

Enduring Special Relativity

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1. Introduction

Objects persist through time. According to some, objects endure: they are wholly present at every time at which they exist. According to others, objects perdure: they are temporally extended four-dimensional wholes and are only partly present at every time at which they exist in virtue of having some temporal part that exists at that time. The thesis that persisting objects are four-dimensional and perdure—perdurantism—is at least partly motivated by the theory of special relativity and the Minkowski model of space-time. The view that objects endure—endurantism—on the other hand, is almost always expressed in pre-relativistic terms, and thus endurantists are sometimes accused of failing to take seriously empirical discoveries. Furthermore, it is sometimes argued, endurantism is either straightforwardly inconsistent with special relativity or at the very least can be made consistent only in an “outmoded and bizarre” way.¹

Before considering which of endurantism and perdurantism best accords with our metaphysical intuitions, therefore, it is imperative to consider whether the theory of special relativity is inconsistent with endurantism. Otherwise considerations pertaining to how well endurantism or perdurantism preserve our various intuitions are simply moot. To that end, I consider three arguments that purport to show either that the theory of special relativity is inconsistent with endurantism or that at

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the very least perdurantism has substantial explanatory benefits over endurantism.

In section 2, I consider an argument that reaches the conclusion that endurantism is inconsistent with special relativity via the claim that endurantism entails the truth of presentism, the thesis that only the present is ontologically real. Since presentism is inconsistent with special relativity, the argument goes, then so too is endurantism. I defend in this section an eternalist version of endurantism and thus avoid committing the endurantist to the questionable metaphysics of presentism. In the third section, I consider a number of variations on the argument according to which the endurantist's notion that objects are wholly present whenever they exist is inconsistent with special relativity. I reject a recent form of this argument that attempts to show that given special relativity, objects are either composed of nonpresent parts and are thus not wholly present whenever they exist or that endurantists are committed to the ontological profligacy of holding that different enduring objects exist relative to different frames of reference. I then present two possible responses that the endurantist can make to the general worry about how objects can be wholly present given a failure of absolute simultaneity. Finally in the last section I consider a recent argument by Yuri Balashov that although endurantism is consistent with special relativity, it lacks some explanatory resources to which perdurantism can avail itself. I conclude that, although the endurantist does not have the same resources as the perdurantist in some respects, she can avail herself of other resources to explain why enduring objects fill the space-time volume that they do.

2. Presentism and Endurantism

The theory of special relativity states that observers in different frames of reference will disagree about the spatial distances between objects and the durations between events. The latter is to say that there is no absolute simultaneity: while from one frame of reference R_1 two events E_1 and E_2 are simultaneous, from some other frame of reference R_2 , events E_1 and E_2 are not simultaneous. For many decades now, this discovery has provided fuel for an argument against presentism. If presentism is true, then all that exists, exists in the present. So all objects that exist, exist simultaneously. If we suppose that relative to reference frame R_1 at t_1 events E_1 and E_2 exist and are simultaneous, then given presentism, we know that t_1 is the present. Now let us suppose that relative to some reference frame R_2 , E_1 and E_2 are not simultaneous. Let us suppose that relative to an observer in reference frame R_2 , E_1 is simultaneous with the observer at t_1 . At t_1 , however, E_2 is in the future of the observer at R_2 , that is, there is some causal signal

that can be sent from R2 to E2. Since objects only exist in the present, and E2 is future relative to R2 at t_1 , it follows that relative to R2 at t_1 , E1 is present and exists and E2 is future and does not exist. Thus relative to R1 at t_1 , E2 is present and exists, and relative to R2 at t_1 , E2 is not present and does not exist. Thus the idea of an objective present flounders. A more sophisticated version of the argument is as follows:²

1. Assumption: Presentism is true: If an event E exists then E is in the present, and if E exists, and event E* is simultaneous with E in some frame of reference R, then E* exists.
2. Assumption: Special relativity is true.
3. Assumption: There is some event E1 that exists.
4. Suppose E1 is simultaneous with some event E2 relative to reference frame R1.
5. E2 exists. (1,3,4)
6. Suppose that E2 is simultaneous with event E3 relative to reference frame R2.
7. E3 exists. (1,4,5)
8. Suppose that E3 is future relative to E1 (there is some causal signal that can travel from E1 to E3).
9. E1 is present. (1,3)
10. E3 is present. (1,7)
11. E3 is future. (8)
12. So there is a contradiction. (10,11)

The problem for the presentist, of course, is that there is no unique class of events that are simultaneous from all frames of reference. Thus since there is no privileged frame of reference, there is no way to determine which events are present and, hence, which exist. So if we have an argument that endurantism entails presentism, we can see how we reach the conclusion that endurantism is inconsistent with special relativity. It is certainly not an uncommon view to hold that presentism and endurantism are in some way deeply inter-related doctrines. Mark Hinchliff,³ for instance, argues that the puzzle of how it is that objects change as they persist through time is best explained by the combination of presentism and endurantism, and Hestevold and Carter take the view that presentism entails endurantism.⁴ More worrying for the endurantist, however, is Trenton Merricks's contention that endurantism is coherent only in the context of a presentist theory of time.⁵ Merricks argues that the idea that an object is wholly present at a time makes sense only if one first accepts presentism.

The core of Merricks's argument is that the notion of being wholly present is one that can only be understood in terms of parthood: to be wholly present at a time is to have all of one's parts present at that time. But it cannot be that to be wholly

present at a time is to have all of one's parts *at that time* present at that time, for that is trivially true even if one is a perdurantist. But then the difficulty is that persisting objects change over time and, thus, gain and lose parts. Thus if all times are ontologically real, it is not true of some changing object *O* that *O* at *t* has all of its parts simpliciter at *t*, since there will be some parts that *O* had in the past that *O* does not have at *t*. *O* can only have all of its parts at *t* if either *O* never changes, which we know is not true of any actual composite object, or if *t* is the only ontologically real time. In this latter case, *O* has all of its parts at *t* because at *t* it is true that there are no parts of *O* that exist at other times. Thus endurantism entails presentism.

