virtue of their electric charge  $e^-$ . *Having a charge of  $e^-$*  is a powerful property of electrons that lies unmanifested until in the presence of specific pluralities of powers, that act as its manifestation partners. Of course, when two electrons repel each other, they both manifest their powers. Thus, it is constitutive of the power-based view of causation that «[...] our ordinary everyday view of the world as divided into active and passive components dissolves under the microscope of science» (Ingthorsson 2021, 141).<sup>176</sup> The same holds for the (non-fundamental) power of water to dissolve salt. In such a case, it is tempting to regard water and salt as having, respectively, an active and a passive power. However, when we consider the event of dissolution 'under the microscope of science', it appears that it is just the manifesting of more fundamental powers. Given the appropriate quantitative ratio between water and salt, the polarity of water molecules breaks the ionic bonds between negative chloride ions and positive sodium ions. Such a process is then fully accountable in terms of electrostatic interactions between water molecules and ions, and so, lastly, reciprocal interaction between electrons. When we consider it in its most fundamental aspects, the process is «symmetrical, continuous, wholly reciprocal» (Heil 2016, 131).

Given such a view of causation, let us come back to Garcia's criticism. The burn mark on my hand is the outcome of the reciprocal manifestation of certain powers. These powers must be regarded as non-fundamental powers of the hot stove to burn and of my hand to be burnt. They are in principle reducible to plurality of (more) fundamental powers. On a power-based view of causation, Garcia's (C2) turns out to be false. Even worse, it turns out resting on a category mistake. The causal structure of the world is a mosaic of manifestations of powers, where powers, arranged in the proper constellations, are the true causal actors. Substances play a role just inasmuch as bearers of powers. Substances may of course be hot, due to the manifestation of certain powers. However, no power is itself hot. Hence, given such a view of causation, Garcia's (C2) is always false: candidate entities eligible to play the role of causal agents cannot be hot.

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<sup>175</sup> Interestingly, some philosophers (Engelhard 2010, Lowe 2013b, Molnar 2003, Robb 2017) came to the same conclusion from the opposite direction, by characterising causal powers as tropes.

<sup>176</sup> The genuineness of active/passive components in causation is defended by Lowe (2013b).

Of course, a power-based metaphysics of causation just shows that there is an alternative to the view surreptitiously introduced by Garcia that, *contra* his criticisms, rehabilitates tropes as causes in causal relations, at least those tropes that can be construed as powers, and thus dissolve any objection of overdetermination. In other words, an appeal to power-based causation shows that Garcia's criticisms are not unavoidable. Without further arguments, though, the appeal does not undermine a substance-based view of causation. Remarkably, substances satisfy both Garcia's (C1) and (C2).  $Stove_1$  is something unique to  $Stove_1$  in the very strict sense of being identical with it. And, of course,  $Stove_1$  is also hot.

For the sake of argument, let us simply concede that some sort of substance-based view of causation is correct. A power-based metaphysics of causation cannot, in itself, undermine Garcia's objection. Powers, inasmuch as modifier tropes, are rigidly dependent on the objects that have them nonderivatively and primarily. However, tropes are not the right sort of things to instantiate the properties accountable for causal effects in the world because they *are* those properties. Nevertheless, recall that the issue under consideration concerns overdetermination. Particularly, it concerns whether the brand of multi-thingism that APN endorses leads to systematic overdetermination.

Generally, there is overdetermination for an event when there are two (or more) sufficient and wholly distinct causes for the same event (Whittle 2016, 8). More precisely, the conditions for overdetermination can be traced back to the following (Korman 2015, 192; see also Árnadóttir 2015, 5-6):

- (1)  $O_1$  causes  $e$
- (2)  $O_2$  causes  $e$
- (3)  $O_1$  is not causally relevant to  $O_2$ 's causing  $e$
- (4)  $O_2$  is not causally relevant to  $O_1$ 's causing  $e$
- (5)  $O_1 \neq O_2$

(1) states that  $O_1$  is a sufficient cause for  $e$ , and (2) states the same for  $O_2$ . (3) and (4) state that  $O_1$  and  $O_2$  are causally disjoint. Lastly, (5) ensures that  $O_1$  and  $O_2$  are numerically different. When such conditions obtain, the event  $e$  is overdetermined by the causes  $O_1$  and  $O_2$ .<sup>177</sup>

