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The Unrealities of Time

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ABSTRACT: *Is time flowing? A-theorists say 'yes', B-theorists say 'no'. But both take time to be real, which means that B-theorists accept that time is real, even if lacking a property usually ascribed to it. In this paper, I ask what the different properties usually ascribed to time there are in order to draw the list of different possible kinds of realism and anti-realism about time. As we will see, there are three main kinds of anti-realism. I will argue that if time is defined as the universe's fourth dimension, there is no way time could be unreal.*

RÉSUMÉ : Le temps s'écoule-t-il? Les théoriciens A répondent positivement, les théoriciens B négativement. Les deux camps s'accordent cependant sur la réalité du temps. Cela signifie que les théoriciens B acceptent la réalité du temps en dépit du rejet d'une propriété qui lui est communément attribuée. Dans cet article, je veux examiner les différentes propriétés qui sont généralement attribuées au temps afin de faire la liste des différents types de réalisme et d'anti-réalisme. Nous le verrons, il existe trois types d'anti-réalisme. Je soutiendrai que si l'on définit le temps comme la quatrième dimension de l'univers, l'irréalité du temps est exclue.

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1. Introduction

These days, one can hear some physicists claiming that time is or might be unreal. But it is difficult to understand what exactly is supposed to be unreal, since there is no consensus about what time *is supposed to be*. In this paper, I offer a clarification of different possible kinds of anti-realism about time in order to understand these anti-realist claims. I should emphasize that this work involves conceptual analysis, not philosophy of physics. Hence, I will not claim to fully understand the models on which physicists are working. My aim is more modest: in offering clarifications of the concept of time, I hope to make clear what different options are on the table with respect to the (un)reality of time. Let us start by quoting some claims. For instance[1], Julian Barbour writes:

> I believe in a *timeless universe* for the childlike reason that time cannot be seen—the emperor has no clothes. I believe that the universe is static …[2].

[1] See also Witten (2001, 125).

[2] Barbour (1999, 251).

Or to take another example, Carlo Rovelli writes:

> Einstein's discovery is that newtonian spacetime and the gravitational field are the same entity. This can be expressed in two equivalent ways. One states that *there is no spacetime*; there is only the gravitational field. This is the choice I have made in this book[3].

To be sure, Rovelli and Barbour are not endorsing the same view. But what they share is the idea that time is unreal. Once again, I am not a physicist and I will not pretend to fully understand how the world would look like if Rovelli's or Barbour's views describe adequately the actual world. However, I believe there is an *overstatement* in the idea that time is unreal and that some conceptual analysis might help understand what exactly comes under attack with such anti-realist claims. I believe that the idea that time is unreal is not only counter-intuitive, but more problematically, incompatible with what we know about the universe in which we live. I hope that at the end of the day I will have convinced you that, even in the more anti-realist account about time, there is still something 'temporal' in the world, at least in a minimal way, and that physicists cannot deny reality to time, but only to particular *properties of time*.

Before pursuing, it is important to say a few words about *fundamentality*. Physicists and philosophers of physics sometimes say that there is no time at the fundamental level of reality[4]. This idea of fundamentality might correspond to two things. Either there is a *genuine fundamentality* because the world is layered in a plurality of levels, or this is only a *way of speaking*. I believe that most of these physicists mean this fundamentality to be only a way of speaking. Hence, the idea that there is no time at the fundamental level of reality would only mean that, properly speaking, there is no time *at all*.

But alternatively, some might believe that time is a sort of emergent property or phenomenon. This relation of emergence carries the idea of a robust relation between distinct properties or phenomenon. Time would be real at some *less basic level*, and unreal at some *fundamental level*. The idea of a stratified ontology with some level connected to another level by ontological connections is not specific to philosophical matters about time (or spacetime). Let us remember debates on the relation between mental and physical properties, or between normative properties and natural ones. Are aesthetics properties of a landscape *supervening* on natural properties of that landscape? Are they *grounded* in it? Are they *emergent* properties? Is this relation an instance of an ontological primitive? Or, on the contrary, are we just dealing with a *relation of identity* between two descriptions of one and only one entity? Hence, the idea of a fundamental level is not proper to philosophy of time, to say the least.

However, let us just notice that in the case of time, *local supervenience* is unavailable. Indeed, for any entity *x* that could be said to supervene on any entity *y*, *x* and *y* have to exist at the same place at the same time. Then, claiming that time locally supervenes on a physical situation generates a vicious circle. It would mean that time supervenes on a physical situation at some place and at some time. Then, if time supervenes on the non-temporal realm, it does so with a relation of *global supervenience*: the whole time (or spacetime) supervenes on the whole non-temporal (or non-spatio-temporal) realm. It means that, for two possible worlds *w1*

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3 Rovelli (2004, 77).

4 See for instance Monton (2009).

and *w2*, if *w1* and *w2* are physically indiscernible with respect to their non-temporal (or non-spatio-temporal) properties, they are also indiscernible with respect to their temporal (or spatio-temporal) properties.