Finally then, we can put these two arguments together to conclude that endurantism entails presentism and presentism is inconsistent with special relativity and thus endurantism is inconsistent with special relativity. Now presumably presentists have something to say about the relation between presentism and special relativity, and presumably it involves maintaining that presentism is not, for whatever reason, incompatible with special relativity. Perhaps the presentist will reject the idea of an objective present. Perhaps she will argue that which objects are present, and thus which exist, is relative to a frame of reference. Nevertheless, presentism is still true because, relative to each frame, only those objects that exist in the frame relative present, exist. I do not know if this is coherent, for it remains unclear to me how this reconciliation is supposed to work. So it seems to me that the weakest response the endurantist can make to this argument is to maintain that endurantism is not incompatible with special relativity because presentism isn't incompatible. Perhaps it can be shown that presentism and special relativity are not incompatible, but I leave it to those presentists of stronger constitution than I to take on the task. The only other way to resist this argument is by rejecting Merricks's conclusion that endurantism is coherent only given a presentist ontology.

The first thing to notice about Merricks's argument is that it bears a striking resemblance to a more general problem faced by any endurantist who embraces eternalism, and that is the problem of how to reconcile change over time with strict identity over time. Merricks ponders how it could be that an enduring object has all of its parts present at a time if that very same object had different parts at some other time. So too, more generally, if an enduring object *O* at *t* is strictly identical to *O* at any other time *t*^{*}, then *O* at *t* must by Leibniz's Law have all of the same properties at *t* and *t*^{*}, and that would seem to rule out the possibility of change. The parallel between properties and parts here is that just as the endurantist wants to say that there is some sense in which an enduring object has all of its

parts present at every time at which it exists despite the fact that it is composed of different parts at different times, she also wants to say that there is a sense in which an enduring object has all of its properties at every time at which it exists (the sense in which it is strictly identical over time) despite the fact that the object changes properties over time. Thus to find a solution to Merricks's problem about parthood, it will be profitable to consider what the endurantist says about the exemplification of temporary properties.

The general problem of temporary intrinsics given an eternalist ontology has lead endurantist eternalists to embrace one of two strategies that involve relativizing in some manner either properties themselves (indexicalism⁶) or the having of those properties (adverbialism⁷) such that, for instance, an object that is red at t_1 has the property red-at- t_1 or is red t_1 ly. Instantiating such relativized properties at a time, however, is not sufficient for an object to count as being red at that time in the usual sense in which we mean to attribute redness to an object at a time. For given Leibniz's Law, an object O will instantiate the property of being red-at- t_1 or the second order property of having red t_1 ly *at every time* at which it exists, including times at which O is not red.⁸ For the sake of simplicity, I will use the adverbialist strategy in the following examples, but anything I say applies equally to the indexicalist account. So suppose that at t_1 O is red, at t_2 O is red, and at t_3 O is blue. On an adverbialist analysis, at t_1 , O has the property of being red t_1 ly; it also has the property of being red t_2 ly and blue t_3 ly. So it cannot be that O is red *in the everyday sense* just in case O instantiates red in a t_n ly manner. Or, to put it another way, if O is red solely in virtue of instantiating redness in some temporally modified manner, and if O is red solely in virtue of instantiating blueness in some temporally modified manner, then since at t_1 O is red t_1 ly and is blue t_3 ly, it follows that t_1 O has the contradictory properties of being both wholly red and wholly blue. So it must be that the everyday claim made at t_1 that 'O is red' is true iff at t_1 O is red in a t_1 ly manner.

So the adverbialist needs to distinguish between what we will call 'metaphysically basic' properties which are the temporally relativised properties of being, for instance, blue t_3 ly at t_1 and the ordinary 'English' sense of 'property' which involves being blue t_3 ly at t_3 . Call the metaphysically basic sense of having a property, having a property_{mb} or being P_{mb} . Then for the endurantist, having a property P at t in the ordinary sense corresponds to having property_{mb} P at t in a t ly manner. That is, being blue at t_1 in the ordinary sense is having the property_{mb} at t_1 , of being blue t_1 ly, thus the ordinary attribution of 'O is blue' made at t_1 is true iff O is blue t_1 ly.

Given that O is strictly identical across time though, it cannot be that 'O is blue' is true of O at one time and not another.

So we must understand 'O is blue' uttered at t_1 , not as a proposition in the narrow sense but, rather, as picking out different propositions at different times in the same manner as do indexicals. Then if O is red at t_1 , at t_1 'O is red' picks out the proposition 'O is red t₁ly at t_1 '. Hence for any property P, 'O is P' picks out the proposition 'O is P tly at t'. Thus the property of being red names a relation between a time and having the property_{mb} of being red in a particular temporal way—red t_nly. Thus the property of being red in this ordinary sense picks out a different property at t_1 than at t_2 . So there is no contradiction in saying that the very same object O is red at t_1 and is not red at t_2 .

So too we can define the notion of being wholly present in terms of having all of one's parts present using this same strategy applied to parthood. We can say that an object is wholly present at a time just in case all of its parts are present at that time where 'P is part of O' is true at any time t iff at t, P is part_{mb} of O tly. In this case we note that there is some metaphysically basic sense of having a *part* in a temporally modified way. Call this having a part_{mb}. For suppose that O is at t_1 composed of A and B, and at t_2 composed of A and C. At t_1 O has part A and B t₁ly and has part C t₂ly. So there is some technical sense—having a part_{mb}—in which O has part C at t_1 . For the endurantist though, just as having a property is not the same as having a property_{mb}, so too having a part is not the same as having a part_{mb}. The ordinary sense of having a part is captured by having some part_{mb} P at t in a tly manner.