APN concedes that, given a substance-based metaphysics of causation, it is committed to a kind of overdetermination, that may be called *substance overdetermination*. When the baseball hit the windows, both the baseball and its constituting portion of matter cause the breaking of the window. In such scenarios, each of the conditions (1) – (5) is satisfied. However, this is a sort of cheap

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<sup>177</sup> Notice that  $O_1$  and  $O_2$  stand here for substances while  $e$  for an event, but that is utterly irrelevant. Conditions (1) – (5) properly capture causal overdetermination no matter what entities are the suitable causal relata.

overdetermination, so to speak. In fact, APN is not committed to overdetermination to the more fundamental level of powers, or *powers overdetermination*.

According to a substance-based metaphysics of causation, substance themselves are causes of events. However, how do substances cause events? They do so in virtue of some of their causal powers. For instance, Lowe claims that «[...] fundamentally speaking, *all* causation is substance causation, because only substances strictly and literally possess causal powers» (2013b, 157). Even more clearly, Whittle (2016, 3) argues for substance causation by appealing to the fact that substances possess and manifest causal powers:

- Some actual substances possess causal powers
- If a substance possesses causal powers, then it is efficacious
- If a substance is efficacious, then it can be a cause,
- Some actual substances' causal powers are manifested

Therefore,

- Some actual substances are causes

According to Whittle's argument, and in line with Lowe's claim, substances are causally efficacious because they exemplify causal powers that manifest themselves. The causal efficiency of substances is thus grounded in the fact that substances exemplify manifesting causal powers. Hence, even for theorists endorsing substance-based causation, causal powers play a crucial role in accounting for causality in the world. Substances are the true causes of events; however, they are so just because they are the bearers of manifesting causal powers.

APN is committed to substance overdetermination: the baseball and its constituting portion of matter both cause the breaking of the window. However, it is not committed to the more fundamental power overdetermination. An event is power-overdetermined just in case:

- (1) Powers  $p_1, p_2, \dots, p_n$  are manifested and their outcome is the event  $e$
- (2) Powers  $p_1^*, p_2^*, \dots, p_n^*$  are manifested and their outcome is the event  $e$
- (3) The manifestation of  $p_1, p_2, \dots, p_n$  is not causally relevant to the manifestation of  $p_1^*, p_2^*, \dots, p_n^*$  whose outcome is the event  $e$
- (4) The manifestation of  $p_1^*, p_2^*, \dots, p_n^*$  is not causally relevant to the manifestation of  $p_1, p_2, \dots, p_n$  whose outcome is the event  $e$
- (5)  $p_1, p_2, \dots, p_n \neq p_1^*, p_2^*, \dots, p_n^*$

There is power overdetermination when an event is the outcome of the manifestation of two (or more) sufficient and wholly distinct pluralities of powers. Theorists endorsing a substance-view of causation

should regard powers overdetermination as true anathema: causal powers ground the efficacy of substances and thus their role in causal relations. Such theorists would want to claim, for instance, that electrons repel each other in virtue of their respective exemplifications (and manifestation) of the causal power *having a charge of  $e^-$* . No further (proper or improper) plurality is needed to account for the causal interactions between them: the reciprocal manifestation of *having a charge of  $e^-$*  is indeed sufficient for the outcome to obtain, and thus to account for the causal relation between electrons.

According to APN, though, condition (5) does not obtain. Recall that causal powers are conceived as spatiotemporally-indexed tropes that a hylomorph and its constituting matter share, the only caveat being whether the trope is exemplified derivatively or not. The (non-fundamental) power of the stove to burn my hand is literally identical with the power of the cast iron to burn my hand: it is just that the cast iron exemplifies it nonderivatively, whereas the stove exemplifies it derivatively. Hence, there is no power overdetermination. Two disjoint objects literally cause both the same event: however, at the fundamental level, there is just one plurality of powers, that they share, and whose manifestation is sufficient for the efficaciousness of both substances. Therefore, a substance-based view of causation grants Garcia's criticisms to be correct; however, they just show that APN is committed to a cheap sort of overdetermination. Yet, APN is not committed to the more fundamental power overdetermination: for every causal relation, there is just one plurality of causal powers that ultimately grounds it. APN can still account for causality in the world without having to multiply causally unnecessary entities.

