The Southern Journal of Philosophy (2007) Vol. XLV

Time for Change

Steven D. Hales
Bloomsburg University

Timothy A. Johnson
Zygo Corporation

Abstract

Metaphysical theories of change incorporate substantive commitments to theories of persistence. The two most prominent classes of such theories are endurantism and perdurantism. Defenders of endurance-style accounts of change, such as Klein, Hinchliff, and Oderberg, do so through appeal to a priori intuitions about change. We argue that this methodology is understandable but mistaken—an adequate metaphysics of change must accommodate all experiences of change, not merely intuitions about a limited variety of cases. Once we examine additional experiences of change, particularly those in (special) relativistic circumstances, it becomes clear that only a perdurance account of change is adequate.

1. Introduction

Things change, and an adequate metaphysics of objects needs to explain how. Moreover, any theory of change is going to be inextricably linked to a theory of persistence. If objects don't persist, but are momentary, then the only sort of change is coming-into-being and passing-out-of-existence, which is not the same as a change in an object. So if objects do change, at least with respect to time, then they must persist over time. The two dominant theories of persistence are (1) four-dimensionalism or perdurantism, according to which objects are temporally

Steven D. Hales is Professor of Philosophy at Bloomsburg University. His recent books include Relativism and the Foundation of Philosophy *(MIT, 2006) and* Beer and Philosophy *(Blackwell, 2007).*

Timothy A. Johnson has a PhD in physics from Brown University and is a scientist at Zygo Corporation. He has published in The Philosophical Quarterly*,* Physical Review*, and other journals.*

extended and their persistence through time is explained in terms of temporal parts, and (2) three-dimensionalism or endurantism, according to which objects have only spatial extension and wholly exist at each moment of their existence. There is widespread suspicion that perdurantists are committed to a "block" universe without change or that, at best, they explain the phenomenon of change by supplanting our definition of real change with an ersatz version.

Put neutrally, an object undergoes change if it possesses a property at one time and lacks that property at a different time. According to endurantism, objects wholly exist at each moment of their existence; all of the parts that compose an object are simultaneous with each other. When an object changes, the whole object has a property at one time and loses it at a later time; the object itself is wholly present at both times. However, according to perdurantism, objects are extended in time as well as in space, and so a perduring object changes when one spatiotemporal part of the temporally extended object has a property that a different spatiotemporal part lacks.

The motivation for the endurantist account of change is straightforwardly rationalist: endurantism as a general theory of persistence is intuitively plausible, so any account of change must derive from the endurantist model. The motivation for the perdurantist account of change is that modern physics, and the theory of Special Relativity in particular, suggests that perdurantism may be a better fit with our current understanding of space and time; hence, our theories of change and persistence ought to reflect that.

In the first part of the present article, we argue that an intuition-driven approach is fundamentally mistaken. We acknowledge that there are strong 3-D intuitions about persistence and change but provide an error theory that explains why we have these intuitions and why they have no evidentiary value in adjudicating between the 3-D and 4-D accounts of change. Our intuitions are shaped by our ordinary, everyday experiences of the world, and these experiences are powerfully three-dimensional. However, a fully adequate metaphysics of change must accommodate not only familiar experiences of change, but all measurable instances of change.

In the second part of the paper, we defend a 4-D, perdurantist theory of change. We argue that there are examples of change under relativistic conditions that cannot be handled by a 3-D theory and, in fact, saddle endurantists with a contradiction. The contradiction that sinks the endurantist explanation fails to arise at all under perdurantism. Thus, the only reason for accepting an endurantist theory of change is a mistaken rationalist, intuition-based methodology—an intuition that itself is suspect as a holdout against our contemporary conceptions of space-time. The perdurantist account of change is

not based upon a priori intuitions but, instead, derives from the best current understanding of space-time and reconciles that with our experiences of change, and the kinds of experiences of change that might arise if relativistic effects were more a part of our everyday world.

2. Intuitions and Endurantist Theories of Change

The debate over endurantist versus perdurantist theories of change has been primarily a matter of intuition-driven argument. Of course, if empirical findings were irrelevant to this debate, then pure rationalism would be the only available methodology to use, and there would be little use in complaining about it. As we argue later, scientific discoveries are quite germane to assessing theories of change and give the nod to a four-dimensional treatment. The problem with the defenses of three-dimensional change is that they either implicitly assume that science means nothing for metaphysics, or they consider intuitions that stem from everyday experience to be of greater evidentiary value than a more comprehensive and correct scientific picture of the world.

Mark Hinchliff, for example, rejects perdurantism because according to perdurantists, whole objects do not undergo change of intrinsic properties. Hinchliff argues that if one bends a candle, the candle undergoes a change in its intrinsic properties: the candle is straight and then bent. Perdurantists are unable to accommodate this fact, he claims; under perdurantism, a temporal part of the candle is straight and a separate temporal part is bent, but not the whole candle itself. Following Hugh Mellor, Hinchliff finds this approach to be unsatisfactory, since his intuition of change requires one and the same changing thing to have both of the incompatible properties. The problem is thus that perdurantism denies "one of our intuitions about change" (Hinchliff 1996, 120).[1] The perdurantist account of change is rejected because it is unintuitive. Hinchliff's own explanation of change involves a defense of presentism, and he is admirably clear about his motives: "presentism seems to be our intuitive or commonsense conception of the nature of time" (131).

