

How the block grows

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Abstract. I argue that the growing-block theory of time and truthmaker maximalism jointly entail that some truthmakers undergo mereological change as time passes. Central to my argument is a grounding-based account of what I call the ‘purely incremental’ nature of the growing-block theory of time. As I will show, the argument presented in this paper suggests that growing-block theorists endorsing truthmaker maximalism have reasons to take composition to be restricted and the ‘block’ of reality to literally grow as time goes by.

I. INTRODUCTION

According to the *growing-block theory* of time, while, (i) as time goes by, newer and newer entities constantly come into existence, (ii) no entity is ever annihilated in the process. The two main claims of the growing-block theory can be expressed by means of some primitive temporal operators (thought of as irreducible to quantification over times)¹ as follows (‘**A**’, ‘**P**’, and ‘**G**’ stand for ‘it is always the case that’, ‘it was the case that’, and ‘it will always be the case that’; ‘**E**’ is the existence predicate):²

(GB1) It is always the case that there is something which did not exist previously

$$\mathbf{A}\exists x\sim\mathbf{P}Ex$$

(GB2) It is always the case that everything will always exist

$$\mathbf{A}\forall x\mathbf{G}Ex$$

Growing-block theorists hold that both past and present entities exist and that the ‘present time’ is the latest time on the block of reality. Therefore, growing-block theorists also accept the following principle (except for the first moment of time, if any):³

(A-change) Some time t is such that it was the case that t is present (‘ $\pi(t)$ ’)

and yet t is not present (anymore)

$$\exists t(\mathbf{P}\pi(t) \wedge \sim\pi(t))$$

¹ For a similar approach see Sider (2001, pp. 14-15, 20; 2011, chapter 11) and Correia and Rosenkranz (2018, chapter 5).

² I will take the existence predicate ‘ E ’ to obey the following principle:

$$(EX) \quad \forall x(Ex \leftrightarrow \exists y(y = x))$$

As it will be clear below (section 2), I will allow for existential facts of the form ‘ Ea ’ to be *ungrounded*. For this reason, I leave here open the question about whether, within the framework of a theory of grounding, ‘ E ’ can be also *defined* along the lines of (EX). See, for some discussion, Fine (2012, pp. 59-62).

³ At the first moment of time it is false that it was the case that p , for every p (even logical truths). *A fortiori*, at the first moment of time it is also false that some t is such that *it was the case that t is present*.

Normally, talk of the ‘growth’ of the block is just taken to express the fact that the domain of the quantifier featuring in (GB1) and (GB2) is constantly increasing (see, for instance, Correia and Rosenkranz 2018, p. 168). Instead, in this paper I aim to present an argument showing (against the backdrop of some plausible assumptions) that growing-block theorists endorsing *truthmaker maximalism* (that is, the idea that every truth has a truthmaker) must take at least some entities to literally grow as time passes by acquiring new proper parts, and namely, those entities that make true propositions that cease to be true at a later time. As I will show, not only does this entail that growing-block theorists are confronted with an instance of the familiar puzzle of mereological change (which, in this case, seems to be best resisted by rejecting *mereological universalism*), but it also suggests that they should at least see favorably the idea that the block of reality itself literally grows as time goes by.

Before moving forward, some *caveat* is in place. The characterization of the growing-block theory by means of (GB1) and (GB2) appears to be pretty standard in the literature (see, among others: Sider 2011, pp. 263-264; Deasy 2017, p. 391; Correia and Rosenkranz 2018, pp. 36-50). Indeed, (GB1) and (GB2) appear to represent a very natural and intuitive way to capture what C. D. Broad (1923) considered to be the two main core aspects of the growing-block theory of time:

‘The sum total of existence is always increasing [...]. (Broad 1923, pp. 66-67)

‘There is no such thing as *ceasing* to exist; what has become exists henceforth forever.’ (Broad 1923, p. 69)

(see Correia and Rosenkranz 2018, p. 36 for some discussion). Be that as it may, however, in this paper I will not be concerned with the question about whether (GB1) and (GB2) are the best way to capture the idea of reality is a ‘growing block’ or whether there are theories not complying with either (GB1) or (GB2) that still deserve the label of ‘growing-block theory’. Instead, in what follows I will only focus on discussing the consequences of endorsing truthmaker maximalism for ‘growing-block theorists’ in the sense of (GB1)-(GB2). Of course, this also means that those who (i) find the general idea of a ‘growing reality’ appealing, (ii) agree with the results of this paper, but (iii) think that the price of truthmaker maximalism for (GB1)-(GB2)-theorists is too high, may take the argument I will present below as a *reductio* of the idea that (GB1) and (GB2) should be taken to be necessary elements of any ‘growing-block theory of time’.