Then just as we understood that 'O is red' picks out a different proposition at different times, so too we must understand 'P is part of O' as picking out a different proposition at different times. At t, 'P is part of O' picks out the proposition 'P is part_{mb} of O tly' and at t_1 it picks out the proposition 'P is part_{mb} of O t₁ly.' So the property of having some part at a time is a different property to having that part at some other time. The property of having P at t is the property of having P tly at t. Thus there is no contradiction in holding that O has part P at t_1 and lacks part P at t_2 , for the property of having part P at t_1 is the property of having P t₁ly at t_1 , and the property of having P at t_2 is the property of having P t₂ly at t_2 , and these are distinct properties.

Thus it is possible to define the notion of being wholly present in terms of an object having all of its parts present at a time even though objects change parts over time, and this is possible without recourse to presentism. So far, however, it has not been shown that endurantism is incompatible with special relativity, but this argument against endurantism is but one that avails itself of the theory of special relativity. In the following section we will consider the more worrying problem that arises from a combination of the fact that the endurantist's

notion of being wholly present is defined in terms of objects having all of their parts present at a time, and the fact that special relativity tells us that there is no absolute simultaneity.

3. Special Relativity and Being Wholly Present

Early defenders of perdurantism such as Smart⁹ and Quine¹⁰ objected to endurantism on the grounds that given the truth of special relativity, the same enduring object will have different temporal and spatial properties depending on the frame of reference of the observer. An extension of this worry is a worry about how objects can be wholly present if there is no absolute simultaneity.

To see this, suppose that enduring object *O* has two proper parts *A* and *B*. *O* is wholly present at *t* only if *O* has *A* and *B* tly at *t*, that is, if *A* and *B* both exist at *t* and are part of *O* at *t*. The problem is that while relative to one frame of reference *R*, *A* and *B* exist simultaneously, relative to some other frame of reference *R*^{*}, *A* and *B* do not exist simultaneously. From the perspective of *R*^{*}, let us suppose that *A* comes into existence slightly before *B*. Thus depending on which frame of reference one occupies, *O* will be composed at different times of different parts and thus have different properties relative to different frames of reference.

In fact, a recent paper by Hales and Johnson maintains that matters are even worse for the endurantist.¹¹ It is not just that relative to different frames of reference, one and the same enduring object will be composed of different space-time points. Rather, they argue, if we take special relativity seriously, it follows that objects are composed of nonpresent parts and are therefore never wholly present. This is indeed a damaging criticism, and if it turned out to be successful it would seem to spell the end for endurantism. According to Hales and Johnson, the endurantist is faced with a dilemma. If she holds that an enduring object *O* is composed of the set of space-time points for all possible frames of reference, then she is committed to holding that *O* is composed of parts that, from the perspective of one or more frames of reference, are not simultaneous. But then she must surely reject the idea that *O* is wholly present. On the other hand, if she holds that *O* is composed of the parts that are simultaneous in a particular reference frame at a particular time,¹² then, they argue, she is lead into unacceptable metaphysical profligacy. For in that case the object composed of the parts that are simultaneous in a reference frame *R* is not the same object as the object composed of the parts that are simultaneous in reference frame *R*^{*}. For each of *these* objects is composed of different parts at different times and must, therefore, be distinct. Hales and Johnson's argument proceeds as follows:¹³

1. Assumption: Special relativity is true.
2. Assumption: Endurantism is the thesis that objects are wholly present whenever they exist.
3. Assumption: Simultaneity is sufficient for coexistence.
4. Assumption: Coexistence is transitive.
5. An object *O* is wholly present at *t* iff all of its parts coexist at that time.
6. Let *P* and *Q* be two enduring objects that are proper parts of enduring object *O*.
7. Let *P*₁ and *Q*₁ represent two points on the worldline of *P* and *Q* such that *P*₁ and *Q*₁ are simultaneous at *t*₁ in *O*'s rest frame *R*.
8. Let *P*₂ and *Q*₂ represent two points on the worldline of *P* and *Q* such that *P*₂ and *Q*₂ are simultaneous at *t*₂ in *O*'s rest frame *R*.
9. Let *P*₂ be in the absolute future of *P*₁ and *Q*₂ be in the absolute future of *Q*₁, where *x* is in the absolute future of *y* iff there is some causal signal which can travel from *y* to *x*.
10. So *P*₁ and *Q*₁ coexist and *P*₂ and *Q*₂ coexist. (3,7,8)
11. There is some frame of reference *R** from the perspective of which *P*₁ and *Q*₂ are simultaneous.
12. So *P*₁ coexists with *P*₂. (4,10,11)
13. So all of *O*'s parts do not coexist at the same time. (9,12)
14. Therefore *O* is not wholly present.

What should we make of this argument? The first thing to notice is assumption (3), that simultaneity is sufficient for coexistence. By this I take it that Hales and Johnson mean that simultaneity in some reference frame is sufficient for coexistence simpliciter. This seems plausible. As Hales and Johnson put it, "if two things exist at the same time, they coexist."¹⁴ Now (3) does not tell us that simultaneity is necessary for coexistence, only that it is sufficient. This is important given assumption (4), that coexistence is transitive. For of course, simultaneity is not transitive (or at least, it is not transitive across different frames of reference), and if simultaneity is necessary for coexistence, then coexistence is not transitive either.

