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Time-Travel and Multi-Location Endurance

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RESUMEN

El endurantismo multi-locacional sostiene que un objeto persiste a través del espacio-tiempo solo si se localiza en dos o más regiones espacio-temporales diferentes y temporalmente no extendidas. No obstante, se ha sugerido que esta versión del endurantismo se encuentra reñida con axiomas centrales de la mereología extensional clásica, a saber, transitividad, antisimetría y suplementación débil. En particular, algunos han argumentado [Effingham and Robson (2007), Kleinschmidt (2011)] que, dada la posibilidad de viajar en el tiempo, es posible construir casos en los que un objeto multi-localizado aparentemente violaría tales principios. Mi propósito en este artículo es ofrecer una defensa comprensiva del endurantismo multi-locacional ante estas objeciones y, más en general, cuestionar la manera en la que a veces se ha pensado la relación entre mereología y teorías metafísicas.

PALABRAS CLAVE: *endurantismo, multi-locación, locación exacta, mereología, viajes en el tiempo.*

ABSTRACT

Multi-location Endurance claims that an object persists through spacetime if it is exactly located at two or more different temporally unextended spacetime regions. However, this version of Endurance theory is said to be at odds with core axioms of Classical Extensional Mereology, namely, Transitivity, Antisymmetry, and Weak Supplementation. In particular, some have claimed [Effingham and Robson (2007), Kleinschmidt (2011)] that given the possibility of time-travel, one could construct cases in which multi-located enduring things would seemingly violate such principles. My aim in this paper is to provide a comprehensive defence of Multi-location Endurance from these objections and draw some systematic conclusions about the relation between Mereology and metaphysical theories.

KEYWORDS: *Endurantism, Multi-location, Eexact Location, Mereology, Time-travel.*

I. INTRODUCTION

Unlike standard definitions of endurance – which by and large have relied on the work that the expression “being wholly present” does –

locational accounts of endurance define endurance purely in terms of locational notions. In particular, they appeal to two crucial notions. Firstly, they are usually committed to a multi-location relation, that is, a relation that will commonly hold between a material object (though not exclusively) and the spacetime regions where that object is located. Secondly, they appeal to the notion of exact location, which they treat as a primitive and as the most basic amongst locational notions. Informally, we could understand exact location in the following way: an object x is exactly located at R if and only if x somehow fills the whole of R and no part of R is free of x .¹ Though more will have to be said about this characterization of exact location in II, the resulting account of endurance we get is that an object x is said to endure if and only if x persists and x is exactly located at each of the instantaneous temporal slices of its temporal or spatiotemporal path.

Nonetheless, it has been objected to this account that it conflicts with widely accepted principles of Classical Extensional Mereology (CEM), namely, Transitivity, Antisymmetry, and Weak Supplementation.² In particular, this case against Multi-location Endurance is motivated by a number of time-travel scenarios where the acceptance of such principles together with the possibility of an object being multi-located across spacetime would inevitably lead us into contradiction. The aim of this paper is to offer a defence of Multi-location endurance from this family of objections. Accordingly, in the coming section I will introduce in more precise terms the notion of multi-location, exact location, and the resulting Multi-location view of endurance. In section III in turn I will both present the aforementioned counter-examples to Multi-location endurance and explain why each of them does not succeed in establishing the alleged contradiction that follows from the acceptance of multi-location plus CEM. Finally, I will draw some general lessons in section IV about the relation between mereological axioms and metaphysical theories about material objects.

II. ENDURANCE AND MULTI-LOCATION

The talk of instants of time that pervades the non-relativistic debate on persistence, but taking the consequences of the Special Theory of Relativity demands to replace talk about instants of time with talk about spacetime regions. Spacetime regions are either spacetime points or fusions of spacetime points.³ Enduring objects would inhabit those re-

gions, although those regions would be of a very peculiar kind. Indeed, they would be temporally unextended spacelike regions. The fact that those regions are spacelike means that for any two distinct points of such regions, there must be a spacelike relation. We could further shed some light on the qualification of being temporally unextended by appealing to Balashov's notion of achronal spacetime regions. According to Balashov [(2010), p. 24], achronal regions are like three-dimensional slices that we can cut through spacetime. In the maximal case, a maximal achronal region can be identified with a Cauchy surface, that is, hyperplane of spacetime that intersects every unbounded timelike curve at exactly one point. More precisely then, a spacetime region R is an achronal region if and only if no point that belongs to R absolute-chronologically precedes any other point that also belongs to R .⁴ A material persisting object would be said to endure only if it persists and is located a achronal slices of its spatiotemporal path [Balashov (2010), p. 33].⁵