One possible problem for that supervenience relation is that it doesn't explain anything. It describes co-variance between sets of properties, without telling us why there is such a co-variance. The co-variance could follow from the identity of the two sets of properties. But, as we know, it could be the result of a more robust ontological relation as grounding or realization. From a dialectical point of view, the supervenience relation is very interesting: issues associated with it would also be issues for any ontological relation covered up by the broad category of supervenience. While I do not have a knock-down argument against the idea of emergence, this idea implies a weird ontological relation between a fundamental non-spatio-temporal realm and time properties. Following this idea implies having a primitive ontological relation of fundamentality and accepting a stratified ontology. Nevertheless, in what follows I will focus on the reality of time independently of the indexation of time to a particular level of reality. I believe that all of what I will say is compatible with both a layered and a flat ontology.

Why exactly are these physicists claiming that time is unreal? Probably because the variable *t* classically associated with time cannot be found in some mathematical equations. Hence, they conclude that time is unreal. I take this move to be too radical. As I will try to show, the variable *t* is not the only thing that points towards the existence of time. A better strategy would be to assume that time is real, and that we must find out what it is. This is not to say that one should not be skeptical about the existence of some alleged *properties* of time. As I will argue, there are different kinds of *realism/anti-realism* about time, according to the property of time considered. Hence, in order to understand the various realist and anti-realist claims available, we must look first at the *concept* of time. To start, I will describe McTaggart's famous kind of anti-realism and the discussion it launched between A- and B-theorists[5].

2. A First Unreality

Let us start with a famous debate over the existence of a *flow of time*. According to the A-theory, things *really* are passing in time independently of our perceptions, by the dynamic power of A-properties: properties of being past, present and future[6]. Things are first future, then they are present and after that, they become past. This implies an ontological distinction between past, present and future. The property of being present would be moving in spacetime by applying successively to different slices of this spacetime. An object is present if it is located in the only slice that owns the transitory property of being present. On the opposite, B-theorists about time do

[5] Brian Monton (2009) aims at using McTaggart's claim that time is unreal to interpret physicists' claims that time is unreal. His aim is the same as mine: to make clear what it can mean that time is unreal. I take my account to be a contribution towards this goal. However, while Monton uses McTaggart's conceptual tools to describe different physical views (special relativity, general relativity, quantum mechanics and quantum gravity), my own goal is more conceptual. I want to make clear what the different options are for counting a physical or a metaphysical theory as being anti-realist about time.

[6] For a defense of the view, see for instance Markosian (1993) and Zimmerman (2008).

not believe in the reality of such transitory A-properties. According to them[7], A-properties are unreal and the actual world is only made of B-relations. And, they claim that B-relations are enough to characterize the actual world as being genuinely temporal.

This distinction between A-series and B-series is due to McTaggart[8], according to whom the two ways of organizing events (with A-properties and B-relations) leads to a contradiction. Events are supposed to be both past, present and future because the A-classification can be done from every location in the network of B-relations. But, of course, A-properties are mutually incompatible: an event cannot be, say, both past and future. Hence, events *have* and *cannot have* different A-properties. But this is not the end of the story. The point is that, if one wants to avoid the contradiction, one must relativize properties to times: for instance, an event *is past with respect to t*, and *is future with respect to t1*. But then, the resulting properties being past-with-respect-to-t and being future-with-respect-to-t1 will lead to a new contradiction of second order that will only be avoided by making appeal to new properties of third order, relativized once again to times. And so it goes infinitely. Usually, this sort of infinite regress in explanation is taken to be vicious. Why exactly it is so is a delicate matter. But obviously this kind of explanation, if not contradictory, properly speaking, is at least defective with regard to theoretical economy, since we end up with an infinite chain of justification. In any case, McTaggart concludes that there are no such things as these A-properties. And, because he takes these A-properties to be essential to the reality of time, he endorses the view that time is unreal. More precisely, he takes A-properties to be essential to the reality of genuine change, and takes genuine change to be essential to the reality of time. By transitivity of the relation of essentiality, he takes A-properties to be essential to time. Here I do not discuss the relevance of the argument, since my aim is to classify the different kinds of anti-realism, not to assess them.

Now I would ask: what is the genuine difference between McTaggart's deflationary conception of time and the B-theory? Following Mellor, I take the difference to be merely terminological. As he writes:

> McTaggart argued … that there is in reality no such thing as time. … [In] McTaggart's sense it is still made by those who think that time is merely one of the four dimensions of an unchanging 'block universe'.
>
> [McTaggart] admits of course that there is a fourth dimension of what we call spacetime, a dimension which we mistake for time. But as he thinks variation in this dimension no more entails change in his sense than spatial variation does, he declines to call it time. That is what he means by saying that time is unreal[9].

According to Mellor, McTaggart and the block universe theorists (that is, in this context, the B-theorists) agree on the existence of a fourth dimension. They differ only about a mainly verbal matter: should we entitle ourselves to *call* this fourth dimension ‘time’? McTaggart says ‘no’ because he takes the passage of time to be an essential aspect of the concept of time. The B-theorists say ‘yes’ along a revisionary conception of time: time is real, but it differs substantially from the pre-

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7 See for instance Smart (1963), Mellor (1998, 2001), Oaklander (2013).

8 McTaggart (1908).

9 Mellor (2001, 45, 47).

theoretical concept. Here I fully agree with Mellor: I fail to see where the difference really lies between a B-world and McTaggart's world[10]. Both worlds are structured by four dimensions, and what we call time is a space-like dimension. According to the B-theorist, this space-like dimension can be called 'time,' while for McTaggart, it cannot. Hence, from now on I will take for granted that the B-theory is a genuine first candidate for being a kind of anti-realism about time.