Relatedly, APN can address the infamous double weight argument. Again, there is an event, say the bending of the scale's load cell, that has two sufficient and, given APN, wholly distinct causes: two mereologically disjoint substances, say a statue and its constituting portion of clay. However, what really accounts for the bending of the load cell is the exemplification and the manifestation of certain causal powers. APN does say that the statue and its constituting portion of clay are mereologically disjoint; however, it also says that they exemplify all and the same tropes, and thus all and the same causal powers. What ultimately accounts for the bending of the load cell is the manifestation of a plurality of causal powers. They are distributively exemplified, say, by fundamental particles composing the portion of clay. The weight of the portion of clay is thus a (nonfundamental) causal power grounded in the fundamental causal powers of such particles. The weight of the portion of clay is also exemplified by the statue, yet derivatively. Moreover, such causal powers, inasmuch as spatiotemporally-indexed tropes, are the same in the robust sense of numerical identity between particulars: the weight of the statue is literally identical with the weight of its constituting portion of clay. Hence, the manifestation of the former *is* the manifestation of the latter. Therefore, since both power-based and substance-based accounts of causation agree in considering

causation as ultimately manifestation of powers, there is no fundamental overdetermination in the case of the weighting of the statue and the portion of clay. Power theorists would say that the bending of the load cell is simply caused by the manifestation of a single plurality of causal powers. Substance theorists would say instead that the bending of the load cell is caused by two mereologically distinct objects but, still, in virtue of the very same plurality of causal powers. Since at the fundamental level there are no two wholly distinct outcome-producers, then, there are not two causal effects either.

Interestingly, the present construction of causal powers as tropes, that are exemplified either derivatively or underderivatively by hylomorphs and their constituting portions of matter, allows addressing the demand for an explanation of the causal transmission under material constitution:

It is true that we are still short of a full explanation of causal transmission between the relata of the constitution relation. Why, exactly, is causality transmitted? [...] An answer to that question would, I think, be welcomed by many philosophers in many different areas of philosophy who are concerned with the causal efficacy of property instantiations that are constituted by other property instantiations. Nevertheless, it is clear that constitution does transmit causal efficacy, and we have no reason to think it does not. (Zangwill 2012, 5).

We can analyse the present explanation in four subsequent steps.

First step: APN construes material constitution as a relation that implies the sharing of tropes between constituting and constituted entities, as opposed to their mere resemblance. For instance, the Sun and a slice of cheese are both yellow because they exemplify two resembling yellowness tropes. Differently, a statue and its constituting portion of matter are both white because they exemplify *one and the same* whiteness trope. Many ways in which an hylomorph is *are* ways in which its constituting portion of matter is, in a strict literal sense. Moreover, the supportive account of derivativeness allows making sense of the difference between how hylomorphs and their constituting matter share some of their properties versus how two fully distinct objects share some of their properties.

Second step: some (usually physical) properties are powers that bestow their bearers with the possibility to partake causal relations. There seems to be no reasons to deny an extension of trope theoretical construction to such properties: they are natural, qualitative, and intrinsic properties.<sup>178</sup> For instance, mass is generally regarded as a power.<sup>179</sup> The same reasonably goes with all the other powers.

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<sup>178</sup> Given their ‘physical intentionality’ (Molnar 2003, 61), it is tempting to regard powers as extrinsic; however, see Coates (forthcoming) for a criticism and a characterisation of powers as intrinsic properties with extrinsic natures.

<sup>179</sup> For instance, Heil claims that «[...] to have mass is to have the power to affect and to be affected by other massy things in certain ways» (Heil 2013, 31). Molnar characterises rest mass as a continuously manifesting power: «Massive objects are spontaneously manifesting their gravitational power in continuous interactions with space-time» (Molnar 2003, 87). Williams discusses the possibility for mass to be an extrinsic property, on a par with weight (Williams 2019, 77). In such

Third step: the theory of derivativeness extends to them as well. Powers are natural, qualitative and intrinsic properties. The powers we are interested in here are exemplified by portions of matter nonderivatively. When a portion of matter comes to materially constitute a hylomorph, then it exemplifies those powers too, yet derivatively. Again, the powers the hylomorph and its constituting portion of matter exemplify must be identified with tropes.