Now, we said that locational durantists attempt to ground endurance theory by appealing only to locational facts and that they do so by bringing up two crucial locational notions: exact location and multi-location. Exact location is a relation that objects (though not exclusively) bear to spatial or spacetime regions. One straightforward way to understand exact location is contrasting it with weak location. Weak location is the minimal locations relation that an object could bear to a region. Informally speaking, we can say that an object x is weakly located at a region R if x 's location overlaps R . Exact location is more demanding than weak location, for if x were to be exactly located at R , no part of x could lie outside of R .⁶ Defining exact location in terms of a more basic locational notion has proven to be a controversial matter. This difficulty has opened a divide between those who treat exact location as a primitive and those who define it in terms of a more basic locational notion. The main motivation for choosing the former option has often been that it precisely allows for the possibility of multi-location, whereas the latter does not so.⁷ Be that as it may, almost all parties in dispute seem to agree that any acceptable characterization of exact location should satisfy what I call the Basic Condition:

(BC) It is a necessary truth that if an object x is exactly located at a region R , then x has exactly the same shape and size (and geometrical and topological properties more generally) as does R , and x stands, in all the same spatiotemporal relations as does R .⁸

A few clarifications nonetheless about the import of (BC) are required before we move on.⁹ The current formulation of the condition is intended to be restricted only to material objects. That might raise the issue in turn of whether immanent universals are truly exactly located where their instances are. The issue of course is not trivial at all for multi-location endurantists, who often have motivated the possibility of multi-location from the case of immanent universals. Though space constraints do not allow me to develop an elaborated argument, I think one could offer two provisional considerations here to address this concern. Firstly, one might argue that immanent universals inherit their locations from their instances and therefore have their locations derivatively. Such derivative character would account for the fact that they do not have the shapes and sizes of the regions they occupy, though they still might stand in the same spatiotemporal relations. Secondly, one could introduce a second notion of exact location, as the one suggested by Eagle (2010) or Calosi and Costa [(2015), *forthcoming*], so as to keep the first notion restricted to material objects and the second one to immanent universals. The idea would be that this second notion is sufficiently similar to our first notion of exact location to motivate the possibility of multi-location, but crucially different in the relevant respect to avoid the odd result that universals have the shape of the regions they inhabit.¹⁰

Accordingly, if x bears the exact location relation to each of two disjoint spacetime regions, then x would also bear the multi-location relation to them. So, whereas exact location is in some cases a one-to-one relation and in some others a one-to-many relation, multi-location is necessarily a one-to-many-relation. More formally, we could say that

x is multi-located at the $R_s =_{df}$ there are at least two distinct R_s and x is exactly located at each R .

The upshot for enduring objects would be that they do not extend through the sum of the spacetime regions they occupy, but rather that they would be multi-located at each of the regions whose fusion is identical to their spatiotemporal path. This establishes an important difference with perdurantist accounts, for perdurantists would hold that objects are exactly located at the sum of all the spacetime regions that such object occupies throughout its existence, that is, at its spatiotemporal path. Unlike perdurantists, endurantists claim that material objects are exactly located at each of the spacetime regions they multiply occupy, but not at the totality of them. They would certainly have a spatiotem-

poral path – as perduring objects do – but they would locationally relate to their path in a different way.

Once we grant this way of drawing the contrast between endurantists and perdurantists in a spacetime framework, we could also add two additional features that characterize enduring objects *vis-à-vis* perduring objects. The first one is that enduring objects would exemplify the intrinsic properties they possess relative to spacetime regions and not *simpliciter*. The second one is that enduring objects are related to their parts by a primitive three-term relation that links objects, parts, and spacetime regions. The thought again is that any object that enters into this relation would have parts-at-a-region and not parts *simpliciter*. Such spacetime regions – both for the case of properties and parts – would correspond to sub-regions of maximal achronal regions. These features of multi-location endurance should come as no surprise given standard formulations of endurance theory in ordinary times frameworks. What we find there is that endurantists usually introduce a temporal qualification in property and part possession in order to account for temporary intrinsic change and mereological change. The two aforementioned features then would be nothing more than the translation to a spacetime framework of standard aspects of endurance theory when formulated in an ordinary times frameworks.¹¹

This modification also spreads to the notion of temporal parthood I have been so far deploying, which relies on talk of instants of time. To simplify things, I follow Gibson and Pooley’s definition of instantaneous temporal part, which neatly maps Sider’s notion of temporal parthood into a spacetime framework. According to Gibson and Pooley,

x is an instantaneous temporal part of y =_{df} (i) x is a part of y, (ii) x is exactly located at a region R that is spacelike and (iii) R is a maximal spacelike sub-region of the spatiotemporal path R of y [Gibson and Pooley (2006), p. 163].¹²