II. MAIN PREMISES

In what follows ‘ T ’ is the operator ‘it is true that’, ‘ Mx ’ is the operator ‘ x makes it true that’, ‘ \leq ’ and ‘ $<$ ’ stand for parthood and proper parthood, respectively, ‘ $\exists F$ ’ is a second-order quantifier into predicate position, ‘ \mathfrak{I} ’ is the second-order predicate ‘is an intrinsic property’, and ‘ C_3 ’ is a first-order predicate standing for ‘has undergone some intrinsic change’ which is defined as follows:

(df- C_{\exists}) x has undergone some intrinsic change if and only if for some intrinsic F ,
 x is F and yet x wasn't F in the past
 $C_{\exists}x =_{df} \exists F(\exists F \wedge Fx \wedge \mathbf{P}\sim Fx)$

I adopt here an abundant conception of properties and assume that the class of intrinsic properties is closed under negation.⁴ Therefore, when an entity loses some intrinsic property F , (df- C_{\exists}) entails that it has indeed undergone some intrinsic change, as the entity in question must have thereby acquired the property of *being not- F* .⁵

I will follow Rosen (2010, pp. 114-115) and take facts to be true propositions and propositions to be structured entities (somehow) built up from worldly items and capable of having objects as constituents (I leave here open the question about whether constituents can or should be regarded as mereological parts). ' Cxy ' stands for ' x is a constituent of y ' (for readability's sake I will use ' f ', ' g ', ' h ',... as variables ranging over facts). If A is a sentence or a propositional variable, I will use ' $[A]$ ' as a term standing for 'the fact that A '. I will also embrace a *predicational* approach to metaphysical grounding (see Correia and Schnieder 2012, pp. 10-12) and take the notion of partial grounding to be expressed by the predicate ' \Leftarrow ' ('...is partially grounded in...'). ' $\mathcal{F}(x)$ ' stands for ' x is a fundamental fact' and is defined as follows:

(df- \mathcal{F}) $\mathcal{F}(x) =_{df} \sim \exists y(x \Leftarrow y)$

Finally, I will also assume *foundationalism*, here understood as the idea that every non-fundamental fact is fully grounded in some plurality of fundamental facts.⁶

Beyond (A-Change) and (GB2) the main argument of this paper relies on the following four premises:

(T-Max) For every p , if it is true that p , then there is some x that makes p true
 $\forall p(Tp \rightarrow \exists xMxp)$

(I-Ch) For every p , if p was true and it is (now) untrue, then for every x , if x was a truthmaker for p , then x has undergone some intrinsic change
 $\forall p((\mathbf{P}Tp \wedge \sim Tp) \rightarrow \forall x(\mathbf{P}Mxp \rightarrow C_{\exists}x))$

(P-Inc) For every true proposition p that was untrue in the past, there is some entity x and some fact f such that:
 (i) x didn't exist in the past,

⁴ On this idea see, for instance, Sider (1996, p. 15) and Weatherson (2001, p. 370).

⁵ For simplicity's sake, throughout the paper I will use ' F ' and the like as both names of properties and predicates. I will thus say both things like ' F is an intrinsic property' and ' x is F ', and let the context disambiguate.

⁶ See Dixon (2016).

- (ii) f is a fundamental fact,
- (iii) x is a constituent of f ,
- (iv) either f is the fact that p or the fact that p it is (at least) partially grounded in the fact that p .

$$\forall p \left((Tp \wedge \mathbf{P}\sim Tp) \rightarrow \exists x \exists f (\sim \mathbf{P}Ex \wedge \mathcal{F}(f) \wedge Cxf \wedge ([p] = f \vee [p] \Leftarrow f)) \right)$$

- (I-part) If F is an intrinsic property, then, for every x , if x is F , then for every y and g , if the fact that x is F is grounded in g and g has y as a constituent, then y is a part of x

$$\mathfrak{S}F \rightarrow \forall x \left(Fx \rightarrow \forall y \forall g (([Fx] \Leftarrow g \wedge Cyg) \rightarrow y \leq x) \right)$$

In the remainder of this section I will discuss these premises in turn.

2.1 (T-Max) and (I-Ch)

(T-Max) expresses *truthmaker maximalism*, that is, the idea that every truth has a truthmaker. It is common among truthmaker theorists to also assume *truthmaker necessitarianism*, that is the idea that, if an entity x makes a certain proposition p true, then it is necessarily the case that, if x exists, then p is true:

- (T-Nec) For every x and p , if x makes p true, then, necessarily, if x exists, then p is true
- $$\forall x \forall p (Mxp \rightarrow \Box(Ex \rightarrow Tp))$$

However, it appears difficult for growing-block theorists to endorse both (T-Max) and (T-Nec). In fact, it seems plausible to think that truthmaker necessitarians should at least find attractive the temporal counterpart of (T-Nec):

- (T-Alw) For every x and p , if x makes p true, then, it is always the case that, if x exists, then p is true
- $$\forall x \forall p (Mxp \rightarrow \mathbf{A}(Ex \rightarrow Tp))$$

Indeed, (T-Nec) actually *entails* (T-Alw) if the following plausible principle is also assumed:

