

Relativity of Simultaneity and Eternalism: In Defense of the Block Universe

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Abstract Ever since Hermann Minkowski's now infamous comments in 1908 concerning the proper way to view space-time, the debate has raged as to whether or not the universe should be viewed as a four-dimensional, unified whole wherein the past, present, and future are regarded as equally real or whether the views espoused by the possibilists, historicists, and presentists regarding the unreality of the future (and, for presentists, the past) are more accurate. Now, a century after Minkowski's proposed block universe first sparked debate, we present a new, more conclusive argument in favor of the eternalism. Utilizing an argument based on the relativity of simultaneity in the tradition of Putnam and Rietdijk and explicit novel but reasonable assumptions as to the nature of reality, we argue that the past, present, and future should be treated as equally real, thus ruling that presentism and other theories of time that bestow special ontological status to the past, present, or future are untenable. Finally, we respond to our critics who suggest that: (1) there is no metaphysical difference between the positions of eternalism and presentism, (2) the present must be defined as the "here" as well as the "now", or (3) presentism is correct and physicists' current understanding of relativity is incomplete because it does not incorporate a preferred frame. We call response 1 deflationary since it purports to dissolve or deconstruct the age-old debate between the two views and response 2 compatibilist because it does nothing to alter special relativity (SR), arguing instead that SR unadorned has the resources to save presentism. Response 3 we will call incompatibilist because it adorns SR in some way in order to save presentism a la some sort of preferred frame. We show that neither 1 nor 2 can save presentism and 3 is not well motivated at this juncture except as an ad hoc device to refute eternalism.

1 Introduction

As Ladyman et al. [12] wisely note, the following are distinct but frequently conflated, deeply related questions in the metaphysics of time:

1. Are all events, past, present and future, real?
2. Is there temporal passage or objective becoming?

3. Does tensed language have tenseless truth conditions?
4. Does time have a privileged direction?

This paper will focus almost exclusively on question (1). In the philosophy of time, this major question has captivated philosophers for decades now. This problem stems from two competing notions of time. The first, originally suggested by Heraclitus, is called presentism.¹ Though we will later present the presentist position more clearly so that it can be made relevant to a more thorough and modern treatment of presentist/eternalist debate, a good starting definition for presentism is the view that only the present is real; both the past and the future are unreal.² This view is close to, but not the same as, possibilism, which states that the future is unreal while both the past and the present are real. Both of these stances claim to adequately capture the manifest human perception of time. We tend to view ourselves as occupying a unique temporal frame that we call the present that always moves away from the past towards an uncertain future.

However, with the advent of relativity, a different stance, whose primary ancient proponent was Parmenides of Elea, provided a viable alternative to Heraclitean presentism. This new stance, eternalism, was translated into the language of relativity by Hermann Minkowski in 1908 to suggest that time and space should be united in a single, four-dimensional manifold. Thus arose the notion of a 4D “block universe” (BU) in which the past, present, and future are all equally real. This view is called eternalism, and two arguments by Putnam [16] and Rietdijk [17] allegedly show that special relativity (SR) with its relativity of simultaneity (RoS) implies that only the BU perspective is correct.

This paper proceeds as follows. First, we examine the basic structure of the RoS eternalism argument suggested by Putnam, Rietdijk, and more recently Stuckey, Silberstein, and Cifone [23, 24, 27, 28] (hereafter SSC) and present our own novel interpretation or version of the argument for eternalism. Following our proposal, we suggest various points of contention that presentists and possibilists might exploit or have exploited in seeking to either refute eternalism or collapse the presentism/eternalism dichotomy. We have compiled a reasonably exhaustive taxonomy of possible outs that the presentist or possibilist could take to avoid the argument from RoS for BU.³ After elaborating our own version of the argument, we respond to each counter-argument and show that these objections do not dismiss RoS’s problems for presentism.

¹ Recent defenders of presentism include Bourne [1], Craig [5], and Smith [6], whom we take to be our primary presentist opponents for the purposes of this discussion.

² What is meant here by “real” is the topic of great debate (see Dorato [10] and Savitt [20] for more on this issue), and we will later clarify our criteria for reality in such a way that much of the vagueness that arises from an imprecise definition of ‘real’ is dismissed.

³ One possible refutation of the RoS argument, derived from the work of Harvey Brown (Brown [2]; Brown and Pooley[3]), suggests a kind of re-interpretation of Minkowski space-time as a codification of the behavior of matter as opposed to representing the geometrical structure of space-time. Our response is to be found in Appendix A but has not been integrated into the paper at large because the objection does not fit smoothly into our primary taxonomy.

2 The Argument from the Relativity of Simultaneity

2.1 *General Outline and Definition of Terms*

Before presenting our RoS argument against presentism, we first provide a general outline of RoS arguments for eternalism and give preliminary definitions of some relevant terms. The general form of the arguments against presentism utilized by Putnam, Rietdijk, and SSC goes as follows:

1. Define presentism.
2. Define the term “co-real”.⁴
3. Show that the consequences of the definition of “co-real” and RoS contradict presentism.
4. Conclude that presentism is false from the conjunction of 1 and 3.
5. Conclude that eternalism is true from the rejection of presentism.

To begin with, we must provide our own definitions for the terms that form the foundation of our revamped version of the RoS argument. The first term to be defined is “presentism”. Presentism is a kind of realism that takes as real only those events⁵ which occur in the present. For instance, since we are sitting next to our friend Joe who is currently reading a paper, the event of his reading a paper and the event of our writing this paper are both real while the event of Joe’s leaving to eat dinner is not real because it has not happened yet and the event of our leaving to eat lunch is not real because it has already happened. In terms of simultaneity, then, one can define presentism as the view that the only real things are those which are simultaneous with a given present event. Eternalism, by contrast, is the view that all events past, present, and future are equally real. Thus, Joe’s reading, our typing, Joe’s leaving for dinner, and our leaving for lunch are all equally real despite the fact that one of these events has already occurred while another has yet to occur. Eternalists hold that all events are equally real, regardless of whether or not said events are simultaneous.

There are two elements, then, that are important for establishing both presentism and eternalism: reality and simultaneity. The debate presupposes that there is a

⁴ The actual term “co-real” appears only in the SSC papers, but since these present the most recent incarnation of the RoS argument against presentism, we follow their terminology here. It should be noted that Rietdijk does not provide an analysis of the term ‘reality’ in his paper, and while Putnam does discuss some basic assumptions about reality that are necessary for his argument to go through, they are not argued for or supported in any great detail.