III. BRICK WALLS, STATUE DOGS, AND TIME TRAVEL

In this section I present – at last – two objections raised in the recent literature against the possibility of multi-located objects. The objections describe different puzzling scenarios for supporters of multi-location, but structurally are fairly similar. The first step of these objections assumes the possibility of time travel for macroscopic objects, such as

bricks and plastic dogs. The second step further stipulates that the time traveling macroscopic objects are multi-located at the same time and seemingly compose a further object with themselves. The last step shows how these strange cases of composition conflict with well-established principles of CEM. The proponents of these counter-examples to multi-location are [Effingham and Robson (2007) and Kleinschmidt (2011)]. Effingham and Robson target multi-location via Weak Supplementation, whereas Kleinschmidt expands the objection to other principles as well. Although Kleinschmidt starts in her example with Transitivity, she shows that the conflict extends to Antisymmetry and Weak Supplementation [Kleinschmidt (2011), pp. 258-68]. Due to space constraints, I limit the subsequent discussion in III.2 to Transitivity, although the alleged conflict with the remaining mereological principles could be equally handled with the same reasons I give to dismiss the conflict with Transitivity.

III.1 *On Time Travelling Bricks and Pseudo-walls*

Let us start with the initial objection advanced by Robson and Effingham against multi-location, whose goal is to derive a contradiction from Weak Supplementation and objects, such as walls, composed by one single multi-located part:

Assume you are an endurantist. Imagine you are presented with what appears to be one hundred bricks, $\text{Brick}_1, \text{Brick}_2, \dots, \text{Brick}_{100}$, stacked together so as to arrange what appears to be a brick wall. The bricklayer, Marty, asks you whether the wall is a composite object or not. Presumably you will answer positively. However Marty claims that contrary to your intuitions the wall in question is not a composite object, and that he will demonstrate this. To begin his demonstration, Marty demolishes the wall. Let the time of the demolishing be t_{100} . He then takes Brick_1 to a nearby time machine, whereupon you both travel back in time to t_1 . Here Marty takes you to a shop and purchases a normal house brick, which he then places in the region that will be occupied by Brick_1 at t_{100} . Obviously Brick_1 is the brick purchased from the shop. Marty then places the future version of Brick_1 from t_{100} next to the past version of Brick_1 so that it is in the region that will be occupied by Brick_2 at t_{100} . Clearly then, Brick_2 is numerically identical to Brick_1 . You both travel forward a hundred units of time to t_{101} , where Marty takes Brick_2 (which you now know to be Brick_1 also), and then you both return to t_2 where Brick_2 is placed in the location where Brick_3 will be. Travelling forward in time again to t_{102} Marty takes Brick_3 (which you now know to be both Brick_1 and Brick_2) and travels back one hundred units of time to t_3 where the brick is placed in the loca-

tion reserved for Brick₄. This process is repeated until an entire wall has been constructed from the same object during the interval between t_1 and t_{100} . Likewise, Marty has removed 'different' bricks from the demolished wall leaving just a single brick at t_{200} (the brick originally purchased from the shop at t_1) [Effingham and Robson (2007), p. 633].

Admitting the possibility of time travel, we are left then with a trilemma: either deny that the time-travelling bricks compose a wall at t_{200} , reject Weak Supplementation – or at least propose a modified version of it that deals with this sort of cases – or admit the paradoxical nature of multi-location in the face of these scenarios. Effingham and Robson argue that multi-location endurantists cannot but to accept the third option of the trilemma. Since I believe, in contrast, that there is good reason from an endurantist perspective to embrace the first option and possibly even the second, I argue that there is enough room for endurantists to avoid being tied with the third option of the trilemma.

Let us look then at the first option of Effingham and Robson's trilemma. There are at least two strategies endurantists could follow here. The first one is to endorse some form of Mereological Nihilism, that is, the view that denies there is composition between two or more material objects. Mereological nihilists can comfortably handle this and other even more mundane paradoxical cases one could come up with, for they deny that there is composition between material things, so trivially principles like Weak Supplementation are vacuous. In short, there would be no paradox for mereological nihilists because there would be no walls. There are, however, some problems with this line of response. Mereological Nihilism is a hard view to motivate, so it will demand from the multi-location supporter a fair amount of additional work to make a good case in its favour. But even if we grant the truth of Mereological Nihilism for any of the available reasons offered in recent literature,¹³ it might still be an *ad-hoc* move to appeal to this view in order to solve this paradoxical scenario. Just as mereological nihilists can offer paraphrasing schemes for statements about ordinary composite objects and thus retain a satisfactory expressive power, they could equally do so for standard principles of CEM, such as Weak Supplementation. That is, they could paraphrase the talk about parts that features in standard principles of CEM into talk about simples arranged wall-wise. The problem then is that our new scenario would force mereological nihilists to let their paraphrased version of Weak Supplementation go. So in sum, it is not clear

whether there is a way out here for the endurantist who supports multi-location even she endorses Mereological Nihilism.