- (Nec-to-Alw) For every p , if it is necessarily the case that p , then, it is always the case that p is true
- $$\forall x \forall p (\Box p \rightarrow \mathbf{A}p)$$

(see Dorr and Goodman 2020 for a recent defense of this principle).⁷ It is then easy to prove that (T-Alw), (T-Max), (GB2) and (A-change) form an inconsistent tetrad:

⁷ Correia and Rosenkranz (2020, pp. 596-8) doubt that (Nec-to-Alw) should consider part of the logic governing the interaction of tense and modality. Notice, however, that, on the one hand, even if it fails to be a logical truth in the relevant sense, (Nec-to-Alw) can clearly still be taken to be a metaphysical truth concerning time and

Proof: Consider a time T that was present in the past (by A-change). The proposition <T is present> was true. By (T-Max), <T is present> had a truthmaker (let us call it ‘M’). According to (GB2), M must still exist. By (T-Alw), <T is present> is still true. Yet T is *not* present. *Contradiction!*

Therefore, growing-block theorists endorsing truthmaker maximalism seem forced to embrace some form of *truthmaker contingentism*.

One of the most plausible instances of truthmaker contingentism in the literature appears to be what I will label here *truthmaker intrinsicalism* which draws on the theory presented by Parsons (1999).⁸ According to truthmaker intrinsicalism, if x makes P true, then P ’s truth *supervenes* on the *intrinsic nature* of x , where the intrinsic nature of x consists in the totality of x ’s intrinsic properties. The intuitive thought behind truthmaker intrinsicalism can be expressed as follows. To say that an actual truthmaker x for a proposition P may exist and yet P be false is to say that although x actually makes P true, x ’s existence is not enough. Therefore, what is responsible for P ’s truth must be something else concerning x : the way x is *intrinsically*.

As stated above, I am adopting here an abundant conception of properties and am also assuming that the class of intrinsic properties is closed under negation. Given these assumptions, truthmaker intrinsicalism entails that if a certain entity x makes a certain proposition p true, then it is necessarily the case that, if x exists and yet p is not true, then x instantiates some property that it doesn’t actually instantiate (‘Act’ is the actuality operator ‘it is actually the case that’ thought of as always rigidly pointing back to the actual world):

(T-Int) For every x and p , if x makes p true, then necessarily, if x exists and p is not true, some F is such that (i) F is an intrinsic property, (ii) x is F , and (iii) it is actually the case that x is not F .

$$\forall x \forall p (Mxp \rightarrow \Box((Ex \wedge \sim Tp) \rightarrow \exists F (\mathfrak{S}F \wedge Fx \wedge Act \sim Fx)))$$

Suppose, in fact, that x is an actual truthmaker for p and that there is a merely possible world w at which x exists and yet p is false. According to truthmaker intrinsicalism, the way x is intrinsically at w must be different from the way x is intrinsically in the actual world. In turn, this must be either because x doesn’t actually instantiate some intrinsic property it instantiates at w (as T-Int says) or because x doesn’t instantiate at w some intrinsic property F it actually instantiates. However, in the latter case x must instantiate at

necessity; on the other hand, the kind of metaphysical views Correia and Rosenkranz (2020, pp. 596-8) appeal to in order to undermine the ‘logicality’ of (Nec-to-Alw) (which involve either (i) entities acquiring essential properties they didn’t have before, (ii) *haecceities* coming into existence without having the possibility of ceasing to be, or (iii) the universe ending at a certain point in time as a matter of metaphysical necessity) seem to show that a rejection of (Nec-to-Alw) is likely to commit one to some controversial metaphysical thesis. The assumption of (Nec-to-Alw) in this context seems, thus, to be pretty safe.

⁸ On truthmaker contingentism see also Briggs (2012).

w the property of *being not-F* (given the abundant conception of properties I am assuming in this paper) which must also be an intrinsic property (given that the class of intrinsic properties is closed under negation). Therefore, also in this case it follows that (T-Int) is true.

The temporal counterpart of (T-Int) says that if a certain entity x makes a certain proposition p true, then it is *always* the case that, if x exists and yet p is not true, then x instantiates some property that it doesn't instantiate *now* ('N' is the now-operator 'it is now the case that' thought of as always rigidly pointing back to the present 'stage' of temporal passage at which a certain time T is present):⁹

(T-Int-temp) For every x and p , if x makes p true, then it is always the case that, if x exists and p is not true, then some F is such that (i) F is an intrinsic property, (ii) x is F , and (ii) it is now the case that x is not F .¹⁰

$$\forall x \forall p (Mxp \rightarrow \mathbf{A}((Ex \wedge \sim Tp) \rightarrow \exists F (\mathfrak{S}F \wedge Fx \wedge \mathbf{N}\sim Fx)))$$