The B-theory is anti-realist about time if and only if a particular property of the concept of time (that it flows) is *essential* to it. And as I already said, this essentiality is a verbal matter. Obviously, it is not because the matter is verbal that this is not a genuine problem. Indeed, one could ask how many properties of the concept of time must be denied reality before concluding that time is unreal. But this is not the problem I address in this paper. Instead, what I will do is examine how many time properties there are, and hence, how many anti-realist conceptions of time can be endorsed. Let us list these different properties.

3. Time's Properties

We have just seen that *flow* is a first property of time about which we can be skeptical. What remains then from the concept of time when it is stripped out from its A-properties? Obviously, we are left with B-relations, relations of before-after. This is a first way to understand the point. But it already takes for granted that the concept of B-relations is a primitive one, one that cannot be analyzed in something else. According to McTaggart, however, the concept of B-relations is not primitive. B-relations result from the transition of A-properties within C-series[11]. Or, to put it differently, the time dimension owns its direction thanks to the direction of the flow of time. It is not perfectly clear what conception of C-relations McTaggart used[12]. Here, I do not explore this historical point; I will take C-relations to be order relations having no intrinsic direction without saying anything more about them. A C-relation looks like a B-relation, except that it lacks an intrinsic direction.

It must be said that there is another possible way to construe the connections between A, B and C-series. According to Russell[13], time is wholly made up of B-relations, meaning that both A-properties and C-relations are unreal. He is well-known to endorse the view that B-relations are *intrinsically* and *primitively directed*, without any need to refer to A-properties. Basically, the idea is that one can both admit B-relations and deny reality to C-relations and A-properties, in construing directionality to be embedded in B-relations. Following Oaklander[14], one can choose to call these relations 'R-relations', reserving the name 'B-relations' for entities resulting of the application of A-properties to C-relations. Conflating B-relations and R-relations has no importance for my current purpose. It only means that one can be both realist about B-series and anti-realist about A-series and C-series because dimensionality is intrinsic to B-series. Hence, Russell's and, more recently, Oaklander's views are kinds of anti-realism about the flow, but are realists about both

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10 At least regarding the flow of time. We will see that some B-theories depart from McTaggart's view under other aspects.

11 Or more exactly, B-relations would result from the transition of A-properties in C-series, if time was real. McTaggart's aim is precisely to show that a contradiction follows from the alleged existence of A-properties.

12 According to McDaniel (2013), one could interpret this relation as either a *primitive relation* or an *adequacy relation*.

13 Russell (1938, 95-96, originally published in 1903).

14 Oaklander (2013).

directionality *and* dimensionality. Hence, in what follows, I will not specifically discuss Russell's view[15]. From now on, by 'B-relations,' I will mean either *primitively directed B-relations* (R-relations), or *derivatively directed B-relations* (resulting from the application of A-properties to C-relations).

We just had a grip on new properties of the concept of time: *directionality* and *dimensionality*. Let us put it differently. First, time is supposed to *flow* (A-properties). Second, it is supposed to have a *direction* (engaging the reality of B-relations). Finally, it is supposed to have a *dimensionality* (engaging the reality of C-relations). I take these three properties (flow, direction and dimensionality) to be at the heart of our questions about time. Importantly, they allow us to construe different kinds of anti-realism about time. If there are three distinct properties of the concept of time, correspondingly there are three conceivable kinds of anti-realism about time. We already saw the famous B-theory, a view that can be understood as a kind of anti-realism if one takes transitory A-properties to be *essential* to time[16]. Let us define the last two kinds of anti-realism as the *C-theory* and the *D-theory*. The C-theory denies reality not only to the flow of time, but also to the direction of time. Hence, the C-theory is a kind of anti-realism if and only if directionality is an essential aspect of time. On the other hand, the C-theory is a kind of realism about time if and only if directionality is *not essential* to time. The D-theory is far more radical in that it denies reality to the time *dimension*. I will address this view later in the paper.

In the same way one could argue that the B-theory of time is not a kind of anti-realism about time, for the very reason that the existence of A-properties is *not essential* to the reality of time, one could argue that the C-theory and the D-theory are not kinds of anti-realism because the existence of respectively B-relations and C-relations are not *essential* to the reality of time. I fully agree. All these claims characterize as *full-blown anti-realism about time* if and only if properties whose reality is denied are judged to be essential to time. But, for now, let us focus on the reality and unreality of time's properties in order to come back later to the reality of time itself.

These properties can both be denied reality, but one cannot choose to deny reality to any combination of time's properties. Some properties are embedded more deeply than others in our concept of time, as shown by this table:

	Realism	**Anti-realism**
Flow (A-properties)	A-theory	B-theory/C-theory/D-theory
Directionality (B-relations)	B-theory	C-theory/D-theory
Dimensionality (C-relations)	C-theory	D-theory

It is quite natural to draw this table when recalling that McTaggart takes B-relations to result from the transition of A-properties in C-relations. Or, to put it differently, time gets its direction (B-relations), from the flow of time (transition of A-properties) within a dimension (structured by C-relations). Hence, *realism about A-properties* implies realism about B-relations and C-relations[17]. *Anti-realism about A-*

[15] For a detailed discussion of the view, the 'R-theory', see Oaklander (2013).