In the light of this result, I hold that the best way of arguing for the first option of the trilemma is to simply claim that Brick₁ does not compose a further distinct object with itself and that endurantists are in a good position to offer a reasoned rejection of this possibility.¹⁴ An enduring object that is exactly located at multiple spacelike regions of its spatiotemporal path is not exactly located at the fusion of those regions nor constitutes a four-dimensional object located at the fusion of the regions it happens to be exactly located. We might say that it covers its spatiotemporal path, or that it is entirely or pervasively located at some sub-regions of it, but not exactly located at it.¹⁵ To demand from the endurantist that there is a fusion of a distinct object other than Brick₁ here is nothing more than to undermine the possibility of formulating a locational account of endurance such as the one the multi-location endurantist is putting forward. This reveals what I take to be a deep flaw in Effingham and Robson's argument against this type of endurance theory. For, if their trilemma is meant to be effective against multi-location endurantists, it ought to be able to grant the possibility of the brick wall composed by Brick₁ and its future versions from locational and mereological principles available to the endurantist herself. In that way, it could allow Effingham and Robson's to charge multi-location endurantists with denying the existence of what it is a *bona fide* composite material object (the brick wall), denying the truth of a highly plausible mereological principle (Weak Supplementation), or advancing an incoherent view for the persistence of material objects. But from the reasons offered above that is far from clear. Thus, multi-locations endurantists can perfectly deny some of the underlying assumptions of the unappealing options one and two of the trilemma and in that way avoid option three, which Effingham and Robson believe is the only option open to endurantists here.

Getting back to Effingham and Robson's example, what endurantists should stress then is that what their time travel scenario achieves at best is to test in a more forceful manner, if one wants, the locational and mereological tenets endorsed by endurantists. But for this very same reason nothing in this or other similar scenarios prevents the endurantist from appealing to these locational and mereological constraints entailed by her view to solve the *crux* in which she finds herself here. Accordingly, the endurantist should not accept that there is a fusion of bricks simply because they are all exactly located at different regions at the same time, as the alleged brick wall is not something different from Brick₁ it-

self exactly located at many spacetime regions, whose fusion gives us the impression to be occupied by a brick wall.

Now, if the brick wall is ultimately nothing over and above Brick_1 at different regions of its path, how do we account for the different properties Brick_1 and the wall seem to instantiate? The brick wall, for instance, occupies a different region than Brick_1 and has a different shape and weight. At least for these more notorious discrepancies, the answer here is relatively straightforward and can be explained once we examine the relation between an enduring multi-located object and its spatiotemporal path. That the brick wall occupies a different region than Brick_1 is explained by the fact that an enduring object's spatiotemporal path is composed by the regions the enduring object is exactly located at, so it trivially cannot be identical to any of these sub-regions of its path. As to shape properties, it would be odd to ascribe to Brick_1 the property of being wall-shaped because of the shape it results from the *fusion* of Brick_1 with its later versions. Let us assume, only for the sake of the point I am making here, that shapes are extrinsically possessed by material objects such as Brick_1 , given that spacetime regions are the primary bearers of shapes and material objects only have them derivatively.¹⁶ Presumably, we would want to say, following (BC), that material objects inherit their shape from the regions they are exactly located at. However, neither Brick_1 nor its future versions are exactly located at a wall-shaped region. It is only the spacetime region that Brick_1 covers (I use "cover" here in the precise sense in which I have defined this notion) that possesses such shape. But we know already, from our definition of multi-location endurance, that enduring objects are not exactly located at the region they cover and thus cannot inherit its shape. There is no reason then to consider that Brick_1 should be wall-shaped. Lastly, one might wonder whether the question about the weight of the brick wall makes any sense at all, as it basically amounts to ask how much does it weight an enduring object along its spatiotemporal path. If this ambiguity is cleared, questions about the weight of Brick_1 should only be restricted to spacetime regions Brick_1 is exactly located, not fusions of them. There is no question then about the weight of the alleged brick wall.¹⁷

One last point before we move to the next example in section 3.2. We said at the beginning of this section that the available solutions for the endurantist to solve this trilemma are not limited to the first option. I would wish to expand now on this claim and perhaps and perhaps qualify it to a certain extent. Consider the following maxim that applies to the

relation between Mereology and metaphysical theories: mereological principles should be considered as part of the ideology advanced by metaphysical theories and not as external to them [(Donnelly (2011))].¹⁸ Building up on this maxim, endurantists could claim that the metaphysical picture Endurantism offers about the persistence of material things rules out the truth of Weak Supplementation and thus embraces the second option. Effingham himself, persuaded by Smith's criticism, endorses this move.¹⁹ If we take then the second option, we do not dispute the fact that Brick₁, by virtue of multi-location and time-travel, composes a brick wall, but instead dispute Weak Supplementation.