⁵ We use the term “events” here to bypass any concerns that may arise due to the identity of individuals like those raised by French and Krause [11] or issues of endurance and perdurance. Such issues as identity and endurance/perdurance, while interesting, need not directly bear on this debate, and so we invoke events that are assumed to be of infinitely small extension and duration (as such they should be fully understood only in terms of their identifying coordinates) to bypass such debates. We are not committed to the claim that such events are in some way the atomistic components of what exists in space-time; rather, we simply invoke them to avoid begging the question on issues like identity and endurance/perdurance.

unique (non-equivocal) sense of the term reality that both sides share. The dispute therefore is over whether or not present events have some ontologically privileged status qua their property of “existing at time some time t where t is in the present”. To this end we will first minimally characterize the terms “reality” and “simultaneity” for use in the context of our revamped argument. Before beginning, we should emphasize that we are being purposefully vague with our first characterization of reality here so as to determine reality’s most general non-equivocal properties which we will build upon later in this paper. Two events which “share reality” as we characterize it share a single, unique feature (i.e., the same ontological status with respect to realness); this uniqueness, we believe, is the absolute minimal criterion an event would have to satisfy for it to be considered “real” in any meaningful sense of the word.

To better understand the minimal sense of reality at work here, we define two separate notions: the “reality value” and “reality relation.” “Reality values” or “R-values” can be thought of as representing the ontological status of any given event. Within space-time, every event can be assigned an R-value that denotes its ontological status, and there is a one-to-one and onto mapping of possible R-values onto ontological statuses. In the interest of defining reality generally, we will not attempt to enumerate how many R-values exist, but one could easily take reality to be binary and thus assert that, for any event, if its R-value is 1, that event “is real”, and if its R-value is 0, that event “is not real.” One could use higher values to denote other states, such as “possibly real”, “real in the future”, etc., but, as previously stated, we will not attempt to enumerate all such possible R-values here.⁶ It should be pointed out that our uniqueness criterion on reality translates into this system simply as the claim that every event has a single unique R-value. This seems intuitive since an event with an R-value of both 1 and 0, on our scheme, would be both real and unreal, which would be a contradiction.

Our other sense of reality as expressed in the “reality relation” will be essential to our discussion of co-reality. The reality relation can be recast as the idea of “equal reality” and exists between any two or more events that can be considered “equally real.” Translated in terms of R-values, a reality relation exists between any two events that have the same R-value. For instance, if events A and B are equally real, then the R-value of event A is the same as the R-value of event B. One should notice here that our definition of “equally real” does not assume that two equally real events are both “real”; equally real events A and B may have whatever R-value you please as long as the R-values are the same for both A and B. This relation explains what a presentist means when she says, “The present is the only thing that is real” since the presentist will hold that events in the future and the past will have different R-values from events in the present.⁷ Thus, our purposefully limited characterization

⁶ See Appendix B for a more nuanced view of R-values and possible objections to the RoS argument that one might raise based on our naive characterization of R-values described here.

⁷ To reiterate, what we have characterized here is the minimal position a presentist must take with regard to a characterization of reality. It might be objected that, at this point, we have not actually defined “what reality is.” We will cash out a richer notion of reality later in the paper so that we are

of the “equally real” relation has been defined so as to be useful in a definition of co-reality.

As for simultaneity, if it is possible for one to construct a hyperplane of simultaneity (i.e. a four-dimensional manifold in space-time constructed in such a way that all of the events connected by this manifold are space-like separated from one another) between any two or more events, then these events are said to be simultaneous. Such simultaneous events are required to be space-like separated events that appear to be simultaneous in some subluminal inertial reference frame. Light-like and time-like separated events cannot have a hyperplane of simultaneity constructed between them. Also, a hyperplane of simultaneity may be drawn between any two space-like separated events, meaning that the space-like separation of events A and B is necessary and sufficient for their simultaneity.

Combining the criteria of equal reality (“equally real” means that two events have the same R-value) and simultaneity (“simultaneous” means that two events are space-like separated such that a hyperplane of simultaneity can be constructed between the two events) gives us the relation of “co-reality”, which refers to, as the name suggests, two events that are equally real and “simultaneous.” The presentist perspective can be restated in terms of this “co-reality” as the stance that “simultaneity between events is a necessary and sufficient condition for the reality (that is, for both events sharing the R-value 1 corresponding to “real”) of these events if at least one of these events occurs in the ‘present’”. For the presentist, any two space-like separated points are thus co-real as we have defined “co-reality”. Our restatement of presentism in terms of co-reality here is the assumption that we alluded to in step 1 above.

Our previous examples should make our notion of co-reality more explicit. For instance, the presentist takes Joe’s paper reading and our paper typing to be co-real events because they are space-like separated, meaning that there exists some frame in which these two events are simultaneous. However, our paper typing and our leaving for lunch are time-like separated, so there is no sub-luminal frame in which

careful not to beg the question against critics like Savitt and Dorato; for now, we are characterizing reality only to a minimal degree in an attempt to determine the properties of the “co-reality” relation, and as such we need only endorse the minimal sense of reality that bears upon our discussion of co-reality.

The presentist might object to our characterization of her conception of reality, but to refuse the characterization of reality we have provided here would be to take an anti-realist stance since a non-unique or equivocal conception of reality would make the idea of “reality” a useless concept for the purposes of this debate. Thus, the presentist cannot argue against our minimal characterization of reality and remain a committed presentist, and the same goes for the eternalist. In the words of Dolev, if one denies this minimal ontological assumption then “neither the tensed nor the tenseless view has the final word in the metaphysics of time.”

The presentist could argue against us on the grounds that it is relations, perhaps, that are fundamentally real and not events; this, however, would simply lead us to re-atomize our space-time such that these relations become the fundamental ontic units which assume R-values and the relation of “equally real” connects two such lesser relations. Therefore, even if one makes an argument that forces us to change the fundamental ontic units of our setup, our basic characterization of R-values and “equal reality” can stand unadulterated.

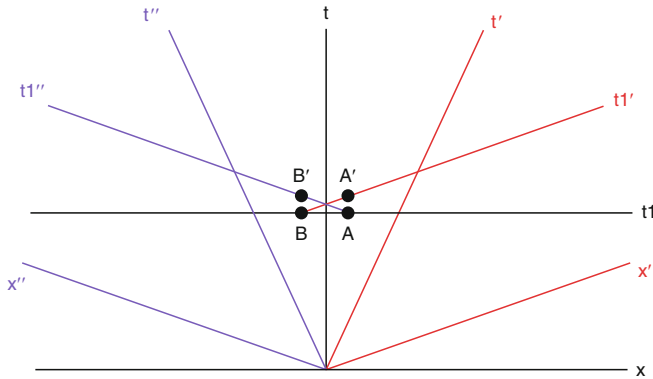


Fig. 1 RoS proof space-time diagram

these two events are simultaneous and they are therefore not co-real. These two criteria of reality and simultaneity as we have defined them are necessary and sufficient for our use of “co-real”, and so we turn next to our RoS argument that utilizes this notion of “co-reality” to reveal the tension between presentism and relativity.