Hinchliff is not alone. Charles J. Klein rejects perdurantism because it conflicts with objects changing their intrinsic properties, and he employs an argumentative strategy very similar to Hinchliff's. While Klein concurs that the nature of change is to be understood through intuition, he appeals to intuition to understand objects as well, which he claims "are naturally thought of as being wholly located at the present moment" (1999, 230). Klein defines "the intuitive conception of change" as one that involves objects being wholly present at a time and having a property F and being wholly present at a later time

and possessing a property G that is incompatible with F. From there Klein proceeds to argue that "no perduring object is ever a subject of real change" (1999, 225, 232). Since perdurantists deny that objects are wholly present at each moment of their existence, Klein's argument is short indeed.

Most recently, David S. Oderberg gives almost exactly the same argument as Klein, writing that "things change. If anything counts as a datum of metaphysics, that does … four-dimensionalism [is] inconsistent with a fundamental metaphysical datum" (2004, 686–87). His central strategy is to provide an a priori definition of "change"—one that he thinks is the intuitively correct understanding of change—and to show that various temporal parts theories are unable to accommodate this understanding. Here is a reconstruction of his central argument:

1. Object X changes from being F to being not-F =df. X is wholly present at t and (at t) X is F, and X is wholly present at t+1 and (at t+1) X is not-F.
2. According to perdurantism, objects are not wholly present at a time; instead objects have temporal extension and are "spread-out" over time.
3. Since the definition of change requires that objects are wholly present at a time, change is incompatible with perdurantism.

The preceding is not a terrible argument; it is valid and we concur that the second premise is true. While the first premise has intuitive plausibility, there are reasons to doubt it. For example, consider the mereological sum of Aristotle and David Oderberg. For endurantists, Oderberg is wholly present now and Aristotle was wholly present then, although it does not seem that the sum is wholly present now. If *x* is a part of *y* and *x* changes, then *y* changes. Thus when Aristotle underwent change, the Aristotle+Oderberg sum changed, although it was not wholly present at any particular time.[2]

However, the main problem with the approach of Oderberg, Klein, and Hinchliff is their strategy. In deciding issues about change, what data must be accommodated? What are the desiderata? Oderberg et al. argue that the chief desideratum is the accommodation of our intuitive understanding of change. They (1) give an a priori definition of change, (2) claim that the fact of change is an indisputable metaphysical datum, (3) claim that defenders of perdurantism cannot accommodate change, and (4) conclude that so much the worse for perdurantism. In our view, their error is in assuming that it is primarily our intuitions that must be preserved.

What we need is a diagnosis and a reconsideration of the data to be saved in developing a metaphysical picture of the world. Here is the diagnosis: we have certain kinds of experi-

ences that are best interpreted as things changing. For instance, we experience the presence of some properties at one time and the lack of those properties at another time. We experience a Toyota Corolla free of rust in 1987 and rusty in 2007; we experience ourselves hirsute in our youth and balding in middle age. Our intuitions are a reaction to—a way to make sense of—these experiences. To be sure, many of our intuitions—our naïve pretheoretical beliefs about the physical world—are endurantist, Newtonian, 3-D. According to these intuitions, there are objects that wholly exist at each moment and, as they move from now to now, they gain and lose properties. So we explain change in terms of this gain and loss.

Yet the real data to be saved are not these intuitions. We need to save the appearances, that is, the experiences. The intuitions are a reaction to what really matters. The test of an adequate theory is not whether it can preserve pretheoretical intuitions, but whether it can accommodate the experiential data upon which those pretheoretical intuitions are grounded. Unfortunately, this lesson has been hard to learn. People tend to be resistant to scientific evidence that does not conform to their personal intuitions of the world, either dismissing the relevance of science entirely or assuming that recalcitrant scientific data can be brought to heel under their preferred intuitive model. Giulio Libri, one of the foremost philosophers at Pisa in the early seventeenth century, refused to even look through Galileo's telescope (Langford 1966, 41), since under his rationalist intuitions heavenly bodies must be perfectly spherical and not mountainous or craggy as the telescope revealed. More recently, Ned Markosian (2004) is prepared to dismiss the corollary of Special Relativity that there is no absolute simultaneity on the grounds that it would undermine his pet theory of presentism, for which he offers numerous intuition-based, rationalist arguments. Similarly Gary Rosenkrantz (2005) is prepared to discard perdurantism—which he freely acknowledges has heavy scientific support—since he thinks it conflicts with his broadly Lockean view of personal identity. Rosenkrantz's argument for the psychological continuity view of the self is explicitly intuition-based and loaded with rationalist machinery such as haecceities, privileged access, and a theory of intentional reference. Libri, Markosian, and Rosenkrantz are quite clear: if science comes into conflict with our intuitions or common sense, then so much the worse for science.