Fourth step: the previous reply to Garcia's criticisms made apparent that powers are the fundamental grounds of causality in the world. A power-based view of causation appoints powers themselves as the causally efficacious. A substance-based view of causation appoints instead substances as causally efficacious, but nonetheless grounds their efficacy into their exemplification of powers.

Since powers are the ultimate grounds of causality, causal transmission must be transmission of manifesting powers. Powers are tropes, and the relation of material constitution ensures that hylomorphs and their constituting portions of matter share numerically the same (non-excluded) tropes, and thus the same powers. Hence, APN, when supplemented by the present views on properties and property instantiation, meets Zangwill's demand for an explanation of the causal transmission under material constitution.

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a case, though, objects would have their mass in virtue of having a further property, now intrinsic, and standing in specific qualitative relations. Hence, such a scenario does not really threaten our causal explanation.

## Conclusion

Aristotelian Parts Nihilism is a non-reductive theory of material objects that is also fully compatible with Classical Extensional Mereology. At its core lies the numerical and categorical distinction between hylomorphs, entities that ‘have a metabolism’, and structureless entities, that are instead characterised as having just extensional persistence and identity conditions. Moreover, since it can endorse, and make sense of, Mereological Essentialism, Aristotelian Parts Nihilism is actually compatible with Pure Mereology, a staunch theory that ends up extending mereological considerations concerning objects to characterise some of their modal features as well. Thus, not only it can furnish fully extensional conditions of persistence over time and transworld identity for portions of matter and gerrymandered objects, but also it does not impose any mereological constriction on the formulations of such conditions for hylomorphs. Since Aristotelian Parts Nihilism claims that hylomorphs do not have proper parts at all, at least according to the one serious, mereological sense of parthood, and since they are generally spatiotemporally extended, it follows that hylomorphs are extended simples. Sure, extended simples are bizarre metaphysical creatures; yet philosophers have largely tamed them by developing theories of location and properties that can account for their persistence and qualitative heterogeneity, respectively. Moreover, albeit simple, it is still possible, and indeed deserved, to clarify the nature of the intimate relation between hylomorphs and what we have called their real, or natural, parts. The label actually comes from the works of philosophers who have already tried to shed light on the issue, either with CEM in the background or weaker mereologies. Of course, in the present essay, I have stuck with CEM.

Aristotelian Parts Nihilism is the solution I advance to the issue the Troublesome Argument raises. The Troublesome Argument is nothing less than one of the core paradoxes of the metaphysics of material objects. We have considered a statue, Statue, together with its constituting portion of matter, Alloy. On the one hand, we have clear modal intuitions conveying on Statue and Alloy different persistence conditions. And, of course, things with different properties are numerically distinct. On the other hand, though, Extensionality of Proper Parts provides the identity between Statue and Alloy, *proviso* the sameness of their proper parts. Philosophers have mostly opted either to explain away the relevant modal intuitions or reject some fragment of mereology that includes Extensionality of Proper Parts.

As for the first strategy, I have considered counterpart theory, inasmuch the most successful theory that promises to achieve the result. Counterpart theorists claim that Statue and Alloy are indeed identical, and it is possible to explain away those intuitions that push for their distinction. Although counterpart theory enjoys a large pool of enthusiasts, it is far from uncontroversial. In order to show

some of the major difficulties of the theory. I have presented, discussed, and possibly slightly expanded three recent arguments against the theory: De's Respectfulness reading of the Humphrey Objection, Mackie's Vacuous Satisfaction argument, and Barker and Jago's argument from the asymmetry of material constitution. De's argument shows that a cogent reading of Kripke's infamous Humphrey Objection pressures the counterpart theorist to endorse five-dimensionalism, a fairly unpopular metaphysical theory of material objects. Not only five-dimensionalism is controversial in itself, because of its metaphysical consequences, but also it comes with unwanted semantic revisionism. The weakest conclusions we can draw from Mackie's and Barker and Jago's arguments, if considered jointly, show instead that counterpart theory and one-thingism stand and fall together. Moreover, Barker and Jago's argument also aims to show that the conjunction of the two theories is not tenable, since counterpart theory is not apt to account for the genuine informational asymmetry instances of material constitution provide. Thus, it is natural to look at those theories of material objects that take seriously both transworld (genuine) identity and multi-thingism. However, many of those theories end up trading out Classical Extensional Mereology for weaker mereologies in order to avoid Extensionality of Proper Parts.