Hales and Johnson claim that "it is natural and common to assume that coexistence is transitive" and cite Putnam, among others, as a source of this view.¹⁵ But whether it is natural to see coexistence as transitive depends entirely on how one understands coexistence. Given that our folk intuitions are stubbornly pre-relativistic, it is certainly *natural* to think of coexistence as transitive. Of course, this is not what Putnam means when he says that coexistence is transitive. For Putnam, since the universe is a block universe in which all four-dimensional objects tenseless exist, all such objects coexist.¹⁶ Since on this view all it takes to coexist is to exist in space-time, it trivially follows that coexistence is transitive. We can

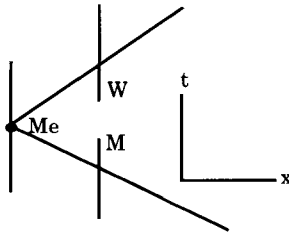
see that this notion of coexistence is entailed by Hales and Johnson's claim that simultaneity in some reference frame is sufficient for coexistence simpliciter. For it turns out that for any two events E and E^* , there is some reference frame R from the perspective of which these two events are simultaneous. Thus any two events will coexist, and thus coexistence is indeed transitive.

It is clear though that this minimalist reading of coexistence, according to which everything coexists with everything else, is not what Hales and Johnson mean to capture by the term. What they mean to capture is the sense in which I coexist with my dog in a way that I do not coexist with Caesar. It is only this that makes it sensible to define being wholly present in terms of the coexistence of parts at a time (after all, on the minimalist reading it makes no sense to talk of objects coexisting *at a time*).

There is certainly a way of defining coexistence in terms of the sufficiency of simultaneity, such that coexistence is transitive, and thus $P1$ and $P2$ coexist. Whether this captures any folk sense of the term is open to debate, but the endurantist *could* accept this as an account of coexistence. But then if that is what we mean by coexistence, there seems no reason that the endurantist would accept (5), which defines wholly present in terms of coexistence of parts at a time. For the endurantist holds that an object is wholly present at a time just if all of its parts exist *at that time*. That is, the endurantist holds that an object is wholly present at t just if all its parts are simultaneous at t . If we understand coexistence as Hales and Johnson do, however, it turns out that $P1$ and $P2$ coexist despite the fact that $P2$ is future relative to $P1$. In this sense of coexistence, there is no reason to suppose that all of an enduring object's parts coexist at the same time. After all, to say that $P1$ and $P2$ coexist in this sense is really just to say that $P2$ is simultaneous with $Q2$ in some frame, and $Q2$ is simultaneous with $P1$ in some other frame. This tells us that tenselessly, part $P2$ of O is just as ontologically real as part $P1$, but the endurantist never denied that.

I think though, that it is far more likely that the endurantist will accept (5) but will deny that simultaneity is merely sufficient for coexistence and thus will deny (4), that coexistence is transitive. The point is that since the endurantist's notion of being wholly present is defined in terms of coexistence, the definition of coexistence that is used must be one that captures what the endurantist means by the term. Now it seems pretty clear that when the endurantist says that an object is wholly present at a time just if all of its parts are present at that time, that is, if all of its parts coexist at that time, she means that an object is wholly present at t just if all of its parts exist simultaneously at t .

To see this, let us consider an example. Suppose that there is a man M who presses a red button and at that moment is vapourized. Pressing the button then causes a machine, somewhat in the manner of a Star Trek transportation device, to a moment later instantly create a woman from the surrounding atomic matter. Suppose further that I am observing these events from some inertial reference frame. This is represented in the diagram below, where M represents the worldline of the man up until he presses the button and ceases to exist, and W represents the worldline of the woman who a moment later springs into existence. The point W at which the woman comes into existence is in the absolute future of the point M at which the man ceases to exist. The broken lines represent everything that is outside the future and past light cones of me relative to my reference frame.



Relative to my reference frame then, I am simultaneous with both the man when he is still alive prior to pressing the button and with the woman after she is miraculously created. Thus I coexist with both the man and the woman. If coexistence is transitive, then it follows that the man coexists with the woman, despite the fact that the man ceases to exist before the woman comes into existence: the man's ceasing to exist is in part the cause of the woman coming into existence. There is no sense in which the man and the woman exist at the same time. This is the sense in which simultaneity is not transitive. Though relative to my frame of reference I am simultaneous with both the man and the woman, it does not follow from this that the man is ever simultaneous with the woman. So it is difficult to see why we should think that there is any sense in which the man and the woman coexist. This is because the sort of relativistic nontrivial sense of coexistence that Hales and Johnson are attempting to capture is one according to which simultaneity is not just sufficient but is also necessary for coexistence. And this is not just some peculiar feature of endurantism and its attendant notion of coexistence.

Indeed, given a trivial relativistic notion of coexistence, it is not even true that coexistence is transitive relative to one and

the same frame of reference. And this is so even if one adopts a four-dimensionalist ontology. For the four-dimensionalist will presumably hold that objects O and O^* coexist just if they have temporal parts that are simultaneous in some reference frame. But then consider a case in which me, my dog, and my grandfather are all located within the same reference frame. Although there are temporal parts of me and my dog that coexist and temporal parts of me and my grandfather that coexist, it does not follow that my dog and my grandfather coexist: for it might be that relative to that frame of reference, there are no temporal parts of my dog that are simultaneous with any temporal parts of my grandfather.