[16] Obviously, the B-theory is often taken to be a realist account of time, in opposition to McTaggart's view. However, following Mellor (2001), I take this classification to be mostly terminological: one can *choose* to take the B-theory as a kind of anti-realism.

[17] Or solely B-relations, if one wants to endorse Russell's view.

properties leaves open different options: first, realism about B-relations and C-relations (the B-theory), second, realism about C-relations and anti-realism about B-relations (the C-theory), and finally, anti-realism about B-relations and C-relations (the D-theory).

One could immediately object that these *three properties* are not enough to characterize time. Time is supposed to have other properties, like *universality* (the fact that time's measured metric is the same for every observer, an idea famously undermined by special relativity) and *topological properties* (for instance, the fact that time has a beginning and/or an ending and is linear or cyclical). For topological properties, it should be clear that their existence supposes that there is a time dimension. Indeed, topological properties specify the 'geometry' of this very dimension. Hence, the destiny of topological properties is closely connected to the existence of a time dimension (realism about C-relations), and in some cases, probably of a directed time dimension (realism about B-relations: for instance, if one wants to distinguish between the beginning and the ending of time, one must recognize a direction). What about universality? As others, I believe that universality has been undermined by special relativity, and that one should be anti-realist about this particular alleged property of time. It is also worth noticing that, with the important exception of universality[18], the fact that these properties can be found in the pre-theoretical concept of time is contentious. It is not particularly clear that our pre-theoretical concept of time is relationalist or substantivalist about time (granting that there is a genuine difference at all between the views—something that, following Benovsky[19], can be questioned), or, say, that it construes time as having a first instant. For these reasons, in what follows, I will focus only on the following the properties of time: directionality and dimensionality. I will take the debate between A-theorists and B-theorists to be classical enough to say no more about it: one can accept the existence of a flow, or on the contrary, deny it. In what follows, I will focus instead on the newly introduced C-theory and D-theory. Let us focus first on the C-theory, that is, the combination of realism about C-relations and anti-realism about B-relations.

4. Time Direction: The C-theory

The idea that the dimension of time is asymmetric, or equivalently, has a direction, is quite natural, but leads to a delicate question: what is the source of such a direction? We can distinguish between *direction primitivism*, the view that time is intrinsically and primitively directed, and *direction reductionism*, the view that time takes its direction from something else. Two kinds of direction reductionism are well-known. For instance, it has been claimed that it is not time itself that is directed, but *causation*. Along this line of thought, temporal relations are not intrinsically directed, but only derivatively in that causation is (for instance, this seems to be Mellor's position[20]). Or, to put it differently, temporal relations get their direction from causal relations. A second reductionist option is to reduce in one way or another temporal direction to a nomological direction (an asymmetry exhibited by laws of nature)[21]. In

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[18] It seems quite clear that our pre-theoretical concept of time involves universality; we all behave like there is one and only one time, i.e., a universal measure of processes, allowing people to organize themselves.

[19] Benovsky (2010).

[20] Mellor (2001).

[21] Another option would be to endorse the Aristotelian project of reducing time's direction to change's direction. This view is unpopular because defining change

both cases (reduction to the direction of causation and reduction to the direction of nomological phenomenon), it might be useful, as stressed for instance by Price, to distinguish between asymmetry *of* time and asymmetries *in* time. It is a fact that natural processes have a direction: there are asymmetries *in* time. To take Price's example, buildings may collapse into rubble, but it could not go the other way around: rubbles do not 'uncollapse' into buildings[22]. In what follows, I will take for granted that asymmetries in time have something to do with the direction of causality. If you disagree and feel more attracted by the idea of rooting time's direction in some particular physical process, feel free to pick up your favourite source of non-temporal direction when I refer to causation and asymmetries in time.

But there is another way to go regarding the connection between asymmetries in time and the asymmetry of time. One could take asymmetries in time to derive from a particular intrinsic direction of time itself. Direction primitivism about time is the view that there *is* such a particular intrinsic direction of time itself and that no further explanation of this fact can be provided. On the contrary, direction reductionism about time is the view that there *is* a particular direction of time itself, but one *identical to*, or *supervening on*, or *grounded in* (feel free to pick your favourite *relation of ontological dependence* here) the direction of causation.

Finally, it is important to see that one could be attracted by a third position, namely *direction eliminativism about time*. Think about the situation in philosophy of mind. One can distinguish between the view that mental properties are identical to, are grounded in, or supervene on physical properties (an identity view), and the view that there are no mental properties at all, but only physical properties (an eliminativist view). In a similar way, according to direction eliminativism, time's direction is not real. Or to put it differently, if time is real, then time has no intrinsic direction. Hence, direction eliminativism differs from direction reductionism in that it denies that time has a direction. It allows, of course, for the possibility of asymmetries in time, for instance, by being *direction realist about causation*: there would be genuine directed relations, causal relations, distinct from temporal relations. Actually, presented like that, direction eliminativism about time seems to me to be an attractive view: it points out that we mistake asymmetries *in* time for the asymmetry *of* time.

It should be clear that direction eliminativism is another name of the C-theory: there are directed relations, but these are not *temporal* relations. The moral to be drawn here is that the C-theory offers us a way to be realist about the time dimension while denying reality to a flow and a direction of time. Hence, the difference between the B-theory and the C-theory is a very technical one: they only differ about the *source* of asymmetries along the time axis. The B-theory takes asymmetries in time to result from the asymmetry of time, while the C-theory takes asymmetries in time to originate in the direction of causality. Hence, *direction eliminativism* implies the C-theory and *direction primitivism* implies the B-theory.