It is easy to check that (the 'alwaysation' of) (T-Int-temp) entails (I-Ch):¹¹

(I-Ch) For every p , if p was true and it is (now) untrue, then for every x , if x was a truthmaker for p , then x has undergone some intrinsic change

$$\forall p ((\mathbf{P}Tp \wedge \sim Tp) \rightarrow \forall x (\mathbf{P}Mxp \rightarrow C_{\mathfrak{S}}x))$$

Suppose, in fact, that when T1 was present x was a truthmaker for p . Since (T-Int-temp) is plausibly always true, it was true also when T1 was present. Therefore, it was true also when T1 was present that it is always the case that if x exists and p is not true, x is intrinsically different from how it is at T1. Therefore, it is also *currently* the case (now that, say, T2 is present) that if x exists and p is not true, x is intrinsically different from how it was at T1. Given (GB2), we have that x still exists now. Therefore, if p is indeed not true, x must have undergone some kind of intrinsic change.

To sum up: the growing-block theory, truthmaker maximalism, and truthmaker intrinsicalism jointly entail that whenever a true proposition becomes untrue its former truthmakers undergo some intrinsic change.

⁹ To clarify, I take the following principle to be valid for growing-block theorists (where 'H' stands for 'it was always the case that'):

(N) $\mathbf{H}\forall x \mathbf{N}Ex$

¹⁰ Notice that ' x is F and it is now the case that x is *not F*' is embedded by 'it is always the case that' and so that it doesn't entail that it may be sometimes the case x is *both F and not-F*. In other words, the consequent of (T-Int-temp) only says that, for every time T, if x exists at T and yet p is not true at T, then there is some intrinsic F such that x is F at T and yet x is *not F* at the present time U (which isn't required to be identical to T).

¹¹ More precisely, (I-Ch) is entailed by the 'alwaysation' of (T-Int-temp) jointly with (EX) (see footnote 2).

2.2 (*P-Inc*)

The growing-block theory appears to be (what we may call) a ‘purely incremental’ theory of time, in the sense that what happens as time goes by for growing-block theorists is *only* that newer entities come into existence (instantiating properties and relations).¹² As Broad (1923) himself puts it:

‘Nothing has happened to the present by becoming past except that fresh slices of existence have been added to the total history of the world.’ (Broad 1923, p. 66).

For growing-block theorists ‘all that God has to do’ in order to make time pass a little bit longer is just to create some new entities (along with their properties and the relations they bear to other entities). No other action from God is required, let alone any action that directly changes any aspect of what already existed.

How can the purely incremental nature of the growing-block theory be properly formulated? A first idea may be that of taking the only kind of change entities can go through as they become past to be *extrinsic*:

‘Broad claims that as something goes from being present to being past, nothing intrinsic to it changes. The only change is relational.’ (Merricks 2006, p. 104)

However, this idea cannot be endorsed by growing-block theorist embracing both truthmaker maximalism and intrinsicism, as (I-Ch) requires that the past truthmakers of now-false propositions have undergone some kind of intrinsic change. Furthermore, as it will become apparent below, there appears to be at least one kind of intrinsic change that that past can undergo which appears to be perfectly compatible with the growing-block theory.

A second, more promising way to express the purely incremental nature of the growing-block theory might be that of saying that the only propositions that can become true are those saying of some newly existing entities either that they exist or that they instantiate certain properties and relations. Unfortunately, also this idea proves to be inadequate. Suppose, in fact, that *b* is a newly existing entity and that *a* already existed before. Suppose, furthermore, that for some properties *F* and *G*, *a* is *F* and that *b* is the only entity that is *G*. In this case, the following are all examples of propositions that have just become true and yet intuitively do not comply with the idea just presented:

- (i) *a* exists and *b* exists
 $Ea \wedge Eb$
- (ii) *a* is *F* and *b* is *G*
 $Fa \wedge Gb$
- (iii) Something is *G*
 $\exists xGx$

¹² See also Correia and Rosenkranz (2018, pp. 88-90).

The problem with (i)-(iii) is that both b 's existence and its being G help determine many facts that are not identical either to the fact that b exists or to the fact that b is G (like the fact that a is F and b is G and the fact that *something is G*). This appears to lend some plausibility to the idea that the purely incremental nature of the growing-block theory is best formulated by means of the notion of *metaphysical grounding*.¹³ As a matter of fact, it seems plausible that, although growing-block theorists must accept that as time passes there are new facts not concerning solely the existence of new entities or their properties, they can nevertheless claim that every new fact that is not the fundamental fact that x exists or that x is F (for some newly existing x and property F) must be at least *grounded* in facts concerning new entities. This grounding-based way to express the purely incremental nature of the growing-block theory can be expressed by (P-Inc). According to (P-Inc), although the increase of the sum total of existence may help ground truths that don't concern just newly existing entities, what only goes on at the *fundamental* level of reality while time passes is just that new entities, equipped with their properties and relations, come into existence.