Of course, the four-dimensionalist might reject this notion of coexistence on the grounds that it has what some might see as the counterintuitive consequence that it is true of me today that I coexist with my grandfather, despite the fact that he is no longer alive. This might motivate the four-dimensionalist to talk not of four-dimensional wholes being coexistent but of temporal parts coexisting. Then it is straightforwardly true that the I-now temporal part of me does not coexist with my grandfather, since there is no temporal part of my grandfather that is simultaneous with I-now: I-now is in the absolute future of all temporal parts of my grandfather. But notice that understanding coexistence in this way is strictly analogous to the way the endurantist understands coexistence. For if we took coexistence to be transitive, it would follow that there is some object O in a frame of reference R , such that O coexists with I-now, and O coexists with some temporal part of my grandfather. But even the perdurantist would surely not want to conclude from this that I-now coexists with some part of my grandfather.

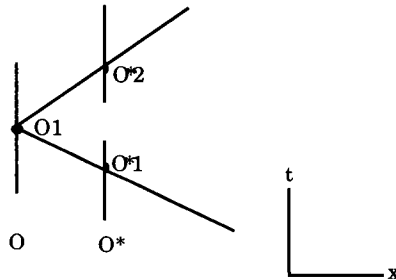
Thus it seems that a relativistic nontrivial sense of coexistence will be defined in terms of the necessity of simultaneity and hence will not be transitive, and that is so regardless of whether one endorses endurantism or perdurantism. If we reject the idea that coexistence is transitive, however, then Hales and Johnson's argument does not go through. For the argument requires that we move from the claim that P_1 coexists with Q_2 and Q_2 coexists with P_2 to the conclusion that P_1 coexists with P_2 .

Now it is not a new idea to view coexistence as intransitive. Yuri Balashov, for instance, suggests that two enduring objects O and O^* coexist iff there is some frame of reference F and time t such that O and O^* are wholly present at t relative to F , where O and O^* are wholly present at t relative to F just if O and O^* are simultaneous relative to F .¹⁷ Although adopting such a definition renders Hales and Johnson's argument unsuccessful, all is not plain sailing. For although Balashov endorses the former as the best endurantist account of coexistence, he argues that it nevertheless brings with it some

unpleasant consequences for the endurantist. It is to these consequences that we turn in the next section.

3.1 Coexistence and Endurance

Balashov argues that although the endurantist can provide a coherent relativistic account of coexistence, such an account has some counterintuitive consequences that the perdurantist's account lacks.¹⁸ Consider the following example. Suppose we have two enduring objects O and O^* . Consider O 's worldline, and consider some point, call it $O1$, on that worldline. Now consider O^* 's worldline, and consider two points on that worldline, call them O^*1 and O^*2 .



Since O^* endures, it is wholly present at O^*1 and O^*2 . Now suppose that relative to O 's frame of reference at $O1$, O is simultaneous with O^*1 , and also simultaneous with O^*2 . Then O coexists with O^* more than once: it coexists with O^* when O^* is at O^*1 and when it is at O^*2 . Now, exactly the same will hold true if we take O and O^* to be perduring objects. In that case however, O^*1 and O^*2 are two distinct temporal parts of O , so when O coexists with both O^*1 and O^*2 , it is merely coexisting with two distinct objects that happen to each be part of some perduring object. When we describe this case in endurantist terms though, O^*1 and O^*2 are both one and the same object existing at different spacetime locations. But how can O be coexistent with O^* twice at the same time if O^* is wholly present whenever it exists, that is, how can O^*1 and O^*2 be one and the same object if they are "both" coexistent with O at $O1$?

Well of course, O^*1 and O^*2 are *themselves* never coexistent: one is in the absolute future of the other. So there is no sense in which they both exist at the same time and yet are wholly present at each of those times. There's no denying, however, that O^* 's being coexistent with O at $O1$ twice is a bit odd. But the theory of special relativity is a bit odd, so that should hardly surprise us. When we consider that relativistic endur-

antism is the thesis that persisting objects are wholly present at every point on their worldline and that each of these points is equally ontologically real, it should come as no surprise that there is some frame of reference from which some object co-exists with an enduring object at multiple points along its worldline. This would only be disconcerting if we thought, for instance, that presentism was true and that O^* exists only in some objective present (say at O^*1).

The problem here really boils down to how it is possible for an object to be wholly present at multiple locations in space-time, and that question bears a remarkable similarity to the question of how it is possible for one and the same *property* to be instantiated at multiple points in space-time. Those such as Armstrong¹⁹ who believe in immanent universals, hold that one and the same property can be “wholly present” at multiple locations: thus I can see red to my left and red to my right, and both of these reds can be numerically identical. Those who are drawn to accept such universals ought not have difficulty understanding how one and the same enduring object can be wholly present at O^*1 and O^*2 and coexist with O at $O1$, just as two numerically identical properties of redness can coexist with me now. On the other hand, those who reject the idea of such universals are more likely to see the two reds as distinct instances of a property, just as they are more likely to see O^*1 and O^*2 as distinct parts of a perduring object. While some might see the analogy between property universalism and endurantism as a reason to prefer perdurantism, it certainly does not show that endurantism is inconsistent with special relativity or even that the endurantist notion of coexistence is unappealing.

3.2 Special Relativity, Parthood, and Properties

So far then, we have rejected Hales and Johnson’s argument on the grounds that it relies on the implausible claim that coexistence is transitive. This means we have rejected the claim that an enduring object is composed of all the spacetime [*space-time*] points for all possible frames of reference and, thus, the claim that enduring objects are composed of nonpresent parts. This suggests that the endurantist will say that an object is composed at a time t relative to a frame of reference R , of all of the space-time points that exist simultaneously at t relative to R . Then an object O is wholly present at t relative to reference frame R , just if all of its parts exist simultaneously relative to R at t . But this latter view, according to Hales and Johnson, means that enduring objects will be composed of different parts relative to different frames of reference and thus the objects that are wholly present relative to different frames of reference cannot be one and the same enduring object.