Of course, it is difficult to overcome one's intuitions, particularly when those intuitions are continually confirmed by ordinary experience. Even if the Earth rotates on an axis, the sun will appear to move across the sky of a fixed Earth. Even if the diversity of life is due to evolution by mindless natural selection, after a few billion years organisms will look as if they were engineered and designed. Even if the universe is relativistic,

slow moving creatures with limited perceptual abilities will perceive it as governed by classical physics. Our intuitions are formed in response to our slow-moving experiences of the world and are useful for understanding that slow-moving world. This is why so many philosophers resist abandoning our pre-relativistic intuitions about time and change, indeed why so many practicing physicists resisted Einstein a hundred years ago.[3] But relativistic phenomena defy such intuitions. We must take into account the full range of measurable phenomena when developing theories of the world, not simply the narrow bandwidth that formed our intuitions.

3. Relativity and the Metaphysics of Change

We have already conceded that the three-dimensionalists have powerful intuitions, grounded in ordinary experience, supporting their view of change. However, to the extent that there is competition between 3-D and 4-D world views, it is not in the ability to predict ordinary experience. Newtonian physics, for example, is generally good enough for day-to-day applications and produces results indistinguishable from those of Special Relativity in most (low speed) circumstances. If you take an ordinary train out for a ride past a platform, you do not observe any relativistic contractions, nor do you need to reset your watch having left the station. Unless the train is traveling at an appreciable fraction of the speed of light, relativistic effects turn out to be negligible, and all those low-velocity inertial frames are just about the same.

The fact that Newtonian physics gives accurate results at low speeds does not mean that the classical theory of mechanics and dynamics is as correct as Special Relativity. Nor does it mean that intuitions derived from classical physics are a good reflection of the way the universe behaves. Examples in which a classical result and relativistic result have the same appearance are no test at all. Such an ambiguity at low speeds doesn't leave physicists rethinking their abandonment of Galilean relativity. It just means that classical theories are approximations that do a pretty good job of predicting the correct results when the phenomena are nonrelativistic. There are phenomena, however, that classical mechanics cannot account for and it is those examples that establish the primacy of relativistic explanations. Likewise, we must ensure that our theories of change are able to account for the full range of phenomena describable by our physics. Relativistic phenomena create problems for a three-dimensional metaphysics. All the successful descriptions of nonrelativistic phenomena are not enough to give an endurantist metaphysics of change any traction over these relativistic problems.

Here is an example of a relativistic phenomenon with clear and direct implications for understanding change. Imagine Lance, a cyclist, streaking down Mont Ventoux on his bike at a significant fraction of the speed of light. Lance passes his trainer, who is standing by the side of the road. As Lance rides by, they both observe a barn a short way down the hill. When Lance was closer to the top of the hill, he saw that the barn had a weathervane atop the roof. But now, passing his trainer, he observes that the weathervane has blown off in a freak gust of wind and is lying in the grass next to the barn. After Lance reaches the bottom of the mountain, he turns and cycles back up at impressive, but no longer relativistic speeds, and stops to chat with his trainer. Lance remarks, "you know, when I started my ride, the barn had a weathervane on it—but by the time I reached you, the weathervane was missing, the barn had changed." His trainer looks at him quizzically and says, "You must be mistaken. I looked up at the barn just as you drew even with me and saw that the barn still had the weathervane; it was unchanged, although a short time later the weathervane was blown down."[4]

Before we can begin to consider the implications of this adventure for our metaphysics of change, we must find a way to describe the things and events in a way that is neutral with respect to theories of persistence. It will do no good to beg the question by offering a description of events in which the language that carries an implicit assumption of endurance and then reveal that our description turns out to be incompatible with perduring objects or vice versa. First, we should describe the parts of this example that are agreed upon by all interested parties. The most important of these is that the universe is relativistic, and that times and distances transform between reference frames according to the familiar Lorentz transformation, $t' = \gamma(t - vx/c^2)$, $x' = \gamma(x - vt)$, $y' = y$, and $z' = z$ written out for each coordinate, where $\gamma = (1\text{-}v^2/c^2)^{-1/2}$, c is the speed of light, and assuming relative motion along the x-axis at speed v. All observers agree that Lance was at the top of the hill before he drew even with his trainer and that they had their conversation subsequent to that. Finally, both the perdurantists and endurantists can agree that there is a barn that persists and that, at some point, changes due to the loss of a weathervane, no matter how they may dispute what it means to persist or to change.