Now, though I am sympathetic to this latter strategy, considering the relative success of the case made in favour of the first option, it is superfluous for endurantists to also let Weak Supplementation go. Moreover, I believe it would be a mistake for a supporter of multi-location not to deny the existence of the brick wall allegedly composed by Brick₁ and deny Weak Supplementation instead. Otherwise, endurantists would not only be liable to denying such principle, but also to the paradoxical consequences that follow from other objections to the possibility of multi-location, such as the ones advanced by Baker and Dowe (2003), (2005) and Hofweber and Velleman (2011), which could be in part handled by invoking Weak Supplementation.²⁰ Besides, it seems legitimate to wonder whether multi-location is truly more plausible than Weak Supplementation. There are plenty of mundane examples that can be invoked in favour of Weak Supplementation, which do not find a natural counterpart in the case in favour of multi-location, and Weak Supplementation could be invoked to dismiss a good number of undesirable cases of spurious composition.²¹ To trade Weak Supplementation off when we have a persuasive rebuttal to Effingham and Robson would not be a wise choice. It seems preferable then to embrace a neutral stance on this question.

III.2. *Statue Dogs and the Transitivity of Parthood*

Consider now Kleinschmidt's Clifford [Kleinschmidt (2011), pp. 256-8], a statue dog composed by Kibble and Oddie. Kibble is a biscuit-shaped statue and Oddie a statue dog which turns out to be the largest part Kibble is made of. As Clifford ages, all of its statue parts melt together into a single mass, while it changes all of its microscopic components and progressively shrinks. At that stage, Clifford travels back in time to the exact moment in which it was originally made by an artist. As

it turns out, Clifford occupies exactly the same spatial region Oddie occupied when Clifford was made, so the artist actually grabs Clifford to make up most of Kibble, which becomes a part of Clifford. But big surprise, Clifford not only looked very similar to Oddie; Clifford was identical to Oddie. According to the transitivity of parthood, if an object *x* is a proper part of an object *y*, and *y* is a proper part of an object *z*, then *x* is a proper part of *z*. So if Transitivity holds, Oddie must be a proper part of Clifford, for Oddie is a proper part of Kibble and Kibble is a proper part of Clifford. But Oddie is identical to Clifford. A paradox follows if we assume Multi-location Endurantism in this scenario.

The problems with Kleinschmidt's scenario are not few nonetheless. To begin with, there seems to be good ground to hold that the very formulation of Kleinschmidt's scenario entails a violation of the transitivity of parthood, even though the scenario is meant to establish that such violation follows from multi-location endurance and the possibility of time travel. What seems to be going on here is that on the hand Kleinschmidt's scenario assumes the truth of the transitivity of parthood in order to charge multi-location endurantists with a paradoxical consequence that follows from their view. But on the other, the very same scenario developed by Kleinschmidt entails the denial of the transitivity of parthood for its construal. Now, if parthood is a transitive relation, then no one should accept – regardless of their allegiance to endurance theory – that Oddie ends up being identical to Clifford. And if Oddie is not identical to Clifford, there is no traction in Kleinschmidt's example. There could be no way then that with this internal tension Kleinschmidt's scenario gets off the ground and has any dialectical force against endurantists, in spite of telling a seemingly coherent story of time-travel and composition.

In order to see the internal problem with Kleinschmidt's scenario more sharply, we could even leave the intermediary Kibble aside (and thus issues pertaining Transitivity) and focus, as Eagle suggests, on the impossibility entailed by the present scenario [(2016), p. 2222-4]. Eagle's point here is that Kleinschmidt's set up of her example objectionably demands from us to accept an impossibility right from the outset, something which is only obscured by the narrative she deploys to introduce the particulars of the situation. Where does the impossibility lie? The answer is simple. We are told, by the transitivity of parthood, that Oddie is a proper part of Clifford, but then that Clifford is identical to Oddie. But one of these two claims must go: either Oddie is a proper part of Clifford

and hence never identical with it, or is identical to Clifford and hence cannot be a proper part of it. Now, if Kleinschmidt either denies that Oddie was initially a proper part of Clifford or that the time traveller turns out to be Oddie, then her paradox of multi-location dissolves. Clifford cannot end up becoming a part of himself simply because it is stipulated in the narrative of Kleinschmidt's time travel scenario. Multi-location endurantists should not be concerned by Clifford's time travel adventures.