2.2 RoS Argument⁸

Consider the following situation: our friends John and Josephine stub their toes at the same time in my stationary reference frame.⁹ The event of John stubbing his toe is labeled A in Fig. 1 and the event of Josephine stubbing her toe is labeled B in Fig. 1. At a later time (but again, simultaneously in our rest frame), both Josephine and John shout in pain from stubbing their respective toes. John’s shout of pain is labeled A’ while Josephine’s shout of pain is labeled B’ in Fig. 1. I note that in my frame, both toe-stubs occur at time t1 in Fig. 1. Thus, events A and B are simultaneous and co-real as per the previously-established criteria.

⁸ One could argue that, having already defined “co-reality” as we have, the RoS argument has already been made for us: any two space-like separated points are equally real, and space-likeness is not transitive (i.e. A and B could be space-like separated and B and C space-like separated but A and C time-like separated), so we must conclude that any two events (time-like, light-like, or space-like separated from each other) are equally real. The RoS argument in 2.2, however, is a bit more nuanced than the argument just proposed, and it makes it easier for one to determine which definitions and assumptions about reality play what role in the argument. As such, we hope the reader will bear with the exposition for this longer argument.

⁹ We are assuming that these “toe-stubs” in this example are the kind of events described in footnote 5 for the reasons stated in that footnote.

Now, some time before this the alien battle cruisers P and D pass each other directly over our heads. The primed axes refer to the frame for battle cruiser P and the double-primed axes refer to the frame for battle cruiser D. Both of these battle cruisers tell a different story from ours. For battle cruiser P events B and A' occur at the same time, and thus B and A' are equally real per co-reality. For battle cruiser D, however, events B' and A occur at the same time, and thus B' and A are equally real per co-reality. We now introduce the symbol "r" to stand for "shares an R-value with" or "is equally real with". The following three statements are true (at least from someone's perspective):

ArB
 BrA'
 $B'rA$

From the previously established criteria for equal reality, we can establish two important facts about co-real events α , β , and γ . First, if $\alpha r \beta$ is true, then $\beta r \alpha$ is true since R-values are unique. Thus, the operator "r" is symmetric. This fact must be true since equal reality is an equivalence relation.¹⁰ The second important fact about equal reality is that the co-real operator is transitive, even across frames. That means that if $\alpha r \beta$ is the case and $\beta r \gamma$ is the case, then $\alpha r \gamma$ must also be the case. This follows directly as consequence of our definition for equal reality.¹¹ Thus, applying the properties of transitivity and symmetry to the above relations, we arrive at the result that:

ArA'
 BrB'

¹⁰ One might object that, for historicists and possibilists in particular, the "co-real" relation is not an equivalence relation. For instance, right now the Norman Invasion is "real" to us because it is in our past, and so the historicist/possibilist would want to say that such an event is as real as our writing this paper; however, at the time of the Norman Invasion, we were not yet born, so we were "not real" at that time. The equal reality relation only holds one way.

However, one can respond to this claim by citing the fact that the equal reality of simultaneous events is an equivalence relation in historicism and possibilism even if the "equal reality" relation in general is not. Two events that happen at the same time must be equally real if it is temporality alone that bestows metaphysical status on events. The above argument only necessitates the treatment of "equal reality" as an equivalence relation for cases where the two "equally real" relata are space-like separated and thus simultaneous. In such a case, equal reality is an equivalence relation even for historicists and possibilists. Thus, the fact that equal reality is not an equivalence relation in general does not mean that equal reality is not an equivalence relation in the case of simultaneity; in fact, the opposite is true.

¹¹ This feature of co-reality is perhaps not intuitive, but a simple conceptual argument can show why equal reality, as we have defined it, must be a transitive property. If two events A and B are co-real in a given frame, this means that they share an R-value. Likewise, co-real events B and C must also share a unique R-value. Since the uniqueness criterion on reality implies that the R-value shared by A and B must be the same R-value shared by B and C, it then follows that A and C must have the same R-value as well, and thus they must be equally real.

Generalizing from this result, then, one can conclude that a prior event (the stubbing of a toe) is as real as a later event (a shout of pain). If the first event (A , for instance) occurs in the “present”, then A' occurs in the future and the RoS argument suggests that the future is as real as the present. Likewise, if A' occurs in the present, then A occurs in the past and the RoS argument suggests that the past is as real as the present. Both of these conclusions contradict the presentist assertion that the present is real while the past and future are not since past, present, and future must share the same ontological status by the above argument. Since presentism in conjunction with relativity and our other basic assumptions leads to a contradiction, presentism must be false given our assumptions. Finally, since variations of this argument would answer equally well anyone who would argue that only the past is real or only the future is real, the only conclusion left for a realist is that eternalism must be correct since both presentism and possibilism must be discarded. We have thus achieved our goal of constructing a rigorous argument for eternalism from RoS in the tradition of Rietdijk, Putnam, and SSC though our argument provides a more detailed analysis of the assumptions about the nature of “is real” that go into the RoS argument.

3 Presentist Points of Contention

There are several points in the above argument for eternalism that presentists (or anti-realists, for that matter) could attack or have attacked. The goal of this section is to provide a basic taxonomy of points of contention presentists utilize or could utilize to respond to both the argument presented above and eternalism in general.

3.1 *Deflationary Objections: No Presentist/Eternalist Distinction*

The first attack on the RoS argument which works equally well against any argument trying to prove or disprove eternalism is that there is, in fact, no metaphysical or empirical distinction between the views supported by presentists and those supported by eternalists. This collapse of the dichotomy between presentism and eternalism is most ardently argued for by Savitt [20] and Dorato [10] in recent papers. Both of these papers utilize semantic arguments to suggest that the distinction between presentism and eternalism boils down to a difference in definitions for “real” which translates, in various contexts, to differences in tensed versus tenseless existence claims. These two authors claim that presentism and eternalism are both essentially either vacuously true when viewed with the proper definition of existence in mind (for instance, to say that the present is the only thing that “exists now” is tautological since “now” is defined in terms of the present) or analytically false when viewed with the improper sense of existence in mind (for instance, to say that the

present is the only thing that “exists tenselessly” is to ignore the past and future that are assumed in the phrase “exists tenselessly”). These two authors go on to attack defenses of eternalism that rely on modality and other semantic considerations, leading them to the conclusion that the problem posed by the presentist/eternalist debate is truly a non-starter by way of a “Wittgenstein-like” or “Austin-like” deflation.