What about the classification of *direction reductionism*? I believe that it depends on what a reduction is supposed to be. But in general, a reduction is supposed to be conservative: if time's direction is reduced, it means that it is saved, not that it is eliminated. In this sense, direction reductionism should count as a particular kind of B-theory, and not of C-theory, since it takes time's direction to be real. Hence, I take Mellor to be a B-theorist and not a C-theorist.

One could ask what would be the advantages of the C-theory. I believe there is mainly one reason to be attracted by the view. It comes as a fact that causal and

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requires a concept of time, leading to a vicious circle. For a defense of this particular kind of direction reductionism, see Bowin (2009).

[22] Price (1997, 17).

temporal relations always have the same direction (allow me to put aside possible cases of time travels and backward causation). Hence, it seems natural to look for a common explanation of these two directions. Obviously, the simplest way to go is to say that we make a mistake in taking causal relations to be temporal relations, or on the contrary, in taking causal relations to be temporal relations. There would one and only one kind of directed relations. Hence, the quest for ontological parsimony should lead us to an elimination of either temporal relations or causal relations. The C-theory corresponds to the first option.

Regarding the second option, it is worth noticing that B-relations are important for different explanations of causality. Causal relations are usually explained away thanks to temporal relations. For instance, Hume takes causal relations to be relations holding between events and satisfying three conditions: regularity, contiguity, and anteriority. Or again, according to the conditional counter-factual analysis *A* causes *B* if and only if it would be true that if *A* did not occur, *B* would not have occurred either. It can be seen that if one wishes to endorse a Humean position about causation, or an analysis in terms of counter-factual statements, she must at least go for the B-theory. Hence, the C-theory might prove to be a bad one in that it closes the possibility of explaining causation in terms of temporal relations.

But, I believe that switching the order of explanation provides us with an interesting position, in particular, if one is skeptical about the Humean and the counter-factual accounts of causation. If one takes causal relations to be primitive, and irreducible to temporal relations, then it is possible to eliminate temporal B-relations and explain the apparent B-relations as the result of causal processes taking place within the C-relations network.

Moreover, the C-theory has a strong advantage in that it can fit with Mellor's desiderata for a criterion explaining the distinction between space and time, granting that we live in a four-dimensional manifold of events. After arguing against McTaggart, who took change to be the special feature of time (time would be the only dimension of change), Mellor suggests that we take causation instead as the special feature of the time dimension (time would be the only dimension in which causal relations always have the same direction).

Hence, we should choose between two possible notions as the main primitive of the explanation, causation or temporal relations. One must go. And, as I tried to show, if one chooses not to use the temporal relation as a primitive notion, one can be either direction reductionist (as Mellor) or direction eliminativist (in other words, a C-theorist).

As I said, direction eliminativism seems to me to be a better view than direction reductionism because it is not entirely clear what it means that the time direction is grounded in (or supervenes on, or is ontologically dependent on) the direction of causation. Direction eliminativism allows us to explain directions in the world without requiring a relation of ontological dependence), contrary to direction reductionism. I take this point to be an advantage of the C-theory, but I do not wish to argue further for this point here. It will do to notice that a C-theory is available if one if skeptical about the classical B-theory based on direction reductionism (along with a B-theory based on direction primitivism).

In a nutshell, if one wants to eliminate causal relations in favour of temporal relations, one must be a B-theorist, and if one wants to be a C-theorist, one must eliminate temporal relations in favour of causal relations. The two strategies seem attractive and share the same ontological parsimony. In any case, the C-theory is anti-realist about time only if the time dimension is expected to be intrinsically directed. Direction eliminativism seems to be a possible way to understand the existence of asymmetries in the world. There would only be asymmetries in time,

and no asymmetries *of* time. Time would only be a *symmetrical* fourth dimension. But is the reality of such a fourth space-like dimension enough to grant reality to time?

Here again we must ask what property time should have to be said to be real. How far in the revision of the concept of time can we go before claiming that the revision has gone too far for time to be saved? Once again, I will not answer this question. On the contrary, I will pursue my enquiry by looking at the last and probably deepest property of time: its dimensionality. As we just saw, it seems at least conceivable to take time to be real as a dimension, even if lacking an intrinsic direction. Now, let us turn to a more radical question. Is it possible to construe time as lacking a dimension? And, if not, is it possible to construe the *world* as lacking a time dimension?

5. Time Dimensionality: The D-theory

As I said, knowing if the B-theories and the C-theories are realist or anti-realist accounts of time is largely a terminological matter. The situation is different for the D-theory. Indeed, it is very difficult to understand what it could mean that time is real, if there is no such a thing as a time dimension. In a nutshell, if there is no time dimension, then there is no time *at all*. But one might be tempted to claim that only the present instant is real and, that in this sense, *presentism*[23], might qualify as a kind of realist D-theory. There would be no time dimension, since there is only one instant, and one instant is not enough to make a dimension. But it should be clear that this move is tricky. Presentism, as it is usually conceived of, does not deny that time has a dimension, and that particular events are ordered in a coherent network of relations of anteriority and simultaneity. Take a possible world that is correctly described by both presentism and an anti-realist account about the flow of time, in which there are no temporal relations. In such a world, there is no time dimension, since there is only one instant (or no instant, depending on what an instant is supposed to be). Now, take a possible world that is correctly described by both the A-theory and presentism. It seems that there is something more in this second world, which I take it to be, in a minimal sense, a dimension: an organization of events. How it could be possible that time has a dimension without being inhabited by events is a particular problem the presentist must answer on her own. But independently of the answer, the presentist, as I understand her, acknowledges the existence of a time dimension. Hence, I fail to see what would be a realist D-theory of time, and I suggest taking the D-theory as a genuine kind of anti-realism about time: if there is no time dimension, then time is unreal.