The example refers to two important times: a time when Lance is near the top of the hill and one when he has drawn even with the trainer. The time at which Lance is near the top of the hill we will call t_0 and the time when Lance has drawn even with the trainer, t_1. We can do this without making any claims about the size of the interval between these two times beyond that it is time-like, and without regard to what anyone

might read on their watches at those moments, except to assert that no matter who is doing the observing, t_1 is always subsequent to t_0. We defer discussions of synchronizing clocks to physics literature, but we note that by indexing those times to events, we can select a particular point in space and time that everyone can identify. So, for example, t_0 will be the time at which Lance's tire contacted a particular painted line on the pavement. Every observer in every reference frame will agree that there was a time that brought the tire and the paint together. However one synchronizes one's clock, t_0 will represent the time of that event; everything in one's reference frame that is simultaneous with that event is at t_0. Likewise, we can find a similar event that occurs as Lance is upon the trainer that will serve as a reference for t_1.

Our example involves the change of a barn, so we also need to describe carefully the instances of the barn that are relevant to this example. There is the barn that is simultaneous with Lance when Lance is near the top of the hill (at t_0). There is the barn that is simultaneous with Lance at the time when Lance has drawn even with his trainer on his way down the hill (at t_1). There is a barn that is simultaneous with the trainer when Lance is near the top of the hill (again, t_0), and there is the barn that is simultaneous with the trainer when Lance has drawn even with him (t_1). Let's label these instances as follows: $B^L{}_0$ is the barn simultaneous with Lance at t_0. $B^L{}_1$ is the barn simultaneous with Lance at t_1. Likewise $B^T{}_0$ and $B^T{}_1$ are the barn simultaneous with the trainer at t_0 and t_1. Perdurantists and endurantists agree that these four instances of the barn ($B^L{}_0$, $B^L{}_1$, $B^T{}_0$, $B^T{}_1$) are in fact all instances of the same barn; there are not four barns. While both endurantists and perdurantists concur that there is exactly one barn in this scenario, perdurantists will maintain that $B^L{}_0$, $B^L{}_1$, $B^T{}_0$, and $B^T{}_1$ are all temporal parts or time slices of a temporally extended barn. Endurantists, on the other hand, will claim that $B^L{}_0$ is simply the entire, whole barn at time t_0 and that $B^L{}_1$ is the entire barn at time t_1. Likewise, $B^T{}_0$ is the entire barn at time t_0 and $B^T{}_1$ is the entire barn at time t_1. Since $B^L{}_0$ and $B^T{}_0$ are both the barn at t_0, they are for endurantists simply different names for the same thing; likewise for $B^L{}_1$ and $B^T{}_1$.

As we find ourselves repeatedly using the term "change," we want to distinguish three different uses of change to ensure that we don't prejudice the argument. The first of these is the experience of change. What it is that we actually observe when we say a change has taken place? This is the preanalytic data that must be explained by a theory of change. The second notion is the 3-D theory of change of the sort defended by Hinchliff, Klein, and Oderberg. This we will call Change_3. The last concept of change is a 4-D change of the sort we defend. Let us call this Change_4. Change_3 and Change_4 are theories of change meant to

accommodate, unify, and explain the experiences of change. Finally, one more idea that perdurantists and endurantists alike can agree upon is that a thing at a time is either changed or it is unchanged, but it cannot be both at once.

With this terminology now established, let's consider again what the trainer and rider observe. At t_0, prior to Lance's passing, the trainer sees B^T_0, a barn that has the property of having a weathervane. At the time the cyclist draws even, t_1, the trainer sees B^T_1, a barn that still has the property of having a weathervane. Thus B^T_1 is a barn that has not changed. Lance at t_0 sees B^L_0, a barn that has the property of having a weathervane. Lance at t_1, however, sees B^L_1, a barn that does not have the property of having a weathervane. Lance disagrees—at t_1 the barn has changed.

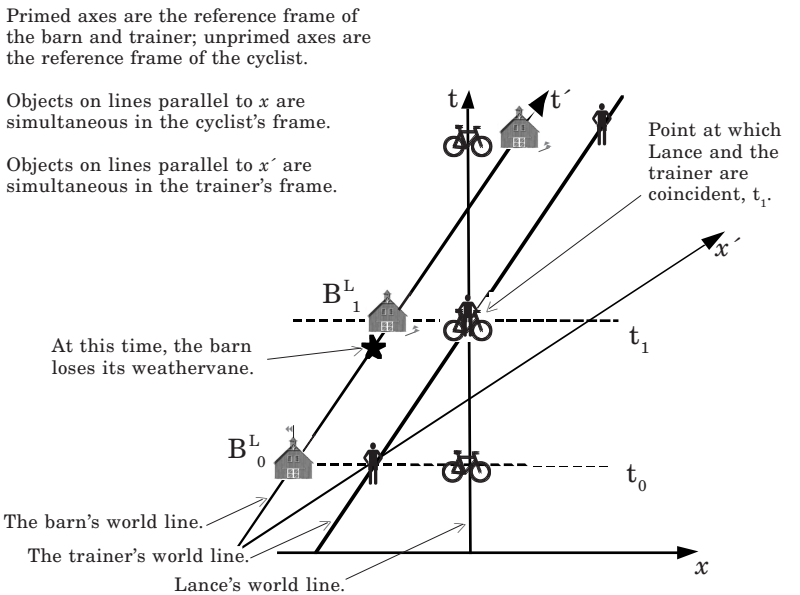
As an initial convenience, we will abstract away the dimensional extent of the bike and of the individuals, so that t_1 finds Lance and the trainer in coincidence: at the exact same place at the same time. This puts them in a condition of absolute simultaneity at t_1—every observer will agree that when they made contact, they were in the same place at the same time. Extending our terminology, everyone will agree that it is Lance_1 and trainer_1 who are in that same place at t_1. This provides an important simplification for the discussion, but the argument does not rely on this condition, and we will revisit below the events when at t_1 there is some spatial separation between Lance and the trainer.