That there is something problematic about the idea that enduring objects are composed of different parts and have different properties relative to different frames of reference is of course the problem enunciated by Smart and Quine with which we began this section. Smart and Quine see the problem as showing that objects are never wholly present, where Hales and Johnson see it as showing that there is an absurd metaphysical profligacy attendant in endurantism in the context of special relativity. To clarify the nature of this problem I will employ an example taken from Hales and Johnson and modified slightly for illustrative purposes.²⁰

Let us suppose that Dave is now sitting in the middle of a very high speed train that travels at a significant fraction of the speed of light. At each end of the train there is a clock, and Dave has synchronized his watch with each of the clocks on the train. Let us suppose for simplicity's sake that the train has two carriages, a front and rear carriage, that are the two proper spatial parts of the train. At each end of the train there is a switch that if pressed, results in that half of the train almost immediately changing color to red inside and out. At each end of the train there is a man sitting next to the magical switch. Dave is in the rest frame of reference of the train, and from his perspective at 12:00 exactly, both switches are pressed, and just after 12:00 the entire train is red. From Dave's perspective, prior to 12:00 the wholly present train was a uniform silver, and post 12:00 the wholly present train is a uniform red. From Dave's perspective, there is no time at which one half of the train is red and the other half is silver.

Now let us suppose that as the train passes a station, Sally is standing on the platform. Let us suppose further that Sally is directly opposite Dave when his watch reads 12:00. At that time, from Sally's frame of reference, the front half of the train appears a uniform silver, while the back half of the train is red. According to Sally then, the train is at one time half silver and half red. Thus it seems that Sally and Dave have an incompatible ontology: Sally is committed to the existence of a train that is at one time half red and half silver, while Dave is committed to the existence of a train that is at all times a uniform color. Thus as Smart and Quine see it, the endurantist must conclude that the train is not wholly present, while Hales and Johnson conclude that this shows that there are really *two* trains, one that is always a uniform color and one that is at one time half red and half silver.

As I see it there are two possible responses that the endurantist might make to this problem. The first response involves accepting that enduring objects will indeed be composed of different parts and have different properties relative to different frames of reference, but pointing out that this does not lead to metaphysical profligacy or to denying that such objects

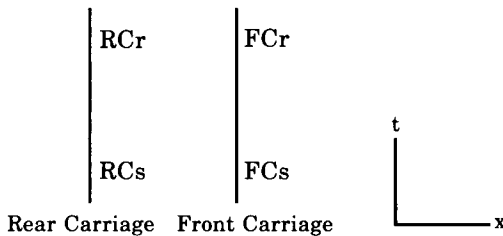
are wholly present. For there is nothing contradictory about having different properties or parts relative to a different frame of reference. It is not that there is some absolute time t at which, from one reference frame an object O has a part P and from another frame lacks P . Rather, an object has the same part at a *different time relative to a different inertial frame*, not at a different time simpliciter.

In a way we can see this problem as a relativistic analog of the problem of temporal indexing from within a frame of reference. How is it that from within a frame of reference R , one and the same object can have different properties at different times and yet be the same object at each of those times? The answer, for the endurantist, is that the object has those properties in a temporally relativized manner: it is red-at- t or red t ly. But it is still true that one and the same object has the property of being red t ly and that it has this property at times other than t . So too we can say that an enduring object has properties 'frameRly'. An enduring object has some property P at t frameRly if it has that property at t relative to frame R . Thus we will say of the train, that it has the property of being a uniform color frameRly, where frame R is the rest frame of the train (Dave's frame), and that it has the property of being half red and half silver frameR*ly, where frame R^* is the frame from which Sally observes the train. It is true of the train at every time and at every frame that it has both of these properties: the train straightforwardly has the property of being half red and half silver at t frameR*ly. So there is no reason to posit the existence of multiple trains: there is one train that has frame invariant "framely" properties, just as relative to a frame, there is a single object that tenselessly has temporally relativized properties.

There is, however, another possible response that the endurantist could make to this problem. In this paper I have sometimes used the common locution of being "simultaneous relative to reference frame R ." The problem for the endurantist arises because there is no "absolute simultaneity": while two events may be simultaneous from the perspective of one reference frame, they will fail to be simultaneous from the perspective of another reference frame. Thus since the endurantist holds that an enduring object O is composed at t of all of the parts that are simultaneous at t , she seems committed to holding that enduring objects will be composed of different parts relative to different frames of reference. In the train case, she seems committed to holding that relative to frame R there is an object composed of two silver carriages and then two red carriages, and relative to R^* there is an object composed of a silver carriage and a red carriage. Thus one and the same train has the property of being uniformly red at t frameRly, and being half red half silver at t frameR*ly.

The locution of “simultaneous relative to R,” however, might be considered a bit misleading. The theory of special relativity only tells us that two objects x and y are simultaneous just if there is no causal signal that can travel between the two of them: if they are space-like separated. When we say that the red and silver carriage are simultaneous relative to Sally’s frame of reference, what we mean is that the red carriage is simultaneous with Sally and the silver carriage is simultaneous with Sally. So when the light from the two carriages reaches her, she will see a train that is half silver and half red.

This case is analogous to the earlier one in which the man presses a button and then ceases to exist, causing a woman to come into existence a moment later. Recall that relative to my frame of reference, I am simultaneous with both the alive man and the alive woman. In that case we were careful not to conclude from that, that the man is ever simultaneous with the woman: for the woman was in the absolute future of the man—a causal signal could pass from one to the other. So too *even relative to Sally’s frame of reference*, there is a causal signal that can travel between the red carriage and the silver carriage. The red carriage is future relative to the silver carriage. To make this clearer, consider the following diagram that shows the worldline of two carriages both of which are silver at RCs and FCs and both of which are red at RCr and FCr.