In an earlier paper, Dorato [9] discusses various other semantic arguments against eternalism specifically in an attempt to show that eternalism is as problematic as presentism. The first contention Dorato raises is against the eternalist perspective that “the past, present, and future are all real at the same time”, which he views as meaningless since one cannot say anything about the relationship between the past, present, and future at a given time since all three temporal regions cannot be simultaneous. There must be a temporal separation between the past, present, and future for them to be well defined, so any statement about how the past, present, and future interact at a given time collapses this distinction and thus becomes meaningless. The second argument against eternalism on semantic grounds is that an eternal truth like “event A takes place at time t ” may be timeless, but the object of this statement, event A, is not necessarily as timeless as the statement about it. Dorato thus believes that eternalism confuses the following two statements:

1. “X is the case at t ” is an eternal truth
2. X exists eternally

And thus, since eternalism makes this error, it is a deeply flawed and confused view. These two linguistic objections to eternalism, as well as the much larger objection that there is no metaphysical presentist/eternalist dichotomy, will be addressed later in this paper.

3.2 Compatibilist and Incompatibilist Objections

Two other groups of people who reject the RoS argument for BU are the compatibilists and incompatibilists. Compatibilist philosophers of time attempt to hang presentism on a given relativistic invariant (like the fact that all inertial frames agree on the ordering of time-like events, or “proper time”).¹² Incompatibilists, on the other hand, invoke some preferred frame or other entity with which to adorn Minkowski space-time in hopes that this new frame will provide a suitable place to hang presentism and becoming. These positions constitute a shift in the definition of “co-reality” as it we presented previously. Both compatibilists and incompatibilists would reject our definition and propose another, though various compatibilists and incompatibilists will propose differing versions of “co-reality”. There are essentially two ways philosophers can and do object to the RoS argument:

¹² It should be noted that we do not disagree with the compatibilist assertion that to be real something must be “real in all frames”; in fact, we embrace this idea, and it is a central aspect of our definition for reality that frame-invariant properties like time-like separation are necessarily “real” features of space-time.

1. Reject our characterization of simultaneity in our definition of co-reality (redefine simultaneity, compatibilist and incompatibilist objection)
2. Reject our characterization of reality in our definition of co-reality (reject transitivity of co-reality, compatibilist objection)

Option 1 can and has been argued for on several different grounds. It has most famously been argued that either (a) our notion of simultaneity is not a suitable criterion for reality because the present refers to only the “here and now”, not simply the now, or (b) simultaneity is relative to some preferred foliation of space-time.¹³ Objection (a) is raised most famously by Stein [26, 27] in his response to Putnam, and objection (b) has been raised by various philosophers and physicists who have rather disparate views as to what the preferred foliation of space-time is and from whence it issues.¹⁴ We will address both of these objections to the RoS argument individually in the following sections.

Compatibilist option 2 is typically raised either by those like Savitt [21] and Dolev [8] who believe that an argument for a transitive notion of reality has not and cannot be convincingly made especially within the framework of SR or by anti-realists (including solipsists) who believe that the phrase “reality” should only pertain to one’s own frame (or, worse yet, only to oneself). The first of these objections is then the only one particularly relevant to the presentist/eternalist debate because an anti-realist would no sooner be a presentist than an eternalist. The transitivity of “is co-real with” is objected to on this view precisely because it leads to the view that presentism is wrong. Thus, it seems like any presentist interested in saving her stance would object to the transitivity of co-reality implied by our definition of reality as many before her have chosen to do.

4 Response to Objections

4.1 *Defining Terms: Establishing a Presentist/Eternalist Distinction*

Dorato and Savitt claim that there is no metaphysical or empirical distinction between the eternalist and presentist perspectives by critically examining the terms “is”, “exists”, and “real” used in several definitions of reality and in doing so point out the shoddy conclusions that linguistic sloppiness engenders in the presentist/eternalist debate. Our goal in this section is to provide an original account of reality which supports a metaphysical/empirical distinction between the presentist

¹³ The first of these objections, (a), is a compatibilist objection while the second objection, (b), is an incompatibilist objection.

¹⁴ See Cifone (2004, PhilSci Archive) for specific examples of proposed preferred foliations to space-time.

and eternalist positions. Such a reasonable definition is sufficient to counter Dorato's and Savitt's deflationary claims.¹⁵

Our definition of reality relies upon two concepts: "definiteness" and "distinctness". For an event to be real, we posit, the event must be both definite and distinct. We take a definite event to be one which is meaningfully determined. A useful example of the distinction between definite and indefinite can be found in quantum mechanics.¹⁶ With respect to a particular variable like spin in the x-direction, a pure-state quantum system may be in an eigenstate or a superposition of eigenstates. If there exist a multitude of systems in the same eigenstate, an x-spin measurement on any of these systems will always yield the same value. Thus, we say that an eigenstate of x-spin is property-definite with respect to spin in the x-direction. However, if the system is in a superposition with respect to x-spin, different systems prepared in the same x-spin superposition may give different x-spin values when measured. There is no way to predict the value of the x-spin of such a superposition after measurement given any information about the system prior to measurement, and as such, the superposition of x-spin is said to be property-indefinite with respect to x-spin. Generalizing from our characterization of property definiteness, we define event-definiteness as definiteness with respect to at least one property. Thus, if an event is property-definite with respect to at least one property, we say it is event definite and thus "real".

We should note here that our event-definiteness criterion is an objective criterion of a system, and as such, unlike property-definiteness, a system must be indefinite with respect to all of its properties to be considered indefinite qua system. Therefore, quantum superpositions are not objectively indefinite, for there exists some property with respect to which this superposition is definite by the very nature of superpositions; it is only the x-spin value of such a superposition that is indefinite. If a given event is definite with regard to any property, it is taken to be objectively definite and thus may be real (as long as it meets our distinctness criterion as well, that is).

It should also be pointed out that event-definiteness is a frame-independent property of events in the universe; though different observers may disagree about the state of a given system (as Rovelli [18] points out in his paper on relational quantum mechanics), they will all agree about whether or not it is definite simpliciter. One might take issue with our assertion of the frame-independence of definiteness; for instance, some postulate that quantum collapse is hyperplane-dependent, and thus

¹⁵ For an alternative response to such a deflation by way of logical and linguistic analysis, see pages 14–17 of Sider [22].