Describing Lance's experience in terms of Change_3, we would say that the B^L_0 was the barn with proper parts at t_0, and those parts at t_0 were all the proper parts of the barn that existed. We would also say that B^L_1 was a barn with proper parts at t_1, and they were the same proper parts that had composed B^L_0, now at the later time. At t_0, those parts were the only barn parts that existed, and they composed a barn with the property of having a weathervane. At t_1, those parts were the only barn parts that existed, and they composed a barn with the property of being without a weathervane, a barn that changed. (Note that Lance's inertial reference frame has not changed from t_0 to t_1. The change we are describing is not due to frame relativization of properties.) The properties of the barn's parts were different at different times, and there were no barn parts composing a barn with a weathervane when there were barn parts composing a barn without a weathervane. Change_3 seems perfectly adequate to explain Lance's experience of the barn's change.

Describing his experience as Change_4, we would say that at t_0, Lance observed B^L_0, an oblique (with respect to the barn's rest frame) time slice of spatiotemporal parts of the perduring 4-D barn that composed a barn that had a weathervane. At t_1, Lance was observing B^L_1 a different oblique time slice of spatiotemporal parts of the perduring 4-D barn that composed a barn

that was without its weathervane, that is, a changed barn. Again, this explanation is equally consistent with the observed evidence (and, again, not a change due to frame relativization; Lance's inertial reference frame remained the same). See Figure 1 for a world line diagram showing the events in Lance's frame of reference.

Figure 1. The Events from Lance the Cyclist's Frame of Reference

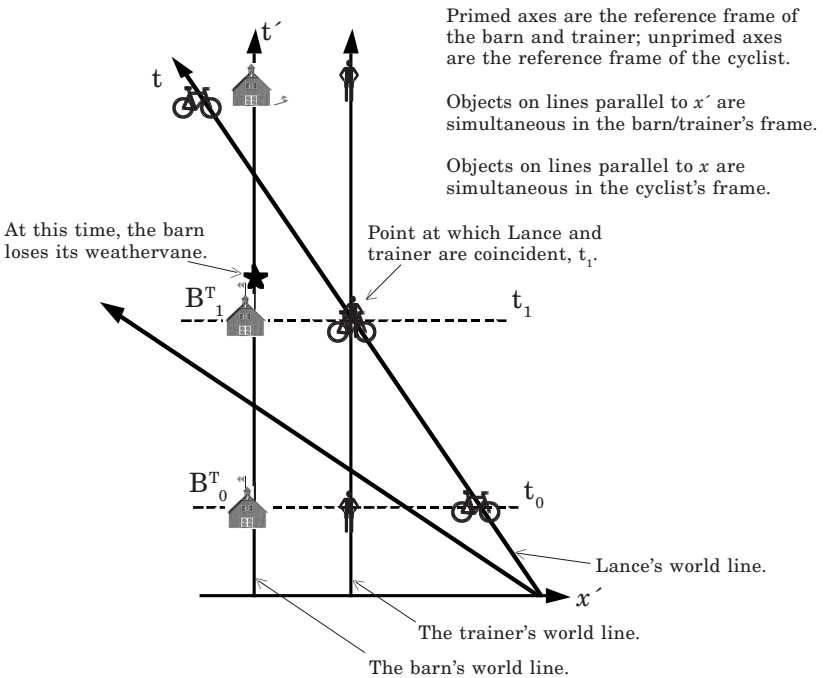


One might be tempted to believe on the basis of this result that there is a standoff—we have two perfectly good explanations, $Change_3$ and $Change_4$, for the same experience. This is the point where rationalists start appealing to the intuitive force of $Change_3$. Fortunately, we do not yet need to resort to appeals to "intuition" (and let's not mince words: a nineteenth century, three-dimensional, classical physics intuition), since there is more evidence to this example that must be accommodated and that may yet resolve the point: we need to reconcile Lance's experience with the state of affairs from the perspective of the trainer.