2.3 (I-Part)

(I-Part) is entailed by the grounding-based definition of the notion of intrinsic property proposed by Rosen (2010):

(GI-def) ' F is an intrinsic property iff, as a matter of necessity, for all x :
 If x is F in virtue of $\phi(y)$ —where $\phi(y)$ is a fact containing y as a constituent—then y is part of x ; and
 If x is not- F in virtue of $\phi(y)$, then y is part of x .
 (The last clause ensures that *loneliness*—the property a thing has when there are no things distinct from it—is not deemed an intrinsic property.)'
 (Rosen, 2010, p. 112)

(Gi-def) has a great deal of plausibility to it, at least *prima facie*. On the one hand, it seems natural to think that the fact that x instantiates the property F can be fundamental only if F is an intrinsic property (if F was an extrinsic property, the fact that F is x would seem to *depend* on the fact that x 's *surroundings* are in a certain way). On the other hand, if the fact that x is F only depends on facts concerning *parts* of x , it seems highly plausible to take F to be an intrinsic property. Suppose, instead, that x is F , F is an intrinsic property, and the fact that x is F is grounded in certain facts having only certain entities y_1, y_2, \dots, y_n as constituents. How could F be an intrinsic property of x if one of the y s wasn't contained in x as a part? Consider, for instance, a certain wall W . W has many parts: bricks, grains of sand, electrons, *et cetera*. Suppose that W has a certain property F that depends on the fact that some entity y that is not a part of W has a certain property G . Intuitively, if y is not a part of W , then y must be an entity that just belongs to x 's surroundings. But in that case F

¹³ On the notion of metaphysical grounding see, among many others, Rosen (2010), Correia and Schnieder (2012), Fine (2012), Bliss and Trogon (2016).

cannot be an *intrinsic* property of the wall, since it doesn't depend solely on how the wall is 'in itself'.

Marshall (2015) and Bader (2013) have recently argued that (GI-def) is open to counterexamples. For instance, the fact that the singleton {Obama} exists depends, according to many authors, on the fact that Obama exists. If one also holds that Obama is not a part of {Obama}, (G-def) ends up classifying the property of existing as *extrinsic* (Marshall 2015, p. 12). Interestingly, however, Marshall's and Bader's examples seem to involve only properties that are *always* had by an object insofar as it exists, such as 'existing', 'having a member', 'having a predecessor' (Marshall 2015, p. 13), or 'being [either I or not-I] or lonely' (where *I* is an intrinsic property; Bader 2013, p. 555n43). However, the class of properties that are relevant for the argument of section 2 belong to the class of properties that can be *changed* over time. Therefore, at least the version of (I-Part) that is restricted to these properties seems to be sufficiently safe from this kind of objection.

III. THE ARGUMENT

Jointly with (GB2) and (A-theory), (T-Max), (I-Ch), (P-Inc), and (I-part) entail that every proposition *p* that has become untrue is such that its past truthmakers have acquired some new proper part:

- (M-Ch) For every *p*, if it was true that *p* and yet *p* is not true anymore, then (i) there is something that was a truthmaker for *p* and, for every *x*, if *x* made *p* true, then some *y* is such that it is a proper part of *x* although it wasn't a part of *x* before
- $$\forall p((\mathbf{P}T p \wedge \sim T p) \rightarrow (\exists x \mathbf{P}M x p \wedge \forall x(\mathbf{P}M x p \rightarrow \exists y(y < x \wedge \mathbf{P}y \not\leq x))))$$

Proof. From (A-change) we have that some proposition *q* (of the form <T is present>) was true in the past but is not true anymore:

$$(1) \quad \sim T q \wedge \mathbf{P}T q$$

By (T-Max), *q* had a truthmaker. Let's call it '*a*':

$$(2) \quad \mathbf{P}M a q$$

By (GB2), *a* still exists even if *q* is now untrue (from (1)):

$$(3) \quad E a \wedge \sim T q$$

By (T-Int) it follows that, since *a* made *q* true and *a* still exists even if *q* is now untrue, *a* must have undergone some intrinsic change. Therefore, there must be an intrinsic property that *a* now instantiates and that it didn't instantiate before. Let *S* be this property:

$$(4) \quad \mathfrak{S} S \wedge S a \wedge \mathbf{P}\sim S a$$

It follows from (4) that the proposition that a is S has changed its truth-value and has become true:

$$(5) \quad \mathbf{P}\sim TSa \wedge TSa$$

From (P-Inc) and (5) we have that some newly existing entity b is such that, for some fundamental fact f having b as a constituent, either f is the fact that a is S or the fact that a is S is grounded in f .

$$(7) \quad \sim \mathbf{P}Eb \wedge \mathcal{F}(f) \wedge Cbf \wedge ([Sa] = f \vee [Sa] \Leftarrow f)$$