Notice in this regard that there is an important difference between Kleinschmidt's time-travel scenario and Effingham and Robson's. On the latter case, the contentious point we identified in section 3.1 is whether there is composition between the same multiply located brick at a given time. But the setting up of the scenario itself does not require from the invested parts in the debate to deny Weak Supplementation in order to get the example off the ground. That is not so in the case of Kleinschmidt's scenario. All that Effingham and Robson's scenario demands is the possibility of time travel and the possibility of multi-located material objects, something that endurantists would readily concede. Certainly, it is irrelevant as far as conceivability (or metaphysical possibility) goes whether the multi-located brick is located at adjacent or distant spatial regions. It also seems to be irrelevant whether the travels in time are one, two, or a hundred. The overall consistency of the scenario seems sound. But unlike the latter, I argue that the way Kleinschmidt in which sets up her time travel paradox is faulted right from the outset and that it should be rejected on that basis as it stands

But what if Kleinschmidt's example could be amended so as to still be troublesome for multi-location endurantists and violate Transitivity right from the outset? Suppose Clifford is composed by Kibble, but Kibble is not composed by Oddie. Instead of Oddie, Kibble has just a hole exactly of the same shape as Oddie. Suppose further that, as time passes by, Clifford shrinks in such way that the hole it initially had disappears and that it becomes exactly the same size and shape of the hole contained in Kibble. Suppose lastly that Clifford travels back in time, coming to be exactly located in the hole contained in Kibble. Does this new scenario violate Transitivity without making impossible assumptions? I do not think so. The argument does demand us to accept anything impossible. Furthermore, it does not violate Transitivity. The reasons why it preserves Transitivity – or Weak Supplementation and Antisymmetry, for what it is worth – are the same reasons I offered in explaining why there is no conflict with Weak Supplementation in the

case of the time traveling brick. I rest my case then in defence of multi-location against time travel objections.²²

IV. CONCLUDING REMARKS

I do not consider that the evidence provided so far conclusively proves the metaphysical possibility of multi-location. After all, it might seem to us as an undisputable Moorean fact that Brick₁ composes a wall with itself through successive time travels. Or, moreover, that the persistence picture entailed by Multi-location endurance might be the wrong way of understanding how objects persist through time and its failure to accommodate CEM's parthood principles one further reason to reject it. But even if we do not reject these two possibilities out of epistemic humility, there is a general point against the metaphysical neutrality of CEM that multi-location endurantists could still make following the maxim introduced in III.1. The question about the metaphysical neutrality of CEM is not a question about ontological commitment, but rather a question about whether it provides a framework about parthood where certain metaphysical theories are more comfortable than others. I hold that CEM is not metaphysically neutral and specifically that it is at odds with endurance theory.²³

Here is a first reason to motivate that bold assertion. CEM, in its standard formulation, deploys a two-place parthood relation. Sider, for instance, labels this choice as the Absoluteness thesis. Absoluteness rules out that parthood holds either relative to times or sortals, places, and what not [Sider (2008), pp. 71-2]. But endurance theory needs a three-place parthood relation between pairs of objects and times or spacetime regions in order to properly account for changes in composition over time. This tenet is a particular instance of the more general need of endurance theory to relativize properties to times. But if this three-place parthood relation is not available to endurantists, the prospects of the view are severely limited. So much so, that the dispute with perdurance theory would seem almost settled in favour of the latter. Perhaps the supporter of the metaphysical neutrality of CEM might reply that the core content of CEM could still be retained under a three-place parthood relation, with temporalized versions of the Reflexivity, Transitivity, and Antisymmetry. But that claim simply proves that CEM is not neutral as far as endurance theory goes, for it naturally endows perdurance theory

with a formal parthood framework where it can formulate its claims about composition.

Here is a second reason. Although the core axioms may vary from some formulations of CEM to others – resulting in weaker and stronger versions of the theory – there are at least three axioms that openly conflict with endurantist solutions to problems of parthood, identity, and constitution. The axioms are Extensionality, Antisymmetry, and Weak Supplementation. I cannot go into the details of the abundant number of examples one could find in recent literature that reveal this tension. Enough is to think nonetheless in all the ensuing discussion following the cases of Descartes and Descartes-minus [van Inwagen (1981)], Dion and Theon [Parsons (2004)], Lump1 and Goliath [Gibbard (1975)], and Tibbles the cat [Geach (1962), Wiggins (1967)], just to mention the most notorious ones. Likewise, the discussion of the peculiar cases of time travelling multi-located objects in previous sections could be taken as a further proof of precisely of this very same point.