Among the most interesting theories of this sort, there are Cotnoir's Mutual Parthood theory and Lowe's Constituting Parthood theory. Cotnoir claims that hylomorphs and their constituting portions of matter are indeed mutual parts. Since he rejects Antisymmetry as well as Extensionality of Proper Parthood, his theory is consistent with the numerical distinction between Statue and Alloy. Lowe preserves instead Antisymmetry and Extensionality of Proper Parthood, by construing hylomorphs as having their constituting portions of matter as proper parts. Despite obvious and relevant mereological differences, Cotnoir's and Lowe's theories both reject a fragment of Classical Extensional Mereology, and that is surely a noticeable theoretical cost that any metaphysical theory of material objects should avoid.

By contrast, mereological hylomorphism is a multi-thingist theory that seems able to preserve Classical Extensional Mereology together with the relevant modal intuitions concerning material objects. The core claim of mereological hylomorphism is that hylomorphs literally outstrip their constituting portions of matter by means of their forms. Every hylomorph has its hylomorphic form as formal proper part and it does not share it with its constituting portion of matter. Hylomorphists take forms both to depend on their compounds for their existence and to provide a substantial characterisation of them on several metaphysical aspects. I have tried to show, though, that such a robust construction of forms hylomorphists provide is inconsistent, and that none of the potential revision of the notion is really desirable.

I have then presented an argument, due to Linnebo, that shows how Extensionality of Proper Parthood, and more generally extensionality principles for any sort of collections, is better off accounted by accepting a corresponding modal principle, Rigidity of Parthood, on pain of accepting that numerically distinct objects may nonetheless be necessarily co-extensional. Hylomorphic forms actually provide a reason to endorse Extensionality of Proper Parthood that is not also a reason to endorse Rigidity of Parthood, since forms allow tracking hylomorphic compounds intensionally across possible worlds. However, the previous argument against hylomorphism suggests we should put aside hylomorphic forms, or at least a robust construction of hylomorphic form (which is arguably the only serious account of hylomorphic forms). As a result, we better provide a theory that can make sense of Rigidity of Parthood as well.

Thus, I have advanced Aristotelian Parts Nihilism, the theory according to which, necessarily, hylomorphs are mereologically atomic. Like mereological hylomorphism, Aristotelian Parts Nihilism is a multi-thingist theory that is also compatible with Classical Extensional Mereology. Moreover, and differently from mereological hylomorphism, it is also compatible with the modal consequences hinted at by Linnebo's argument, that is, with the Rigidity of Parthood, and indeed even with Mereological Essentialism, the thesis according to which complex objects are identity-dependent upon their proper parts. Since hylomorphs are atomic, they trivially satisfy both Extensionality of Proper Parts and Mereological Essentialism. Differently, those principles are suitable for structureless entities, such as the portions of matter and the other gerrymandered entities that Aristotelian Parts Nihilism admits in its ontology.

In the last sections of the work, I have mainly tried to clarify some technical aspects of Aristotelian Parts Nihilism. First, I have discussed the issue of persistence over time and change, both in its classical and locational formulation. Generally, Aristotelian Parts Nihilism is more naturally construed along the lines of endurantism, but it still seems compatible with perdurantism as well. Interestingly, Aristotelian Parts Nihilism is compatible with three-dimensional as well as four-dimensional endurantism, the compatibility with the latter being granted by Mereological Essentialism. Second, in order to adequately characterise enduring material objects, I have endorsed Baker's theory of instantiating a property derivatively and slightly developed it. The expansion of Baker's theory was necessary to make it suitable to the four-dimensional endurantism construction of Aristotelian Parts Nihilism, since such theory of persistence must be supported by some non-standard theory of property instantiation. Third, I have investigated the intimate relation between hylomorphs and what some philosophers have labelled their real or natural parts. I have discussed some previous attempts to identify the nature of such relation, but I have concluded that they are unsatisfying or incompatible with Classical Extensional Mereology (and *a fortiori* with Aristotelian