Suppose, that b is *not* a constituent of $[Sa]$. f and $[Sa]$ are, thus, different facts. From (4) and (7) we have that (i) S is an intrinsic property of a , (ii) the fact that a is S is grounded in the fact f , and (iii) b is a constituent of f :

$$(8) \quad \mathfrak{S}S \wedge [Sa] \Leftarrow f \wedge Cbf$$

(8) and (I-part) jointly entail that b is a part of a , and therefore, that b is a proper part of a (being a different from b):

$$(9) \quad b < a$$

Suppose, instead, that b is a constituent of $[Sa]$. In this case there appear to be at least two ways to conclude that b must be a part of a . The first way uses the following principle:

(C-part) If F is an intrinsic property, then, for every x , if x is F , then for every y , if the fact that x is F has y as a constituent, then y is part of x

$$\mathfrak{S}F \rightarrow \forall x(Fx \rightarrow \forall y(Cy[Fx] \rightarrow y \leq x))$$

Those who accept (I-part) should find (C-part) similarly appealing. In fact, it appears plausible to say that y can be a constituent of the fact that x is F either by being a part of x or by (somehow) being a constituent of the property F (in the sense in which, for instance, Michelle Obama might be said to be a constituent of the property ‘being married to Michelle Obama’). Here F is an intrinsic property of x . But the same kind of intuition bolstering (I-part) seems to also bolster the idea that every constituent (if any) of an *intrinsic* property of a certain entity must be *part* of that entity. Suppose, in fact, that y is a constituent of a property F , x is F , and y is not part of x . In that case, it would seem that at least part of the way x is (namely, its being F) involves some entity that is not contained in x and that must instead be part of x ’s surroundings. Therefore, x ’s being F cannot be considered to be something that is intrinsic to x . For instance, Michelle Obama is not part of Barack Obama. However, we may assume, she is a constituent of the property ‘being married to Michelle Obama’. Barack Obama instantiates the property of being married to

Michelle Obama. (C-part) correctly predicts that ‘being married to Michelle Obama’ is not an intrinsic property of Barack Obama.

The second way to defend the idea that in the case under consideration b must be part of a invokes the principle according to which if an entity y is a constituent of a property F , then the fact that a different entity x instantiates F must at least partially depend on—and, thus, be partially grounded in—some fact having y as a constituent (a fact which may or may not be the fact that y exists; in what follows ‘ CxF ’ stands for ‘ x is a constituent of the property F ’):

(Dep) If y is a constituent of the property F , x is F , and x is different from y , there is some fact f having y as a constituent such that the fact that x is F is partially grounded in f :

$$\forall x \forall y ((CyF \wedge Fx \wedge x \neq y) \rightarrow \exists f (Cyf \wedge [Fx] \leftarrow f))$$

Consider again the property of being married to Michelle Obama. Barack Obama instantiates that property. The fact that Barack Obama instantiates that property is plausibly grounded in the fact that Barack Obama is married to Michelle Obama (see, for example, Fine 2012, p. 68), which is plausibly a fact having Michelle Obama as a constituent. Given (Dep) and (Gi-def) it follows also in this case that b is a part of a , and therefore, that b is a proper part of a .

b didn’t exist before. *A fortiori*, it was never part of a before. This means that a has just acquired a *new* (proper) part:

$$(9) \quad \exists x (x < a \wedge \mathbf{P}(x \not\leq a))$$

By generalization, this argument shows that every proposition p that ceases to be true as time passes is such that its past truthmakers have undergone some kind of *mereological change* and have acquired at least one new proper part, so that (M-Ch) is true. *Q.E.D.*

IV. TRUTHMAKERS AND MEREOLOGICAL CHANGE

Some may use the results reached in the previous section to present the following objection:

- (i) truthmakers are Armstrongian states of affairs (that is, ‘instantiations of universals by particulars’; Armstrong 1997, p. 119);
- (ii) Armstrongian states of affairs cannot undergo mereological change;
- (iii) therefore, the combination of the growing-block theory and truthmaker maximalism is to be rejected (as requiring that at least some truthmakers do undergo some mereological change).¹⁴

(ii) immediately follows under the assumption that Armstrongian states of affairs are *non-mereological composites* (Armstrong 1997, p. 118). However, (ii) should be plausible even for compositional pluralists like McDaniel (2009) who claim that ‘that there are many fundamental parthood relations’ (McDaniel 2009, p. 254)’ and that one of them (‘*s-*

¹⁴ Many thanks to an anonymous referee for this Journal for pressing me on this issue.

parthood'; McDaniel 2009, p. 251) relates the constituents of a state of affairs to the state itself. As a matter of fact, if states of affairs are composite entities, they plausibly possess their parts essentially. Consider the state of affairs *S* of the electron e_1 having spin-up which has as *s*-parts the electron e_1 and, say, the universal U =‘having spin up’. Plausibly, any state *T* that is just like *S* only except for having either a different electron e_2 or the universal D =‘having spin down’ as *s*-parts (instead of either e_1 or U , respectively) would be a *different* state (namely, either the state of e_2 having spin up, or the state of e_1 having spin down).