¹⁶ We are not claiming that quantum superpositions are unreal or non-existent simpliciter; rather, we are providing an example in an instrumental spirit of how a property might be indefinite and thus suggesting how one might generalize from this example to form an idea of general indefiniteness. This indefiniteness, if made general and applicable to all properties, would make an event effectively unreal. However, superpositions themselves are by their very nature in a determinate state with regard to some property, so they are obviously not wholly unreal in this sense.

an observer in one frame will see a quantum system as having some definite property “y” while an observer in another frame might observe y to be indefinite. However, even if collapse is so dependent, the fact remains that each of these observers will observe there to be some definite property “z”, and thus, by our definition, one must take the quantum superposition to be definite qua system. That is, there is no frame of reference from which one can observe the quantum system in question to be without any definite properties. Therefore, our definition of definiteness directly implies the kind of transitivity we exploit in our RoS argument.¹⁷

The other criterion for an event to be real is that it must be distinct. A distinct event must be in some way different from other distinct events (a la Leibniz, call it the discernability of non-identicals). Such a criterion for the distinctness of events is different from a criterion that requires the distinctness of particles. While it may be that two completely indistinguishable particles can both be distinct, the issue of concern here is the reality of events, and it is the case that two completely indistinguishable events cannot be distinct per the identity of indiscernables; or if you prefer, two completely indistinguishable events cannot be numerically distinct. This criterion of distinctness may be viewed as a more pragmatic concern (we have no reason to take event B to be numerically distinct from event A if all of B’s properties are identical to A’s). Such a criterion of reality keeps one from treating as real two (allegedly distinct) “events” that might seem to be different but are truly one and the same event – the differences are purely perspectival as in the Lorentz transformations of SR. For example, as per Newton’s third law of motion, there is no need for us to count as distinct both the event of a car hitting a wall and the event of the wall hitting the car; they are simply two different ways of viewing the same singular event.¹⁸

Having established these two criteria for reality, does there appear to be a difference between the presentist and eternalist positions? The answer is “yes” because the distinctness and definiteness of the past and future are not analytic. The presentist claims that past and future events lack both/either definiteness and distinctness simpliciter while the eternalist says all events past, present and future

¹⁷ We should point out here that presentists who claim that there simply are no past or future events can be treated as taking such event as indefinite on our picture here, since a non-existent event cannot have any definite properties. Thus, our account of definiteness provides a criterion for reality that explains this possible presentist stance.

¹⁸ One might well wonder what purpose introducing “distinctness” as a criterion here serves above and beyond the work already done by definiteness. Distinctness is important in this discussion because it allows for nuances within possible presentist positions. We believe there may be presentists who concede that some future events are determined in that they have some definite property, yet who may still reject that the future and present are “equally real”. They could do so by way of distinctness, claiming that there are an infinite number of events (one of which will be actual, the rest of which will not be) which are all “definite” in some sense but indistinguishable. The future would thus be definite but not distinct, and so the presentist could write it off as unreal. For the purposes of this discussion, it is in our interests to give as many reasonable possibilities to the presentist as we can, and so we have included distinctness in our discussion for the sake of completeness.

possess both definiteness and distinctness. The first fact to note about the future is that it is unknown to us. One might even be tempted to say that it appears indefinite since it seems (at least on some stochastic accounts of quantum outcomes) that there is no way for us to know the future (in principle) no matter how much we know about the present. Such stochastic accounts of objective quantum indefiniteness (as opposed to subjective quantum indefiniteness for deterministic interpretations) should not be confused with what we will call O- (objective) indefiniteness and S- (subjective) indefiniteness more generally. O- and S-indefiniteness are best understood as a different kind of indefiniteness entirely which will be made clearer by an appeal to the idea of “Newton’s god” (NG), an entity in the 5th or higher dimension “looking down” at her space-time “sensorium”.

Depending on whether the future is O-indefinite or S-indefinite, NG would observe different things as she looked down on her “sensorium”. If the future and past are S-indefinite only, NG would physically *see*¹⁹ the past, present, and future – all of space-time, a 4D BU. NG would see events in the past, present, and future – a static multi-colored marble of world-lines/tubes, if you will. If the future and past are truly O-indefinite, however, NG would not be able to see the future or past from her 5th-dimensional perch, but only a continually temporally evolving present. If the future is truly O-indefinite, it does not matter whether NG is observing us flipping a coin or measuring the spin of an electron with stochastic outcomes; either way, she will not observe the future outcome, and likewise if the future is merely S-indefinite then in both the classical and quantum case NG will observe the future outcome. In the O-indefinite case, NG may be able to predict the outcome just as any one of us may be able to predict the outcome of a coin flip, but NG will not be able to observe this future outcome.

The eternalist, presentist, and possibilist positions become clear and distinct given this characterization of O- and S-indefiniteness. Eternalists believe that the future and past are only S-indefinite; though beings within space-time may not be able to observe the past or the future, a being outside of space-time would be able to easily observe them. Thus, NG sees a 4D BU when she looks “down on” the universe. The presentist, on the other hand, holds both the past and future as truly O-indefinite and thus believes that NG would see an evolving 3D time-slice of the universe when she looks “down on” her “sensorium”.²⁰ Finally, the possibilist takes the future to be O-indefinite but the past S-indefinite only, thus leading to the belief that NG would see a growing BU when she looks “down” on the universe. Diagrams of these various NG perspectives may be found in Appendix C.

Another way of viewing our “Newton’s god” argument is in terms of “where” time is in the presentist picture compared to the eternalist picture. In the presentist picture, NG is still constrained by time. The fact that NG is removed from spa-

¹⁹ When discussing what NG “sees” we are only invoking the traditional physical sensory modalities of this entity. We make no claims about other ways of knowing or omniscience that one in NG’s position might be able to employ by means other than perception.

²⁰ On some presentist views, she might even see a point. See Stein [26] for more on this view.

tial strictures does not entail her separation from some notion of time in which she must still continue to exist. It is possible, then, for NG to remove herself from space without removing herself from time on the presentist picture. On the eternalist picture, however, NG is free from the strictures of temporality. It is unclear what the character of the 5D universe NG inhabits is (the 5th dimension could be conceived as some sort of second-order time, a 4th-order space, or some phenomenology of dimensions we do not experience); however, the point is that NG is free from time as well as space as it exists in the BU since the two are inextricably linked, and thus time has the same ontological status as space. The eternalist does not have to argue that time behaves the same way as space does, simply that time and space are inextricably linked, which is a stance that the presentist rejects since the presentist views universe as 3D.

There may be some who believe that NG is not a suitable tool for dealing with the presentist/eternalist distinction; in particular, one might find our NG question-begging since a god's eye point of view might seem to violate basic tenets of SR; however, one must note that by hypothesis NG is removed from the 4D-manifold (space-time) that she observes. Such a being would be constrained to see a space-time that conforms to special relativity even though this "god-frame" itself would not so conform. SR can only make claims about perceptions of space-time from within space-time, and since this "god-frame" is outside of space-time, this relativistic objection does not obtain. Even without positing the existence of NG or even a position from which NG could look, we have already shown that the presentist/eternalist distinction can be stated in terms of the separability of space and time, and so if this objection to NG as question-begging is simply that one cannot remove oneself from space without removing oneself from time as well, then the objection has already conceded our point to us. Using our novel argument for the eternalist position, Dorato's two previous objections to eternalism can be ignored as well. Nowhere in our argument do we claim that the past, present, and future are all "simultaneous", nor is there any confusion between eternal truths about existence and the eternal persistence of events. First, an appeal to some sort of "second order" time is completely unnecessary for our formulation of the eternalist position, and as such the accompanying language of the "past present, and future existing simultaneously" has been discarded. As noted above, Newton's god's frame need not necessarily be conceived as some sort of second order time; further, it is merely a thought experiment to show that Dorato/Savitt type arguments are dependent on verificationism of a sort special relativity need not entail. In the following passage Dainton [7] paints a suggestive picture of what it means to take Newton's god's perspective of the BU seriously:

Imagine that I am a God-like being who has decided to design and then create a logically consistent universe with laws of nature similar to those that obtain in our universe. Since the universe will be of the block-variety I will have to create it as a whole: the beginning, middle and end will come into being together. Well, assume that our universe is a static block, even if it never 'came into being', it nonetheless exists (timelessly) as a coherent whole, containing a globally consistent spread of events. At the weakest level, "consistency" here simply means that the laws of logic are obeyed, but in the case of universes like our own, where there are universe-wide laws of nature, the consistency constraint is stronger:

everything that happens is in accord with the laws of nature. In saying that the consistency is “global” I mean that the different parts of the universe all have to fit smoothly together, rather like the pieces of a well-made mosaic or jigsaw puzzle (119).

It would be absurd to argue, therefore, that two perspectives as different as these are, are in fact, metaphysically and empirically equivalent in principle; such a claim could only be sensible if one assumes a spatiotemporal-anthropocentric verificationism, and there is no non-question begging reason to do so. For this reason, Dorato’s and Savitt’s grander claims must be dismissed. The most these two authors can suggest is that a better definition of reality is necessary before the presentist/eternalist debate can be undertaken, and so, with such a definition provided, Dorato’s and Savitt’s deflationary claims can be rejected. Dorato and Savitt are right to point out concerns with definitions of terms (such as “real”) in arguments such as ours, but generally speaking this is the most that linguistic analysis can contribute to the presentism/eternalism debate. The most such appeals can do is determine that certain positions in the debate are “unspeakables” or that the language used must be clarified for the debate to proceed.

4.2 *The Transitivity of Reality*

Our new definition of an event’s reality as a combination of definiteness and distinctness also has implications for the second compatibilist objection to the RoS argument, namely that there is no good reason why reality or the “is co-real with” relation ought to be transitive. The first response to this claim is that any relativistically invariant relational property must be transitive across all reference frames. For example, consider the property of “light-likeness along direction x ”.²¹ Any two events that are light-like separated in some direction share this property, and all observers in all frames will agree that two events are light-like separated if they are so due to the fact that the speed of light in a vacuum is a universal constant. Thus, if event A is light-like separated from event B and event B is light-like separated from event C in the same direction, then event A must be light-like separated from event C (in this same direction). This deduction is true even if one adds different relativistic frames into the equation. For instance, if event A is light-like separated from event B in direction x in a frame moving with velocity v and event B is light-like separated from event C in direction x in a frame moving with velocity u where

²¹ The “ x ” in “along direction x ” in this property should be a four-dimensional vector pointing from one event to the other. We include this condition to rule out the following, non-transitive case: consider a light beam shot out from a spaceship at A, reflected off of a mirror at B, and returned to the ship at C. A and B are light-like, B and C are light-like, but A and C are time-like. However, this non-transitivity arises from the fact that the direction of the light is changed at B, and so the vector x shifts at this point. We thank Gordon Belot for bringing this objection to our attention.

u is not equal to v , it is still the case that event A and event C are light-like separated in a frame moving with velocity w no matter what the value of w .²² Thus, from this simple example, one can see that a relativistic invariant quantity is transitive across inertial frames.

There are two other relativistic invariant properties aside from “light-likeness” that we would like to discuss now. The first of these is number. All observers, no matter their frame, will agree on the number of events that occur. Thus, no matter what frame an observer is in, it will never be the case that she will see an event take place that another observer does or could not see. Though observers may disagree about some of the properties of an event, no observer will see a “novel” event; that is, there is no event simpliciter that one can only see if one is in a certain reference frame. This means that the very existence, the very definiteness of an event-as-such must be a relativistic invariant, and thus as per our pre-established criterion, definiteness must be transitive across frames.

Another relativistic invariant is the space-time interval between two events. This separation is defined by the Minkowski space-time metric as: $s^2 = t^2 - x^2 - y^2 - z^2$ where “ s ” is the space-time interval, “ t ” represents time, and “ x ”, “ y ”, and “ z ” are spatial coordinates in 3-space. Because the interval between events is an invariant, it is always possible for observers in different frames to distinguish between different space-time events in a consistent manner. Because of this, no observer will confuse two events that are seen as distinct in another frame. Thus, the invariance of the space-time interval implies that distinctness is a relativistic invariant. Thus, as per our pre-established criterion, distinctness also must be transitive across frames.

Now, since reality in our formulation has definiteness and distinctness as necessary and sufficient conditions and since both definiteness and distinctness are relativistic invariants, it follows that reality, the conjunction of definiteness and distinctness, should also be a relativistic invariant. Finally, as has already been established, any relativistic invariant must be transitive across frames, and therefore our “equal reality” relation must be transitive across frames. This argument suggests that, as a logical consequence of special relativity combined with our definition for reality, reality must be frame-independent. This logic provides more than sufficient reasoning to support objectivity in our co-reality definition, and so the weight now falls on the shoulders of Savitt and the presentists to explain why “is real for” should not be transitive if they want to continue pushing this point.

4.3 *Against the Point Presentist*

There have been several arguments against the “here, now” presentist as Stein²³ presents him. This variety of presentist holds the present to consist of a single point

²² Within relativistic limits, of course.

²³ Bourne [1] points out that Stein was not assuming a “common sense” notion of simultaneity when he attempted to redefine simultaneity within relativity as the “here” and the “now”. It seems

in space-time and defines the “now” as both temporal and spatial. There have already been several excellent responses to Stein’s view, most notably those provided by Cifone (2004) and Petkov [14]. We will here reiterate and rephrase Cifone’s and Petkov’s points to show that the “point” presentists, as they are traditionally called, do not hold a viable position.

The first argument against point presentism comes from Cifone. As previously discussed, it is easy enough to see how anti-realism can be reduced to a form of point presentism, but the opposite seems true as well. Point presentists can be taken to be essentially solipsists since what exists at only one point (presumably, the point where the point presentist currently exists) is all that exists. This is not an argument in itself, and there are ways around point presentist solipsism, but these views are almost equally bad. If there is more than one “point present” in the world (that is, if he rejects solipsism), what is required for a point to be “the present”? Is there some “present-maker” that defines the present, that selects it out from all possible “presents”? And if there is, what would such a “present-maker” be? What is more, if there are a large number of “presents” that all compose reality, why do none of them agree with each other? For if the present is only a single point, it follows that multiple “nows” will not count other “nows” as real. There will be no agreement among different observers in different frames, let alone different observers in the same frame, as to what constitutes reality. Thus, it seems that the point presentist loses all semblance of self-consistency when he explains his position and runs the risk of having his position collapsed into absurdity.