It would be common to describe this situation as one in which relative to the train’s rest frame, the front and rear silver carriages are simultaneous and the front and rear red carriages are simultaneous, but relative to Sally’s frame of reference, the silver front carriage is simultaneous with the red rear carriage. But, the endurantist might argue, it is not just that the rear red carriage is future relative to the rear silver carriage, *in the rest frame of the train*. That a causal signal can be sent from the rear silver carriage to the rear red carriage is a frame invariant fact. The red rear carriage is always absolute future to the rear silver carriage. So too the front red carriage is always future relative to the rear silver carriage. Thus, the endurantist could argue, although it is true that relative to Sally’s frame of reference, she is simultaneous with the front silver carriage and the red rear

carriage, this does not imply that the front silver carriage and the red rear carriage are themselves simultaneous. But the endurantist holds that an enduring object is wholly present at t just if all of its parts are simultaneous at t , that is, just if no causal signal can pass between any of its parts at t . So the composition of an object at a time is naturally the composition of that object as viewed from its rest frame at that time, for this is the only frame from which the simultaneity of its parts with *each other* can be measured. Thus since the silver front carriage and red rear carriage are not simultaneous in their rest frame, it follows that there is no object composed of those two parts.

In essence the endurantist will argue that we cannot infer from the fact that Sally is simultaneous with a front silver carriage and a red rear carriage, that there is any object that is half red and half silver. Rather than holding, as the perdurantist does, that Sally is simultaneous with a particular "slice" of a four-dimensional train such that she sees a silver temporal part of the silver carriage and a red temporal part of the rear carriage, the endurantist will hold that Sally is simultaneous with two wholly present spatial parts of the train: a red carriage and a silver carriage. On this view then, enduring objects are not composed of different space-time points relative to different frames of reference. Rather, any enduring object is composed at a time of only those space-time points that cannot send causal signals to one another, that is, to space-time points that are space-like separated. Thus the train is straightforwardly composed of the two silver carriages at one time and the two red carriages at another time; it is never composed of a red carriage and a silver carriage.

This latter view has some advantages over the former view that relativized properties and parts to frames. For consider. The endurantist surely does not want to say that for any frame of reference R and time t , relative to R at t , an enduring object O is composed of the set of space-time points that are simultaneous with R at t . For there are various frames of reference from the perspective of which at t , only one space-time point at which some object exists is simultaneous with an observer in that frame at t . Thus suppose that relative to frame R^* at t_1 , an observer at t_1 is simultaneous with a single space-time point P at which my dog exists. We do not want to conclude from that, however, that relative to R^* at t_1 there exists a wholly present dog, albeit it that the dog is composed of only one space-time point relative to that frame. Rather, the endurantist presumably wants to hold that relative to R^* at t_1 , there is no wholly present dog, but rather, a spatial part of a dog. So it seems that the endurantist will need to hold that relative to any frame of reference R at t , an enduring object O is composed of the set of space-time points that are sufficient for the existence of an O . Thus although there may be frames of reference from the

perspective of which my dog is composed of a set of space-time points such that she is tailless from that frame of reference, there are no frames of reference from which any dog is composed of a single space-time point. This is all very well of course, but it leads to the difficult question of exactly which sets of space-time points are sufficient for the existence of a wholly present object of type *O* and which are sufficient only for the existence of some spatial part of an *O*. Just how much of my dog needs to be present relative to a frame of reference for my dog to be present? These are difficult questions and ones that the second approach nicely avoids.

Finally then, there is one further argument against endurantism to be considered—the argument according to which in the context of truths about special relativity, four-dimensionalism has explanatory virtues that endurantism lacks. Of course even if this argument succeeds, it only shows that four-dimensionalism has some explanatory advantages over three-dimensionalism; it does not show that four-dimensionalism is, all things considered, preferable to three-dimensionalism. Still, it is as well for the endurantist to counter this argument if possible, and in the next section I turn to consider this argument and possible endurantist responses.

4. Perdurantism, Endurantism, and Explanatory Virtues

According to Yuri Balashov, in the context of truths about special relativity, four-dimensionalism has explanatory resources that three-dimensionalism lacks.²¹ Both endurantists and perdurantists agree that persisting objects occupy a particular volume in space-time. Furthermore, if we accept the view that three-dimensional objects are relativistic, then both agree that there exist three-dimensional objects and that those objects have different properties relative to different frames of reference. The difference is that the perdurantist holds that the space-time volume that an object occupies is the mereological fusion of the various three-dimensional parts (the temporal parts) whereas the endurantist holds that the three-dimensional objects are strictly identical across time and wholly present at each frame of reference where their parts (a sufficient number of them at any rate) exist simultaneously.

For the perdurantist then, there exists a relativistically invariant object—the four-dimensional whole that occupies the particular volume of space-time—and observing this invariant object from different perspectives generates the various three-dimensional shapes. Think of the four-dimensional volume as a big sausage. Then slice the sausage along various different planes and you get different shaped sausage slices. What explains why those slices have the properties they do is that they were sliced from the particular sausage they were, in the

particular manner they were. So while three-dimensional objects exemplify different properties relative to different frames of reference, there is some objective, invariant shape that stands behind, and thus explains, each of these different shapes. But what, asks Balashov, “stands behind” the various relativistic three-dimensional objects? Why do all of the relativistic three-dimensional objects fit together so nicely into a unified four-dimensional volume?