Be that as it may, however, growing-block theorists endorsing truthmaker maximalism can actually concede the truth of (ii) as they appear to have good independent reasons not to accept (i). As a matter of fact, as we observed in section II.1, the kind of growing-block theorists under discussion reject the idea that truthmakers necessitate the truth of the propositions they make true. However, Armstrong’s (1997, pp. 116-118; 2004, pp. 48-49) main argument for taking truthmakers to be states of affairs crucially depends on the assumption of the truthmaker necessitarianism:

‘It does not matter whether we work with tropes or universals, and again whether we work with bundles or substances with attributes. The same powerful truthmaker argument for states of affairs or (metaphysical) facts can be mounted. [...] *Truthmakers must necessitate*, and the mere entities or their mere mereological sum by hypothesis cannot necessitate the linkages required. *So there must exist states of affairs to be the truthmakers [...]*’ (Armstrong 2004, pp. 48-49; my italics)

In other words, if truthmaker necessitarianism is assumed, a red rose cannot be the truthmaker for <the rose is red> precisely because its existence fails to necessitate the truth of <the rose is red> (since the rose might have had a different color). Therefore, the truthmaker for <the rose is red> must be an entity that *cannot* exist without the rose being red, like the state of affairs of the rose being red. However, if truthmaker necessitarianism is *not* assumed, there seems to be no reason to introduce in one’s ontology entities like the state of the rose being red (indeed, the apparent ability of embracing truthmaker maximalism without inflating one’s ontology with states of affairs appears to be a *virtue* of truthmaker intrinsicism). Therefore, in this case the role of truthmakers can be played by entities that—like the red rose—are endowed with the needed mereological structure (but without possessing their parts essentially).

It seems, therefore, that growing-block theorists embracing truthmaker maximalism shouldn’t be worried by the objection from Armstrongian states of affairs.

V. HOW THE BLOCK GROWS

Let *P* be a proposition that was true one moment ago (when T1 was present) and that is now (that T2 is present) untrue. It follows from (M-Ch) that there was a truthmaker for *P* that still exists (even if it doesn’t make *P* true anymore) and that has acquired a new (proper) part. Let *m* be such an entity. Suppose that, when T1 was present, *m wasn’t* a mereological atom and so that it had proper parts. Let the *as* be the proper parts of *m* when T1 was present and let the *bs* be the proper parts of *m* now that T2 is present. We can, then, reason as

follows. Since (as we just proved in the previous section) something that wasn't part of m is now part of m , the as are distinct from the bs (in the sense that either some of the as are not among the bs , or some of the bs are not among the as). If we assume that the axioms of classical mereology are always the case, it follows that is also always the case that every plurality of entities has a unique fusion.¹⁵ For instance, m is clearly the unique fusion of the bs . *Let's then assume that*—now that T2 is present—*the unique fusion of the as is different from m* and let k be this entity (I will return to this assumption below). The as existed when T1 was present and m was the fusion of the as then. k is now the fusion of the as . It also appears plausible to suppose that when T1 was present k already existed and was already composed of the as . However, this means that when T1 was present the as had *two* fusions, namely, m and k . Therefore, contrary to what we are assuming, it wasn't always the case that every plurality of entities has a unique fusion. *Contradiction!*

We have reached a version of the familiar puzzle of mereological change.¹⁶ In this case, it may seem that growing-block theorists have three main options to resist the threatened contradiction:

- (O1) deny that k was composed of the as when T1 was present;
- (O2) reject the principle according to which every plurality of entities has at most one fusion;
- (O3) reject mereological universalism.

However, the idea that k started being composed of the as only when m underwent mereological change cries out for justification. Therefore, absent some plausible, independent story of what exactly forces the as to start composing an entity they didn't compose before once m grows by incorporating new parts, this option can be safely left aside. The only two live options to address this puzzle appear, thus, to be only (O2) and (O3). In the remainder of this section I will argue that (O3) seems to be the best option for growing-block theorists endorsing truthmaker maximalism.

According to growing-block theorists, being present boils down to being 'at the edge' of the growing block. In the case of times, a time T is present if and only if every other time on the block (if any) is earlier than T . Given truthmaker intrinsicalism, the truthmaker for $\langle T \text{ is present} \rangle$ is an entity that is *intrinsically* such that *every time U different from T is earlier than T* . This idea, coupled with the argument discussed in section 3, seems to suggest the following metaphysical picture. The 'block' of reality is the mereological

¹⁵ For instance, classical mereology can be axiomatized by means of just two claims: (i) parthood is transitive; (ii) every plurality of entities has a unique fusion (see Hovda 2009, p. 82). In this case, to assume that the axioms of classical mereology are *always the case* is to assume the two following tensed truths (where ' xx ' is a plural variable, ' $yFxx$ ' stands for ' y is a fusion of the xx ' and ' $\exists! y \dots$ ' stands for 'there is a unique y such that...'):