Being granted that the D-theory is an anti-realist account of time, in any possible interpretation (contrary to the C-theory), one might ask if the view might be true. I am inclined to say 'no'. And, by that, I do not want to argue that there is no *conceptual room* for the D-theory and that there is no conceivable world compatible with the D-theory. My point is that the D-theory is largely at odds with what we know of the *actual* world[24]. The view cannot be true of the actual world because there are

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[23] See for instance Bigelow (1996), Bourne (2006), Markosian (2004), Merricks (1999) and Zimmerman (1998).

[24] This point is important because *metaphysical contingentism*, the view that some metaphysical statements might be true in a contingent way has recently received a lot of attention. See for instance Rosen (2006) and Miller (2009, 2010). If contingentism is true, then the D-theory might be true of some possible worlds containing time. As implausible as it is, I am not dealing with this idea here; I focus

too many things populating the universe. The universe is made of various events obtaining at different instants. By denying the reality of a time dimension, one must deny the reality of events themselves, as entities existing in a network of temporal relations.

To make the view more vivid, let us contrast it to related views. It is worth noticing that the D-view is incompatible with both *relationism* and *substantivalism about time*[25]. Indeed, both views take time to be real, at least in the sense that there is a *dimension* of time. According to substantivalism, time is real and is a special substance (different from other substances) containing material substances. Indeed, this idea of *countenance* is one of the two ways to describe the view. The other is the modal one: according to substantivalism, time is real and can exist without matter or objects within it. The countenance and modal features are obviously related in that substances are generally described with an *ontological independence criterion*: to be a substance, an entity has to be ontologically independent from other entities. Hence, if time is a substance in this sense (the countenance idea), it implies that time can be real without other entities taking place within it (the modal idea). On the other hand, according to relationism, time is real and is a collection of relations between material entities (say events, objects and/or matter). Hence, time is not a substance in the sense of ontological independence (there cannot be time in absence of matter), and there cannot be time without entities taking place within it. Anyway, in both cases time is a dimension, whatever this dimension is supposed to be, a collection of relations ontologically dependent on their *relata* (as in relationism), or an ontologically independent substance (as in substantivalism). Hence, the D-view is incompatible with both substantivalism and relationism, by claiming that there is no such a thing as a collection of temporal relations or a temporal substance. To put it differently, relationism and substantivalism both suppose the existence of a time dimension, and only differ about the *nature* (substance or collection of properties) of this dimension.

This shows us that the D-theory is a radical view insofar as it denies what is usually supposed: that there is a dimension associated with time. But counter-intuitiveness is not necessarily a good reason to reject a view. I believe we can express quite clearly why the D-theory doesn't sound like a very attractive view. It denies that there is *organization* in the world. It denies that there are relations ordering events. Surely, we might believe that time is not flowing, or that time does not have an intrinsic direction. But we cannot deny that what happens follows a specific order. At best we can believe that this order is not temporal, but we cannot describe the world as lacking in order: Descartes lived *between* Plato and Kant. It is a fact. This 'between' might be atemporal, if the historical dimension is not an intrinsically ordered dimension as in the C-theory, but the D-theory tells us that there is no dimension at all. Hence, in what follows I will take the reality of such a time dimension as a fact: there is no room for the D-theory (at least in the sense that it cannot be true of the *actual* world). The most anti-realist view about time must concede the existence of a *fourth dimension*.

Hence, there are two ways to understand the D-theory. Either it is a theory about time, or one about the actual world. According to this distinction, the *moderate D-theorist* claims that there is no temporal dimension, what there is *instead* is an *atemporal dimension*. According to a more radical D-theorist, there is no temporal dimension, and no fourth atemporal dimension to be found in the world. As I said

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instead on the temporal ontology of the actual world.

[25] For a presentation and discussion of the views, see for instance Benovsky (2010).

above, it is dubious that there is not a fourth dimension. Hence, the radical D-theory does not seem to be of interest when focusing on the ontology of the actual world. The moderate D-theory is more interesting in that it does not deny the reality of a fourth dimension, but describes it as being something atemporal.

Next, I examine two of the more famous anti-realist views about time in order to see which feature of time they reject. I will focus on Julian Barbour's and Carlo Rovelli's views.