Perhaps most damning to the point presentist, however, is Petkov’s response. Petkov points out that a point presentist reduces reality to a single, 0-dimensional point. If point presentism is correct, he asks, why does the universe appear to be four-dimensional, as evidenced by the aforementioned 4D space-time invariants? The universe defended by presentism which lacks the 4D-manifold in favor of a 3D universe seems unable to support or explain phenomena like length contraction and time dilation, but it appears nearly impossible to reconcile a 0-dimensional view of space-time with such phenomena. Such a view, Petkov argues, reduces to solipsism. After all, consider two observers A and B. If A and B are distinct observers, any observation event by observer A will not be real to observer B since only observer B’s “here and now” are real to him. This solipsism leads to the loss of realism that Cifone (2004) points out. Petkov also claims that only a 4D view is supported by special relativity by refuting the 3D picture of the world as well. His argument is that the phenomena of length contraction and time dilation, both of which allow different observers to hold ontologically distinct and correct beliefs about the 3D properties of an object, cannot be as completely described by a 3D worldview as by a 4D block universe view. He compares the situation to looking at a 2D plane; one can certainly describe the plane as a series of lines in the x-direction for different, constant values in the y-direction, but this “complete” description of the phenomenon does not

that Stein’s original point was not so much that simultaneity had a different nature than previously thought but rather that the conception of simultaneity that comes to play in everyday discourse has no currency in special relativity.

change the fact that it is a 2D plane and not a 1D line that is being described. If a 3D world is inadequate, then, it stands to reason that lower dimensional representations of space-time would likewise be inadequate. Thus, the 0D description of the world presented by the point presentist must be incorrect. If one is to believe in the point presentist as a viable alternative to the eternalist and the traditional presentist, the point presentist must provide physical support for a 0D universe or else abandon his view.

Before leaving point presentism, however, there is one perspective similar to Stein's that advocates changing the definition of simultaneity in order to save the presentist from the RoS argument. This more recent shift is presented by Bourne [1] and ought to be addressed here since it is a challenge to the notion of simultaneity we employ, a challenge that adheres to the logic that Stein originally used when proposing point presentism (see previous footnote). Bourne argues that simultaneity is absolute within space-time. According to Bourne, the notion of absolute reality does not translate into the language of relativity because no one can determine whether or not two events are simultaneous by observations within a frame. He turns simultaneity on its head in presentism, not by defining "what is real" by "what is present" but rather "what is present" by "what is real." Bourne appeals to a linguistic analysis in terms of conjunction, instead of observables in the world as the basis for reality and thus simultaneity. In short, Bourne's reinterpretation of simultaneity insists that simultaneity is absolute by ruling out the possibility of determining simultaneous events (or, it seems, reality) by observation alone.

Bourne's reinterpretation of simultaneity shows to what extremes presentists must go to rescue their philosophy of time from the RoS argument. By the time Bourne is finished with simultaneity, there is nothing resembling the common-sense notion of simultaneity left. Not only is simultaneity dictated as absolute without empirical evidence or verification (for surely one cannot appeal to physical grounds for such an argument), but simultaneity has now also been removed from the realm of science altogether. There is no longer any observation that can determine if two things occur at the same time! Not only does this assertion fly in the face of common-sense views of simultaneity, it also poses dire consequences for science and human knowledge when combined with presentism. If Bourne's simultaneity gives us no access to a distinctively "real" character for "real" events, how can any empirical evidence help in determining which things are real and which things are not? Does linguistics then pose a better means to come to truths about the natural world than science does for Bourne? If we are planning on choosing a metaphysics of time that best accounts for the phenomena at hand without making any wild metaphysical claims, it seems clear that Bourne's reinterpretation of simultaneity does not save presentism since even the claim that the past, present, and future are all equally real is a more conservative claim than that simultaneity and reality are both phenomena to which no one has empirical access.

It is, however, possible that one can reinterpret Bourne's claims about the simultaneity in physical terms; such a reinterpretation of Bourne's simultaneity

would necessitate a preferred foliation of space-time.²⁴ Though we will not address Bourne's revised notion of simultaneity directly any further since he does not explain his simultaneity in terms of preferred foliations of space-time in any satisfying way, we will address preferred foliation presentists generally in the next section.

4.4 Preferred Foliations in Space-Time

A slightly tougher objection to RoS is raised by those suggesting that space-time has a preferred foliation. Such a foliation would run counter to current beliefs not only about eternalism but about relativity as well, for one of the chief tenets of relativity as it is traditionally interpreted²⁵ is that there exists no preferred reference frame. The good news for the eternalist is that there is very little physical evidence²⁶ to support such a preferred foliation, but it such preferred foliations may be postulated. Assuming that such a foliation is found, then, does our RoS argument for BU still follow?

The first response to the preferred foliation objection is that no preferred foliation theory as it currently stands, even if it were proven to be true, provides the necessary physical mechanisms that would be needed to explain why such a frame would be preferred. Until physical motivation for a preferred frame is provided, one cannot abandon the RoS argument. Perhaps there is some way in which the "now" transforms as it goes into other frames. Perhaps the "now", though it is dependent on its preferred space-time foliation, is still present or still has metaphysical influence on other frames. Until physical motivation for a preferred reference frame is provided, one simply cannot know these things. After all, we do use CMBR ("cosmic time") as a pragmatic preferred frame in physics but it does not impugn BU any more than proper time does. In a purely relativistic context, the claim that the Big Bang occurred 14 billion years ago is completely frame dependent; there are other possible, equally valid choices to be made. The point is that none of these invariant features internal to SR changes the fact that M4 unadorned has no resources to

²⁴ Bourne explicitly endorses such preferred-foliation presentists in his book, though he does so in a different section from the one in which he advocates his radical revision of simultaneity.

²⁵ Other non-standard interpretations, like the Lorentz interpretation, yield the same results as the M4, no preferred frame interpretation of space-time, so it should be pointed out that it is not the physical results of special relativity that are threatened by the preferred frame but rather the currently-held understanding of special relativity which is under fire. See Appendix A for more information on the rejection of the geometrical special relativity interpretation.