The endurantist denies that there is any invariant four-dimensional object: all that exists are the various relativistic three-dimensional objects. As Balashov puts it, the endurantist has to start with the various three-dimensional objects and then discover that, lo, they can be arranged into a unified four-dimensional volume, and this arrangement must, for the endurantist, be nothing more than brute fact.²² This way of thinking of things, though, is a bit misleading. It brings to mind the image of finding variously shaped bits of meat around one’s house and then discovering that they fit together into a sausage shape, despite the fact that they are not “sausage slices.”

Consider this idea of a “nice four-dimensional volume” a little more closely. For perdurantists who believe in unrestricted mereological composition, not all four-dimensional objects will fill nice four-dimensional volumes. The object that is the mereological fusion of my-dog-at-t and my-shoe-at-t* does not fill a nice volume. Nor do any of the ‘gerrymandered’ objects that are fusions of noncausally continuous temporal parts. Why do the fusions of some temporal parts fill nice volumes? Well, because these parts are causally related such that each of them are spatially and temporally contiguous and so forth. Why do the wholly present three-dimensional shapes fit together to form a nice volume? Again, not all of them do if one accepts unrestricted composition. But those that do fit together in this manner do so because the various three-dimensional shapes are not separate objects, like pieces of meat, that happen to fit together to form a sausage. Rather, the four-dimensional volume just is the entire lifespan of the enduring object that fills that volume, and it neatly fills that volume because it is causally related to itself at every time at which it wholly exists. Various causal facts about an enduring object O at time t, make it the case that O will exist at t*. So there is no explanatory mystery here.

Another way of thinking about this is to consider what it is we take to be fundamental: the four-dimensional volume or the three-dimensional frame relative “slices” of that volume. Balashov’s argument rests on the notion that fundamentally there exist four-dimensional objects and that the various three-dimensional objects are frame-relative slices of these objects. If fundamentally there exist three-dimensional objects, then why should they fit together in such a neat fashion?

Well, if all we had were relativistic three-dimensional shapes and no theory about how they “fit together,” we would be surprised to discover that they fill the volumes that they do. The theory of special relativity, however, along with various other laws of nature, allows us to predict how objects that exist in the present, will exist in the future. That is, they allow us to predict what the four-dimensional volume of an object will be. We do not take a bird’s eye view of the universe and see various four-dimensional objects, which we can then use to explain the various frame-relative shapes. Rather, we take as basic the three-dimensional objects and use the various “rules” in the form of the laws of nature to predict what those objects will be like in the future. So it can hardly come as a surprise when we discover that those objects fill nice four-dimensional volumes: for that is precisely what we predicted, given our theory. Thus the endurantist will turn on its head Balashov’s claim that it is four-dimensional objects that are basic and, instead, argue that three-dimensional objects are basic, and we come to see that they fill certain four-dimensional volumes in virtue of extrapolating certain principles and making certain theoretical predictions.²³

5. Conclusion

Ultimately, the Minkowski model of space-time is almost certainly not the one that endurantists would have chosen if they could have had their pick. A nice Newtonian world would fit in nicely with our pre-relativistic intuitions and with the idea that objects are three-dimensional and exist wholly at every time at which they exist. Although it may sometimes be the case that, given special relativity, it is easier to express some claims in the language of perdurantism than it is in the language of endurantism, endurantism is nevertheless consistent with special relativity. The combination of endurantism and special relativity merely requires that we reconceptualize some of our ideas and allow that objects can be wholly present at more than one location. Thus ultimately, I think, endurantists will have to be satisfied with enduring special relativity rather than celebrating its existence.

Notes

With thanks to David Braddon-Mitchell, Mark Colyvan, and Dominic Hyde for helpful discussion of these issues.

¹ Hales and Johnson, “Endurantism, Perdurantism and Special Relativity,” 538.

² Variations on this argument can be found in Putnam, “Time and Physical Geometry”; Saunders, “How Relativity Contradicts Presentism”; and Rea, “Temporal Parts Unmotivated.”

³ Hinchliff, “The Puzzle of Change.”

⁴ Hestevold and Carter, “On Presentism, Endurance, and Change.”

- ⁵ Merricks, "Persistence, Parts and Presentism."
⁶ A defender of this view includes Van Inwagen.
⁷ Defenders of which include Haslanger, Johnston, and Lowe.
⁸ Unless one thinks that somehow accepting a tensed theory of the truth of propositions is a way around the problem of reconciling strict identity over time with change. I do not see that it is.
⁹ Smart, *Between Science and Philosophy*.
¹⁰ Quine, *Word and Object*, 172, 253.
¹¹ Hales and Johnson, "Endurantism, Perdurantism and Special Relativity."
¹² Yuri Balashov makes the same point about there being no objective frame independent notion of being wholly present in "Persistence and Space-time."
¹³ Hales and Johnson, "Endurantism, Perdurantism and Special Relativity," 533.
¹⁴ Hales and Johnson, "Endurantism, Perdurantism and Special Relativity," 533.
¹⁵ Hales and Johnson, "Endurantism, Perdurantism and Special Relativity," 533.
¹⁶ Putnam, "Time and Physical Geometry."
¹⁷ Balashov, "Enduring and Perduring Objects in Minkowski Space-time," 150.
¹⁸ Balashov, "Enduring and Perduring Objects in Minkowski Space-time," 151–3.
¹⁹ Armstrong, *Universals and Scientific Realism*.
²⁰ Hales and Johnson, "Endurantism, Perdurantism and Special Relativity," 534–7. In the original example at each end of the train the terrorists have bombs timed to go off, rather than having paint. In all other respects the example is the same.
²¹ Balashov, "Persistence and Space-time."
²² Balashov, "Persistence and Space-time."
²³ I owe this point to David Braddon-Mitchell in discussion.

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