6. Barbour's Time Capsules

Barbour's account of the unreality of time is a work-in-progress theory not empirically confirmed. My understanding of the view relies mainly on the reading offered by Butterfield[26] and Healey[27]. Barbour uses two important concepts: *Nows* and *time-capsules*. Let us introduce the first concept. Barbour's picture of the world is a kind of *modal realism*, according to which possible worlds (Nows) are as real as the actual one. It differs from David Lewis' original modal realism[28] on three important aspects. First, these worlds are not *temporally extended*. They are *instantaneous states*, as suggested by the name 'Nows'. These Nows are spatially extended, but not temporally. Or more precisely because time is quantized, these states are not really instantaneous; they have a temporal extension, but a very small one. Secondly, possible worlds are understood as *physically* possible worlds here. In other words, a possible world is one instantiating the very same laws of nature as the ones holding in the actual world. In this sense, the set of physically possible worlds does not include worlds in which different laws of nature obtain. Third, this picture is realist about space, but not about spacetime. A world is a *space*, not a spacetime. In Lewis' view, a world is identified to a spacetime, not a space. Space at a particular time is just a temporal proper part of a spacetime. Spacetime comes first as a primitive entity, space then as a derivative one. But in Barbour's view, there is no spacetime at all, just a set of spaces (Nows) co-existing together.

To understand the second notion of time-capsules, it might be useful to quote Healey:

> To get an idea of what a Now is supposed to be, one is supposed to think initially in temporal terms. In those terms, a Now corresponds to an instantaneous relative configuration of the universe. But of course, Nows are neither instants nor contained in any independently existing time; they just exist atemporally. Most Nows are not time-capsules. But amongst the vast number of Nows are a few whose internal structure contains a representation of an entire sequences of other Nows -a sequence that, when appropriately ordered in accordance with the internal properties of each represented Now, comes to represent what looks like a possible *history*. These are the time-capsules. Barbour's central idea is that

[26] Butterfield (2002).
[27] Healey (2002).
[28] Lewis (1986).

> experiencing such a time-capsule gives rise to the (misleading) belief that it does indeed represent the sequence of events that have actually occurred, so that the 'history' apparently represented in the time-capsule in fact occurred as a unique sequence of events in time[29].

One can see that time-capsules are specific Nows, having a particular feature: they contain a representation of a sequence (a linear ordering) of other Nows. Why is such an account anti-realist about time? The answer is that *linear order* comes under attack: time ordering is simply blown up. There are no worlds made of events, no histories of worlds, just a 'space' of worlds, that is, a modal space of worlds, with a probabilist function encoding the probability to jump from a possible world to another possible world (even if there is no jump). This view is the most radical anti-realist view about time in the sense that it even denies the existence of a *time dimension*. In this model, we are left with three spatial dimensions and modal dimensions. It seems interesting to me that, in order to eliminate the time dimension, modal ones must be postulated instead.

Now, in general, when one claims that something is unreal because there is something else instead, one could immediately ask where the difference really lies between a *revisionary* account and an *anti-realist* one. Is there really a big difference in saying that time is not real and that what there is instead is a *modal space*, that is, a collection of *modal dimensions* (anti-realism about time dimension), and saying that time is real but merely as a kind of multi-dimensional space? Of course, this modal space is very different from the classical time dimension: in particular, such a 'modal space' is not linear. These dimensions differ greatly from McTaggart's fourth dimension, made of C-series, that was supposed to be linear. Here again, I believe that the choice of calling the view ‘realist’ or ‘anti-realist’ about time is merely terminological. What really matters is how many dimensions there are above the three spatial ones. There is no ontological point in trying to decide if these 'supplementary dimensions' qualify as time or not[30]. Moreover, I am not at all sure that we have something in our pre-theoretical concepts about time and modality that offers us a way to make this terminological choice.

In one interpretation, Barbour's view qualifies then as a moderate *D-theory* (there is no time dimension), in the other it is a *C-theory*. Or more cautiously, it is the view that there are more than three space-like dimensions structuring reality. So, strictly speaking, what is called the time dimension would in fact be two or more space-like dimensions. Hence, the view is difficult to see as a C-theory, because it only saves *dimensionality* by letting go of *linear order*. Hence, it shows that there is a new, very revisionary, way to be realist about time, an account in which time is real, by being two or more dimensions, and by being non-linear. Barbour's view is then a C-theory if one defines it as a *realism about further temporal dimension(s)*, but is not if one defines it as a *realism about C-relations* (taken to be linear relations). Once again, this is a terminological matter: what is expected of the fourth (and more) dimension(s) to count as time? They describe a world of at least four dimensions,

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29 Healey (2002, 309).

30 Unless one believes there are essences in the world, and in particular an essence of time. If so, I am wrong to take this question as a terminological one: there is a substantive matter over the essential properties of time. However, I fail to see a good reason to believe in time's essence, granting that the notion of time refers to very different properties in different contexts.

and only differ with respect to the choice of referring to the supplementary dimension(s) (above space) as time or not. Let us turn now to Rovelli's anti-realism.

7. Rovelli's Anti-realism

Rovelli says there are two ways to understand Einstein's idea that spacetime is identical to the gravitational field: one of the two is real when the other one is not. I believe this is a misleading way to explain what is going on. Before explaining, let us quote Rovelli:

> Einstein's discovery is that newtonian spacetime and the gravitational field are the same entity. This can be expressed in two equivalent ways. One states that there is no space-time; there is only the gravitational field. This is the choice I have made in this book. The second states that there is no gravitational field: it is spacetime that has dynamical properties. This choice is common in the literature. I prefer the first because I find that the difference between the two points of view is only a matter of choice of words, and thus, ultimately, personal taste. If one prefers to keep the name "spacetime" for the gravitational field, then one can still hold a substantivalist position and claim that, according to [General Relativity], spacetime is an entity, not a relation. Furthermore, localization can be defined with respect to the gravitational field, and therefore the substantivalist can say that spacetime is an entity that defines localization[31].