The trainer didn't observe any change, but we will describe his experience in the language of $Change_3$ and $Change_4$. In $Change_3$, at t_0, according to the trainer, there is a barn $B^T{}_0$, a collection of barn parts that are all the proper parts of the

barn that exist, and they compose a barn with a weathervane. At t_1, there is B^T_1, a collection of barn parts that are all the proper parts of the barn that exist, and they compose a barn with a weathervane: the barn B^T_1 is an unchanged barn. According to $Change_4$, at t_0 there is B^T_0, a collection of barn parts that constitute a particular time slice of all the barn parts that compose a barn simultaneous with the trainer at t_0. At t_1, there is B^T_1, a collection of barn parts that constitute a particular time slice of all the barn parts that compose a barn simultaneous with the trainer at t_1. The properties of the time slice at t_0 and the time slice at t_1 are the same—both have a weathervane, there has been no change. See Figure 2 for a world line diagram showing the events from the trainer's reference frame.

Figure 2. The Events from the Trainer's Frame of Reference



This looks like another standoff, until you remember that the barn observed by Lance and the barn observed by the trainer were the same barn. For $Change_3$, this means that B^T_1, which is the barn that exists at t_1, and B^L_1, which is also

the barn that exists at t_1, are identical—they are the same, complete barn. If the barn endures, there can only be one set of barn parts at t_1. Therefore, for endurantism, both of these things must be true: there is a collection of barn parts that are the only barn parts that exist and compose a barn that is changed (Lance's experience), and there is a collection of barn parts that are the barn parts that exist and comprise a barn that has not changed (the trainer's experience). But either the barn has changed (lost its weathervane) or it has not changed (still has the property of being topped by a weathervane). The law of noncontradiction says that both cannot be true.

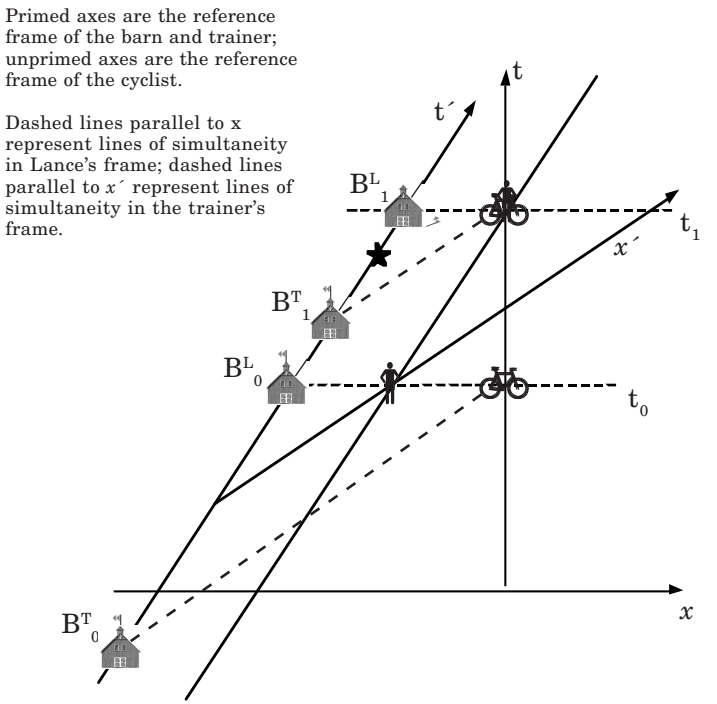
Both Lance and his trainer are correct about the qualities of the barn they are simultaneous with at the moment Lance is coincident with the trainer. Moreover, the loss of the weathervane can be considered as the loss of an intrinsic property, that of possessing a weathervane. (If the reader finds this property insufficiently intrinsic, the example can be modified to accommodate some other appropriately intrinsic property of the barn.) Endurantists—who hold that the whole entire barn exists at every moment and marches from now to now gaining and shedding properties—are immediately confronted with a contradiction: all of the barn parts that compose the barn at t_1 compose an unchanged barn (B^T_1), while also all of the barn parts that compose the barn at t_1 compose a changed barn (B^L_1).

But what of $Change_4$? For both Lance and the trainer individually, there is nothing in their experience of change that would indicate whether they have experienced $Change_3$ or $Change_4$. If $Change_4$ does not fare any better than $Change_3$ in accommodating the joint experiences of Lance and the trainer, then perhaps we should throw up our hands and let our intuitions settle the dispute. Fortunately, $Change_4$ handles the differences between Lance and his trainer with grace. At t_1, Lance observes one particular time slice of the barn parts that compose a perduring barn—a time slice from times in which the barn no longer has the weathervane. Because there is a high relative velocity between Lance and the trainer, at t_1 the trainer sees a different time slice of the barn parts that compose a perduring barn—a time slice from times in which the barn still has the weathervane. The trainer and the cyclist have different experiences of the same barn because they are simultaneous with different spatiotemporal parts of the same perduring 4-D barn. B^L_1 and B^T_1 are not the same—they are distinct time slices of the same object. Thus, for the perdurantist there is no contradiction in the different experiences of change.