On the face of this upshot, I would want to conclude with two recommendations for the present debate. Firstly, abandon the received monistic stance on parthood that is governed by the axioms of CEM and embrace the possibility that this opens for understanding material composition; the second one – and here I explicitly follow Donnelly – is that mereological theories should be developed in conjunction with metaphysical theories, and not be taken merely as background ideological assumptions by the latter, for there might simply not be a core mereology that could serve all plausible metaphysical theories [Donnelly (2011), pp. 245-6]. In recommending abandoning a monistic picture of parthood, I stretch this conclusion to issues that greatly exceed this paper. I am aware that the rejection of the view that there is a single fundamental topic-neutral notion of parthood requires much more careful work. In that regard, notice that my rejection of parthood monism constitutes a stronger stance than simply rejecting the topic-neutrality of parthood. For it could turn out that the axioms of CEM capture the “right” notion of parthood to be applied to material things, but fail to do so in the case of other categories of entities.²⁴

As to the second recommendation, we should conceive of mereology as embedded in the ideology of the metaphysical theory it allegedly supports. Think, to this effect, of the picture of the disagreement between endurantists and perdurantists discussed in II. What the disagreement boiled down to, amongst other things, is whether a notion of parthood that respects Absoluteness or one that doesn’t should be ap-

plied to the part-whole relations that we find in persisting material things. Endurantists hold that persisting things have parts relative to times so Absoluteness is not part of their ideology; perdurantists hold that persisting things do not have their parts relative to anything, so they take Absoluteness on board. Now, there is no way endurantists can get their view up and running if we take Absoluteness or some axiom of CEM as providing neutral premises upon which both parties of the dispute agree. All this might give place to a healthy theoretical anarchy when it comes to principles of mereology, which I welcome. In this new scenario, arguments that invoke mereological principles as premises in order to advance substantive metaphysical conclusions should be evaluated more critically, for those mereological principles will be displaying a part of the particular ideology advanced by theories in question and not a common neutral ground.²⁵

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NOTES

¹ I am not using “fill” here in the technical sense in which it features in Eagle’s theory of location [(2016), (2019)], but rather in an informal and unregimented way. According to Eagle’s locational notion,

x fills R iff each subregion of R overlaps an exact location of x [(2016), p. 2220].

² I here follow Varzi’s time-relative formulation [(2016)] of Transitivity, Antisymmetry, and Weak Supplementation:

Transitivity: $(Pxy \text{ at } t \ \& \ Pyz \text{ at } t) \rightarrow (Pxz \text{ at } t)$

Antisymmetry: $(Pxy \text{ at } t \ \& \ Pyx \text{ at } t) \rightarrow (x=y)$

Weak Supplementation: $PPxy \text{ at } t \rightarrow \exists z(Pzy \text{ at } t \ \& \ \neg Ozx \text{ at } t)$.

³ Spacetime frameworks could be divided into pre-relativistic and relativistic ones. Following a similar set up to Sattig’s (2006), our discussion in the coming sections assumes a very simple pre-relativistic substantialist conception of spacetime. On this pre-relativistic spacetime – roughly, a Neo-Newtonian one – we have a four-dimensional manifold of spacetime points that is more fundamental than space or time, with invariant relations of simultaneity and directionality between points. The points that form this manifold are concrete or substantial

points and any talk either about regions of space or instants of time must supervene on some arrangements of points of the manifold. The relation of simultaneity is an equivalence relation and consequently is reflexive, symmetrical, and transitive. The relation of directionality, on the other hand, allows us to have an ordering independent from the motion of the observers and intrinsic to this spacetime. It is structured on the basis of the earlier-than and later-than relations that hold between spacetime points.

Everything I say about locational accounts of endurance can be extended, with the due adjustments, to a relativistic spacetime like Minkowski's. As far as the formulations of the accounts go, adjustments require us to index claims about locations and composition to inertial frames of reference within that spacetime. But that does not mean that the transition from Neo-Newtonian spacetimes to a Minkowski spacetime does not open new challenges for endurance and perdurance theory.

⁴ Whether three-dimensional objects do really need to occupy Balashov's achronal regions of spacetime or instead some sort of thickness could be allowed for these regions is a relevant issue that I will not settle here. Gibson and Pooley (2006), in spite of claiming that enduring objects occupy temporally unextended, i.e. spacelike regions, deny that they occupy flat spacelike hypersurfaces, this fact being consistent with the spacetime topology entailed by General Relativity and even with a generic curved spacetime, or so they claim. Thus, on what follows, I stick to the minimum agreement to which both parties seem to be committed, namely, that enduring objects exactly occupy multiply space-like regions of the spacetime manifold.

⁵ Informally, I will assume that an object's spatiotemporal path is the fusion of all the regions that such object is exactly located.

⁶ More precisely, no part of x that lies in the temporally unextended spacetime region of which R is a sub-region.

⁷ A couple of remarks on this point are in order here. The first one is that I do not wish to enter into a dispute about the primitive character of exact location. Granted that accounts of exact location which preclude multi-location are off the table for the sake of the subsequent argument [think pre-eminently here in Parsons's (2007)], I wish to remain neutral as to whether we should go for a reductivist or non-reductivist account of exact location. All I will be demanding from the *preferred* account is that it meets (BC). Secondly, one should note the appeal that Eagle's recent attempt [(2016), (2019)] to define exact location may have for multi-location endurantists. However, I believe there are certain reservations endurantists ought to have with Eagle's account. To begin with, Eagle holds that his account of exact location is meant to be applied to mereologically simple entities and not macroscopic mereologically complex objects. And secondly, as Costa and Calosi have recently argued (*forthcoming*), it does not allow endurantists to account for mereological change through time.