It seems to me that it is strictly speaking false that one can choose to believe that the gravitational field is real, or on the contrary, that spacetime is real. We cannot have A=B, with A and B having different existential statuses. This would be a confusion between an *identity theory* and an *eliminativist one*. Hence, one must choose: either one of the two entities is unreal or they are identical and both real. But here, I believe it is important to notice that a field has dimensionality in the same way space has. A field is nothing else than a distribution of properties in a space. So I do not understand Rovelli's claim that spacetime is not real, and that what there is *instead* is the gravitational field. The gravitational field *conceptually* involves the existence of a space, and by this fact, is a richer notion.

Anyway, the two approaches described by Rovelli are realist about dimensionality, the dimensionality of a field, or the dimensionality of a space. This is just a matter of words. What is denied when Rovelli claims that there is no spacetime is that there is no spacetime *above* the gravitational field. But this gravitational field has degrees of freedom, that is, dimensionality. So this is a space: Rovelli's interpretation is one in which the physical world is a distribution of properties in spacetime, or a distribution of properties structured by relations of ordering in dimensions. The idea here is that relations of ordering are necessary to structure the field. Hence, once again, classifying the view as realist about spacetime is mostly a terminological matter.

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[31] Rovelli (2004, 77).

Now, should we construe Rovelli's view as a kind of D-theory or C-theory? Is there a time dimension in his account? Clearly, Rovelli is not denying reality to a four-dimensional manifold, but choosing not calling it spacetime. Hence, his view can qualify as a *moderate D-theory of time*. If time (spacetime) is not real, this is because there is instead a dimension (four dimensions) of the gravitational field. But the view can be classified as a C-theory too. Indeed, Rovelli agrees that this is a terminological choice. One must decide if one takes the fourth dimension as a *temporal* dimension (and the three other dimensions as *spatial* dimensions). Hence, we are free to choose to characterize the view as a C-theory or a moderate D-theory. It merely depends on what we expect time to be. If time is minimally supposed to be a fourth dimension, then this is a realist C-theory. If not, this is a moderate D-theory. In any case, in this account, the world is structured by four dimensions, all of them exhibiting linear order.

8. Conclusion

It is very difficult to deny the existence of time or spacetime in the sense of *dimensionality*. The physical world has at least four dimensions. Even in Barbour's view, in which there is not a fourth linear dimension, there is a modal space instead. What could be more easily denied is that time flows, that there is a fourth *linear* dimension and that there is a *direction* embedded in the fourth dimension. If so, the direction would have to be either an illusion or embedded in the entities inhabiting the time dimension, that is, dispositional properties, causal relations, processes or whatever basic entities one accepts in its ontology above dimensions. In any case, I hope I have convinced you that we should be realists about time in the sense of the four-dimensionalist: the world is necessarily structured by (at least) a fourth dimension.

Now, there is a separate question I have so far refused to answer: what is required for time to be *real*? Surely, we are free to endorse a *revisionary conception of time*. After all, the classical B-theory belongs to revisionary views about time by denying that time flows as is usually supposed. And, the B-theory can be construed as a kind of anti-realism if one follows McTaggart's claim that A-properties are essential to time. Hence, the anti-realist B-theory is ontologically equivalent to the realist B-theory, and the distinction between the two is merely an affair of semantics. It goes the same way for the C-theory, a view that can also be construed as a particular kind of realist revisionary conception of time. One can decide that a new concept of time, resulting from the relocation of direction from time itself to causation, is too different from the older pre-theoretical concept of time, and acknowledge this difference by claiming that our pre-theoretical concept of time does not refer. Or, on the contrary, one could claim that a time that lacks both flow and direction is still real by its dimensionality, by being the fourth dimension of the universe. Again, I take the choice between the realist C-theory and the anti-realist C-theory to be a terminological matter. Anyway, we cannot decently deny that there is at least one dimension *corresponding* to what we call the dimension of time.

The D-theory eschews this particular terminological problem: if there is no time dimension, then there is no time *at all*. There is no point in asking if time can be real without a time dimension. Still, the D-theory is interesting because it can characterize Barbour's view, and indeed, Barbour's view can count as a genuine sort of *full-blown anti-realism about time*. But, in Barbour's view, there is a fourth

dimension, or more precisely, there are more than three dimensions. The choice of considering the dimensions constitutive of the modal space as different from the time dimension is partly terminological. Here again, one can construe the considered proposal as being realist about time by identifying time to the modal space. Hence, the moderate D-theory is ontologically equivalent to a particular C-theory (temporal realism about further dimension(s) with no unique linear fourth dimension).

All of this shows that there are very different anti-realist accounts of the unreality of time. But how are we going to choose between all the candidates which are the necessary properties of time? What are the conditions of existence of time? Since it had never been clear what time is supposed to be, it is simply impossible to say that time is real or not by satisfying or failing to satisfy a particular condition. At the end of this enquiry, we should have no doubt that we are living in a world having at least four dimensions, but we can doubt almost any other property that time is supposed to have. Hence, I hope to have made clear that the possible substantive questions about time are about the existence or not of a *flow*, and the source(s) of asymmetries *in*, and/or *of* the fourth dimension(s). There is no point trying to demonstrate the reality or unreality of time *simpliciter*, since this is a far too complex notion.

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16
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