(TCM1) $\forall x \forall y \forall z ((x \leq y \wedge y \leq z) \rightarrow x \leq z)$

(TCM2) $\forall xx \exists! y (yFxx)$

¹⁶ On the puzzle of mereological change see, among others, Sider (2003, chapter 5), van Inwagen (2006) and Olson (2006).

fusion of every concrete entity and always contains every concrete entity as a part.¹⁷ Therefore, it is always the case that the newly existing present time T is a new proper part of the block that lies at ‘the edge’ of the block. As time goes by, the *block grows* and $\langle T \text{ is present} \rangle$ becomes false. But $\langle T \text{ is present} \rangle$ becomes false precisely *because the block itself has acquired a new proper part*: the time U which is now the ‘new present time’. According to this picture, the growing block is an entity that *literally grows* in time by acquiring newer and newer proper parts. Therefore, in the case we have just considered, *m*—the truthmaker at T1 of $\langle T1 \text{ is present} \rangle$ —*is the block itself*. When T2 becomes present the block undergoes some mereological change and acquires new proper parts. $\langle T1 \text{ is present} \rangle$ becomes false. Now that T2 is present, *m* (the block) makes $\langle T2 \text{ is present} \rangle$ true.

In this scenario the *as* are all the proper parts of the block when T1 is present (notice that in this case it is also highly plausible to think that, when T1 was present, the block *wasn't* a mereological atom). Given that *m* is the growing-block itself we appear to have good reasons to think that *m* is *not* a fusion of the *as* anymore (as we assumed above). Consider, in fact, the following standard definition of mereological fusion:

Fusion: *x* is a fusion of the *ys* if and only if (i) each of the *ys* is part of *x* and (ii) every part of *x* overlaps at least some of the *ys*

Suppose that, now that T2 is present, *m* is still a fusion of the *as*. It follows from the second conjunct of Fusion that every entity that is now part of the block overlaps at least some of the *as*. What are the *as* in this case? Plausibly, a combination of regions of spacetime (spanning up to time T1) and objects located at them. Now that T2 is present, the block has acquired some new proper parts, namely, some other regions of spacetime plus some newly existing objects located at them. If the block was still a fusion of the *as*, it would thus follow from Fusion that each of its new parts overlaps at least some of the *as*. But this doesn't sound at all plausible. Surely, the newly existing regions of spacetime (time T2 and all of its proper parts) are disjoint from each of the old ones. Furthermore, it is also highly plausible to suppose that at least some (if not all) of the newly existing objects will be located *only* at the new regions of spacetime. It is then sufficient to assume just a modicum of ‘harmony’¹⁸ between the mereological structure of objects and the mereological structure of the spatiotemporal regions they occupy to conclude that those objects must be disjoint from all of the *as*. Therefore, we can conclude that the block isn't a fusion of the *as* anymore and so that the version of the growing-block theory under consideration is indeed saddled by the mereological puzzle presented above.

According to the main idea behind option (O2) (see above), now that T2 is present the *as* fuse an entity *k* which is different from the block of reality. *k* is an entity that looks exactly like the block looked like when T1 was present. Since, however, we are rejecting (O1) we must conclude that when T1 was present the block and *k* co-existed. Not only.

¹⁷ Alternatively, one could think of the block as the fusion of every entity whatsoever. I am here ignoring this option for simplicity's sake.

¹⁸ For an introduction to ‘harmony’ principles see Gilmore (2018, § 3).

Since they had the same proper parts, they were plausibly *co-located*. Furthermore, supposing that T1 isn't the first time on the block of reality, this case of co-location must be a case of *four-dimensional co-location*, as it involves two entities that are extended both in space *and* time! It is thus possible to conclude that the most plausible option for growing-block theorists is (O3) and, namely, the rejection of mereological universalism.

The resulting metaphysical picture is, thus, the following. While the block grows, there is always something (namely, the block itself) that is the fusion of every concrete entity. However, at every stage of the growth of the block there is no entity that is mereologically like the block was when some past time was present. For instance, while—when T1 is present—there is indeed an entity (that is, the block) which is the mereological fusion of all the concrete entities, when T2 becomes present there is no entity that is the fusion of all the concrete entities that existed when T1 was present.

VI. CONCLUSION

The metaphysical picture that is suggested by the main argument presented in this paper seems to require growing-block theorists endorsing truthmaker maximalism to reject mereological universalism. This entails that this kind of growing-block theorists have the burden to give an account of the way composition is restricted within their theory. Whether this challenge can be adequately addressed remains to be seen. Notice, for instance, that, since at every 'stage' of the growth of the block there is something that is the mereological fusion of every concrete entity, growing-block theorists cannot simply answer van Inwagen's (1990) 'Special Composition Question' by claiming that composition is 'brutal' (Markosian 1998). Be that as it may, however, if what I have argued in this paper is correct, growing-block theorists endorsing truthmaker maximalism seem to have at least some reason to claim that *this* is indeed how the block grows.¹⁹

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