Parts Nihilism). I have thus advanced my take by labelling the relation *being a real part at a time* and offering a definition of it. The definition provides a reductive analysis of the relation in terms of essence, grounding, location, and mereological considerations on spacetime regions. Lastly, I have taken into considerations issues of causal overdetermination, elicited, for instance, by the infamous double weight argument. Baker's theory of instantiating a property derivatively allows solving the problem almost immediately as far as the three-dimensionalist endurantist version of Aristotelian Parts Nihilism is concerned. The four-dimensionalist endurantist version faces more issues: as an answer to overdetermination concerns, tropes come with some more troubles than old properties. Given the theory of tropes Aristotelian Parts Nihilism can endorse, tropes seem less apt to suit the role of causal relata. However, I discuss the reason for this sort of scepticism and find it wanting for two main reasons. First, the scepticism surreptitiously rests on a substance view of causation, which is by no means the default metaphysics of causation. Moreover, even on a substance view of causation, tropes may still have the ultimate role of explaining why substances enter causal relations. Second, there are indeed further views concerning the metaphysics of causation that seem much more promising for tropes to succeed as causally relevant entities. Among these, particularly, I have considered the rising power view of causation, that construes causation as manifestation of powers. By considering powers as particularised properties that hylomorphs and their matter share, we can distinguish a serious and a cheap sort of overdetermination, and show that, although the four-dimensionalist Aristotelian Parts Nihilism is committed to an innocuous sort of substance causal overdetermination, it is unaffected by the serious power overdetermination.

All in all, I guess the most important result of Aristotelian Parts Nihilism is showing the possibility of developing a multi-thingist theory that neither dispenses with CEM or appeal to 'hidden parts' of material objects. Particularly, Aristotelian Parts Nihilism acknowledges an unstructured level of reality, which suits nicely the extensionalist framework of CEM, together with a structured one featuring hylomorphs, namely material objects that, in Evnine's (2016, 3) expression, 'have a metabolism', which means that they are temporally and modally flexible with respect to their material constitution profile. The main proposal of the theory is that a better understanding and characterisation of such metabolism is forthcoming if we move our focus away from parthood relations and, more generally, mereological considerations. The *real parthood at a time* relation, or some further relation in its vicinity, is a promising candidate to make sense of hylomorphs's metabolism in terms that are not mereological, but rather essentialistic, ground-theoretic, and locative.

Admittedly, Aristotelian Parts Nihilism is still in need of refinement. First of all, its four-dimensionalist version inherits the problem of characterising qualitatively heterogeneous extended simples. The best available theory of property that can do the job is the tropistic one; yet, when it is

coupled with Baker's theory of derivativeness, it delivers a result that is far from elegant. Hence, Aristotelian Parts Nihilism would benefit, albeit mostly aesthetically, from a theory of properties that may account for the qualitative heterogeneity of extended simples more straightforwardly. Second, despite making use of the notion of material constitution, Aristotelian Parts Nihilism does not offer or endorse any definition on the market and is content with a primitivist approach that merely regards it as an asymmetric relation. I regard this point as a virtue of the theory, because it makes it even more ecumenical. Still, a specific definition of material constitution may be advanced and paired up with a new and powerful theory of properties in order to account superiorly for derivative instantiation of properties. Third, granted the genuineness of the *real parthood at a time* relation, it would be interesting developing a general theory of real parthood at times. A first proposal along these lines has been advanced by Canavotto and Giordani (2020), who have developed a mereology for a relation akin to the present one. However, there are underlying differences between our accounts that prevent me to straightforwardly adopt their theory. Moreover, while they actually model their relation as a parthood relation, I clarified that, despite the label I have chosen for it, I do not take *real parthood at a time* to be a parthood relation. Rather, it is a relation that accounts for how objects of certain kinds are sustained, *qua* instances of those kinds, by objects of certain other kinds. *Real parthood at a time* does not come with any necessity: the relata may generally fail to stand in such relation with each other. This feature is supposed to make sense of the fact that objects can change their parts over time and through possible worlds, according to their metabolism. Therefore, a general theory for *real parthood at a time* would be a general theory of metabolism, and as such a further resource for multi-thingers to substantiate their ontological worldview.

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