Furthermore, there is nothing magic going on here: all of the barn parts are accounted for, and the trainer and the cyclist agree on the existence of each part. (For the trainer, the barn

without the weathervane hasn't arrived yet at t_1.) What they don't agree on is their temporal arrangement. Lance and the trainer don't agree on which barn parts are simultaneous with them when they are coincident with each other. (This is not surprising—one of the first things to go in Special Relativity is absolute simultaneity.) $Change_4$ does not stumble when confronted with the varying experiences of change in a relativistic encounter but explains all the experiences in different inertial frames with ease. The unity and consistency of $Change_4$ is visually conveyed with a world line diagram in Figure 3.

Figure 3. Revisiting the Events from Lance's Frame of Reference, with B^L_0, B^L_1, B^T_0, and B^T_1.



We now return briefly to the abstraction that Lance and the trainer were without dimension or substance, to reassure the reader that there is no sleight of hand in the premise. The abstraction allowed us to have Lance and the trainer in exactly the same place at t_1. This ensured that they were

simultaneous at that time in all inertial reference frames. Removing the abstraction so that they are never in exactly the same place at the same time means that our argument is constructed for the particular reference frames of Lance and the trainer. Of course, the argument can be constructed similarly for any arbitrary reference frame, but if Lance and the trainer are not in the same place, but only very close to each other, other observers with motion in the direction of that separation will find that the instance of the trainer they determine to be simultaneous with Lance at t_1 is a different instance of the trainer than the one that Lance finds he is simultaneous with at t_1; simultaneity is not preserved. It should be apparent, however, from Figure 3 that observing from a reference frame in which the trainer is a little ahead or a little behind on his world line when he is simultaneous with Lance at t_1 doesn't change matters in any important way. In other words, changing the distance of the barn from the trainer, changing the time that the weathervane falls, or inverting the example so that the change occurs after the barn is simultaneous with Lance at t_1 can produce the contradiction for any third reference frame. Establishing a "preferred" frame of reference to attempt to fix this instance doesn't eliminate the problem.

To avoid the paradoxical result of a barn being both changed and unchanged, it is necessary to scrap wholesale the 3-D, endurantist approach to change. Support for the 3-D approach comes from nothing more than intuitions that stem from a systematic (and wholly understandable) misperception of the world. An endurantist model of change literally has nothing else to back it, and its defense might profitably be seen as no more than a case of subjective validation. Yet a four-dimensional perdurantist metaphysics of change, informed by Special Relativity, makes perfect sense of the apparent contradictions, just as Special Relativity makes perfect sense of those phenomena that cannot be explained by Newtonian mechanics. Relativistic phenomena like the Twins Paradox are paradoxical only when one tries to understand them within a three-dimensional, classical physics paradigm. Precisely the same dynamic is at work here; the disagreement between Lance and the trainer about whether the barn changed at t_1 is a paradox only to a three-dimensionalist.

4. Conclusion

According to endurantists, an object changes when it has a property at one time and then lacks that property at a later time. The object itself is wholly present at both moments—all the parts that compose the object at a given time are simultaneous with each other at that time. Change is the gain and

loss of properties with respect to time; as the object moves from one time to the next, it gains and loses properties. However, according to perdurantists, an object changes when it has one property at one time in space-time (that is, along one three-dimensional region of simultaneity in the reference frame of the observer) and lacks that property at another time in space-time. At any given moment, the object itself comprises parts that are not simultaneous with each other, and the object is temporally, as well as spatially, extended. The object changes when one spatiotemporal part has a property that a different temporal part lacks.

There is exactly one reason to accept the endurantist view of change: it is the theory of change that squares best with our preanalytic intuitions. This is a fine reason if and only if these two conditions are met: (1) if appealing to intuition to settle the issue is the best methodology and (2) if endurantist change really is the most intuitive. The burden of the first part of the paper was to argue that in the metaphysics of change, a priori intuitions *have no evidentiary value whatsoever*. Therefore, it just doesn't matter whether Change_3 is the most intuitive way to understand our experiences of change; it is wholly irrelevant.

We understand the intuitive pull of three-dimensionalist sensibilities; we feel them as well and understand why philosophers would want to defend them in giving a theory of change. It is worth noting in passing, though, that even in a pure battle of intuitions, Change_3 is hardly a decisive winner. Although Oderberg asserts that change is what happens when a wholly present thing gains or loses properties between one time and the next, the requirement that the object be wholly present (enduring) is not required for our experience of change. All we *experience* is that the parts we observe at one time (be they all the parts that exist or a slice of a temporally extended object) gain or lose properties compared to the parts we observe at another time. Just as a listener now hearing the third movement of Beethoven's Ninth Symphony has not yet experienced the change from pure orchestral instrumentation to the addition of vocal accompaniment but a listener now hearing the fourth movement has experienced such a change, so too an observer at one time might experience a change in an object that an observer at an earlier time did not experience. Perdurantists are no more committed to an unchanging block universe than musicologists are committed to static, unchanging symphonies. Both are perfectly able to explain our experiences of change.