⁸ Taking exact location as a primitive, one could define, as Gilmore (2006) does, the following locational notions:

x is entirely located at $R =_{df} (\exists S) (x \text{ is exactly located at } S \ \& \ s \text{ is a subregion of } R),$

x pervades $R =_{df} (\exists S) (x \text{ is exactly located at } S \ \& \ R \text{ is a subregion of } S),$

x is weakly located at $R =_{df} (\exists S) (x \text{ is exactly located at } S \ \& \ R \text{ overlaps } S).$

⁹ I thank an anonymous referee for pressing me to clarify these aspects of the relation between the notion of exact location and (BC).

¹⁰ Same considerations hold for the case of events and processes, which we could say occupy spatiotemporal regions in virtue of the material objects that are part of them. In their case, however, it seems more plausible to say that they will exactly located at the fusions of all the regions occupied by the material objects which we take to be part of them.

¹¹ I am not claiming here that there is nothing objectionable in these aspects of endurance theory, both in spacetime and non-spacetime frameworks, though by and large I am not convinced by the objections one can find in the literature. For objections to non-spacetime formulations, see Lewis (1986), (2002), Merricks (1994), and Sider (2001). For objections to spacetime formulations, see Johnson and Hales (2003) and Sattig [(2006)].

¹² Notice here that we could perfectly allow parthood, as Gilmore (2007), (2009), (2014), suggests to be treated as a four-place relation between pairs of objects and regions.

¹³ See Dorr (2005) and Sider (2013) for attempts in this direction.

¹⁴ I thank an anonymous referee for helpful comments to clarify the central point of my reply to Effingham and Robson's trilemma.

¹⁵ I take the notion of covering a region from Hawthorne (2006), p. 103, but define it with some changes as follows:

An object x covers a region $R =_{df} R$ fuses the set of regions where x is exactly located at.

¹⁶ For a statement and defence of this assumption, see McDaniel (2003), (2007) and Skow (2007).

¹⁷ This reply to the apparent discrepancies in properties between the brick wall and Brick₁ should in principle defuse the concerns raised by Effingham and Robson's argument to the contrary [Effingham and Robson (2007), pp. 637-8]. See Daniels (2014), pp. 97-9, for a more thorough reply on this issue, which I think it is not necessary to provide here. Both [Daniels (2014) and Eagle (2016)] follow this same general line of response to this paradox of multi-location. They couch their replies nonetheless using a slightly different locational apparatus, which they take from Eagle (2010), but does not change the substance of the argument in any relevant respect.

¹⁸ More on the motivation for accepting this maxim in section §4.

¹⁹ See Smith (2009) and [Effingham (2010) for the exchange that ensues from Effingham and Robson's original piece (2007).

²⁰ For a number of replies to Baker and Dowe's objection, see Beebe and Rush (2003), McDaniel (2003), Sattig (2006) [Costa and Calosi (2015), and Costa (2017)]. For Howfeber and Velleman's, see in turn Rossi (draft).

²¹ In a final rejoinder to Smith, Effingham notices that endurantists who deny Weak Supplementation in order to preserve multi-location still have to endorse an ad-hoc revised version of the principle to rule out undesirable cases of composition [Effingham (2010), pp. 337-40]. Perdurantists do not need to do so, for they could stick to the simple standard version of the principle. And that would give perdurantists, according to Effingham, the upper hand in this debate. However, no advantage is taken by perdurance theory here if we do not endorse any revised version of Weak Supplementation.

²² I thank again the helpful comments received from an anonymous referee for clarifying the point I make in this section against Kleinschmidt objection to multi-location endurance.

²³ And perhaps even more, as Sider claims, for it would make enduring things simply impossible if we take the axioms of CEM to express necessary truths [Sider (2008), pp. 86-7].

²⁴ Just to avoid confusions, I actually believe that the notion of parthood offered by CEM can successfully be applied to sets and events, for instance, but not to every metaphysical picture about material things, hence taking sides with those who think that CEM is just set-theory applied to material composition in disguise. I simply stipulate this possibility, which might suggest otherwise, for making my point across more forcefully.

²⁵ A systematic example of this intuition is the non-well founded mereology developed by Aaron Cotnoir [(2010), (2012); joint work with Bacon, (2013)]. Without entering into technical details, this non-well founded mereology allows for the reflexivity of proper parthood and rules out Antisymmetry, an interesting result which should be noted by multi-location supporters who wish to defend the view from paradoxical time-travel scenarios.

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