Furthermore, there are familiar uses of "change" that involve intrinsic properties differing with respect to things other than time, and these are consistent with change being what happens to those parts of a not-wholly-present thing that are within the bounds of our perceptions. A road changes

from gravel to asphalt at mile marker 10, the climate changes from cold to warm as one drives south for the winter, the air pressure changes as one scales a mountain, even this very article has changed from critical reflections at the beginning to a positive theory of change at the end. Writers like Oderberg, Klein, and Hinchliff know these things and know that they need to explain away Change_4 intuitions to make the Change_3 case. So they dismiss this kind of change as a mere *façon de parler*, not authentic change. For them, true change is the gain and loss of intrinsic properties for an object wholly present and only with respect to time. Roads don't change from gravel to asphalt along their length, they change to asphalt only if we come back later to pave them. Four-dimensionalists, of course, think that the landscape changing from a savanna to a rain forest is much more like what change is all about: one part of a thing giving way to another part (see, for example, Sider 2001, 93). Despite the undisputed intuitive pull of endurantism, intuition has not produced an undisputed champ.

While we can explain why the appeal to intuition seems so plausible, it is the wrong way to defend any theory of change. What we ought to do in formulating metaphysical theories of objects is make sure that our theories accommodate the full range of measurable experiences. Mere appeal to intuitions of change fails to respect this desideratum. Appeal to intuition is psychologically compelling because intuitions about objects are the result of cognitive skills evolved to deal with a slow-moving world of middle-sized objects, and as a result our ordinary experience of the world is overwhelmingly three-dimensional. As long as we stick to examining the features of such objects, our intuitions form a fairly good guide. Unfortunately, the full range of measurable experience includes fast moving objects in a variety of sizes. Intuition is an exceedingly poor guide to understanding the features of such things; there was no need for evolution to build in relativistic intuitions, since the vast majority of our ordinary experiences are Newtonian. Of course, if there were no other methodology available to us besides appeal to intuition, then there would be little point in complaining about its limitations. This brings us to the thesis of the second half of the paper: the right way to decide about theories of change is to examine as complete a range of measurable experiences as our science allows and to develop our metaphysics in a way compatible with this data.

We have argued that Change_3 cannot accommodate relativistic phenomena. Observers in different inertial frames that are simultaneous with each other will perceive the very same object as changed (in one frame) and unchanged (in the other frame). For endurantists, this contradiction is a deep and abiding mystery, whereas for perdurantists the contradiction is illusory and is easily explained. Observers in different

reference frames find themselves simultaneous with different aggregates of the temporal parts of the object, with one series of temporal parts retaining a property and the other series changed and lacking the property.

In the end, the endurantist picture of change has nothing to recommend it, other than its natural fit with limited, incomlete physical intuitions. Properly understood, four-dimensional change is not nearly as strange as its opponents claim, and it is certainly the best way to understand change in a relativistic universe.

Notes

Thanks to Jeremy Butterfield, Peter Forrest, John Hawthorne, Jonathan Tallant, and especially Dean Zimmerman for helpful criticisms of earlier versions of this paper.

[1] Lombard uses similar reasoning to critcize Heller's attempt to wed temporal parts and change (Lombard 1994).

[2] Thanks to John Hawthorne for this point.

[3] See McCormmach 1991 for an excellent fictionalized account of a turn of the century German physicist struggling with the new physics and unable to overcome his intuitions about the world.

[4] It is worth remembering that nothing about relativistic effects depends upon observers, measurement, or epistemic concepts. We use Lance, what he sees, and what he is certain of purely as heuristic devices.

References

Hinchliff, Mark. 1996. The puzzle of change. In *Philosophical Perspectives 10: Metaphysics*, edited by J. E. Tomberlin. Cambridge, MA: Blackwell.

Klein, Charles J. 1999. Change and temporal movement. *American Philosophical Quarterly* 36 (3): 225–39.

Langford, Jerome J. 1966. *Galileo, science, and the church*. Ann Arbor: University of Michigan Press.

Locke, John. 1690 (1974). *An essay concerning human understanding*. Edited by A. D. Woozley. New York: Penguin Books.

Lombard, Laurence Brian. 1994. The doctrine of temporal parts and the "no-change" objection. *Philosophy and Phenomenological Research* 55 (2): 365–72.

Markosian, Ned. 2004. A defense of presentism. In *Oxford studies in metaphysics, volume 1*, edited by D. W. Zimmerman. Oxford: Oxford University Press.

McCormmach, Russell. 1991. *Night thoughts of a classical physicist*. Cambridge, MA: Harvard University Press.

Oderberg, David S. 2004. Temporal parts and the possibility of change. *Philosophy and Phenomenological Research* 69 (3): 686–708.

Rosenkrantz, Gary. 2005. An epistemic argument for enduring human persons. *Philosophy and Phenomenological Research* 57 (1): 209–24.

Sider, Theodore. 2001. *Four-dimensionalism: An ontology of persistence and time*. Oxford: Oxford University Press.