²⁶ There are those who claim that at the end of the day, a correct theory of quantum gravity or a correct interpretation of quantum mechanics (such as Bohmian mechanics) might yield an absolute preferred frame. While technically true, recent work by Callender [4] and Monton [13] suggests that: (a) an absolute preferred frame is not a likely consequence of future theorizing in either case and (b) even if these preferred-foliation theories do pan out as expected, they will run into all the problems outlined in this section.

construct an absolute and objective preferred frame and that RoS implies the equal reality of all events. On our view, one can always conventionally define a preferred frame such as cosmic time; however, unless one can show that a preferred frame is a physical mechanism is the cause of physical effects like Lorentz contraction and time dilation (as opposed to mere relativistic effects), a pragmatic-preferred frame of this sort does not refute BU.²⁷

Callender's [4] objection to the preferred foliation view, however, is perhaps stronger. Callender proposes a problem he calls the "coordination problem". The idea is that even if there is a preferred reference frame,²⁸ there is no reason to believe that this reference frame would provide anyone with a suitable "now" upon which to base presentism. One must in some way prove that the physical preferred frame is precisely the same as the metaphysical preferred frame posited by the presentists. How would one be able to make such an association? And, perhaps more importantly, even if it were possible for one to argue that the physical and metaphysical preferred frames were, in fact, one in the same, how would this alter the presentist's conception of the present?

Let us try to cash out what it would mean to live in a universe in which a preferred frame forms the basis for an absolute reality. Imagine two twins who are born in such a preferred foliation of space-time. The absolute simultaneity of the preferred frame mandates that these two twins will agree on their ages at all points in time (twin 1, Alice, will turn 21 when twin 2, Bob, turns 21, etc.). However, if Bob decides to take a trip and leave the "real" foliation of space-time, the "absolutely simultaneous" events (picked out based on the preferred frame) involving Alice and Bob describe Alice and Bob as being different ages (Alice, perhaps, is 23 while Bob is only 22); however, whenever Alice and Bob interact directly with each other by shaking hands, giving each other a high five, etc., they will agree that they are both the same age. According to the preferred frame presentist, then, Bob's leaving Alice's frame changes his ontological status. His age and size physically change as he travels around the universe, yet Bob is completely unaware that he is undergoing these changes.

²⁷ Another objection to such a move comes from John Mather, winner of the 2006 Nobel prize in physics with George Smoot for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation, in a talk given at Swarthmore College in October 2007. In his talk, Mather suggested that there may be many "preferred frames" provided by the CMBR depending on how the source of the CMBR is moving. If there are, in fact, a multitude of "preferred frames", any idea of "reality" that could be grounded in CMBR would be useless for presentism because our uniqueness criterion would be violated. There would be many "real" frames that one could choose. It should also be noted that Mather himself does not believe that the CMBR frame should be treated as anything more than a useful frame for doing calculations; that is, like the proper time frame, the CMBR frame is not "real" in some special way but is rather just a helpful tool for physical calculations.

²⁸ Specifically, Callender is concerned with a preferred reference frame that might emerge from robust violations of the locality principle in Bohmian mechanics (and other modal interpretations) or preferred frames required for instantaneous collapse in some collapse accounts of quantum mechanics.

This situation produces several problems for the presentist since she must explain why changing one's velocity should cause one's views about oneself to be more or less in line with "reality." When I get in my car and drive to the store, for instance, I have changed my inertial frame; am I now closer to the "real" frame or farther from it? Either way, I don't experience the immediate world differently, nor do I perceive any differences in myself, yet my ontological status has changed. What, then, is the basis for calling such a velocity shift a "shift into (or out of) delusion" since I notice no difference in myself when I speed up or slow down? The other problem for the preferred frame presentist is a related concern: if the preferred frame is what's "real" but I experience the world in exactly the same way whether I'm in the preferred frame or not, why should I care about "reality"? What makes reality a meaningful concept to me if it is not linked with any physical, psychological, or epistemological change? For a preferred frame presentist, reality has no important implications other than to save presentism. Again, reality becomes distantly removed from our experiences, and though we may be able to convert all of our dimensions, temporal and spatial, into our "real" dimensions according to the preferred frame, these real dimensions will be no more important to our lives than our dimensions according to any other frame.

In the end it seems like the preferred foliation proponent is providing a view that is perhaps as inimical to the presentist as to the eternalist. One of the major reasons why presentists hold the position they do is that it seems to agree with the human manifest experience of time. If this experience were hung on some preferred frame due to microwave background radiation or preferred frames as posited by some Bohmians and collapse theorists, it would be possible for a "now" to exist that was completely alien to human experience. Does the phrase "now" even have any meaning when it has been removed from human perceptions of time? The burden falls to the presentists here to prove that a meaningful "now", a physical preferred foliation of space-time, and an identical metaphysical preferred foliation of space-time are all compatible, and since no such reconciliation of all three of these space-time features has been provided by the presentist camp, we are forced to conclude with Saunders [19] that the burden of proof in the presentism/eternalism debate lies entirely on the shoulders of presentists because M4 unadorned does not have the resources to ground the presentist's preferred frame, at least nothing not ad hoc, merely pragmatic, or perspectival.

4.5 The Spatial Presentist: Absurdity in Incompatibilist Presentism?

Having answered the presentist objections to the RoS argument in turn, we would like to propose another argument along the same lines as the RoS argument which, we believe, should serve as a preemptive criticism against incompatibilist presentist arguments to come. Suppose that there exists a new kind of realist called a spatial presentist. The spatial presentist believes not that all events occurring simultaneously are real but that all events that occur in the same place are real. Perhaps there

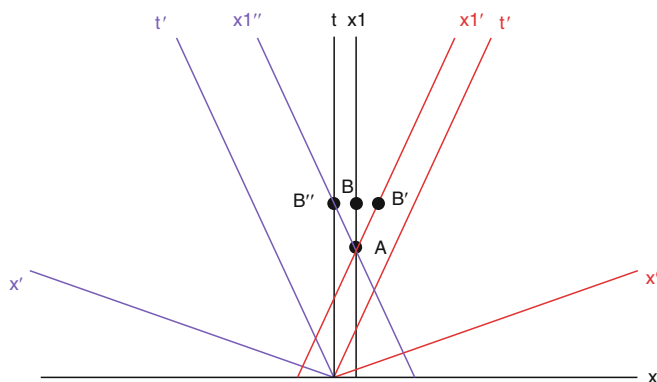


Fig. 2 Spatial presentist argument

is a sphere (infinitesimally small, for our purposes) that the spatial presentist has set aside, following which he claims that “the only things that are real are those in this sphere”. One might ask, then, what would be real after the creation of the sphere at an event A in the above diagram, which shows, from relativistic considerations, what events will be observed to fall inside the sphere by observers in different inertial reference frames.

From Fig. 2, it is clear that we are left in a situation directly analogous to the temporal presentist situation previously established in our RoS argument, for the above space-time diagram shows a property we will call the relativity of same position or RoSP. One can simply rotate our Fig. 1 and make a RoSP argument to disprove spatial presentism in the same way that the RoS argument disproves temporal presentism. The arguments are completely symmetrical in the same way that RoSP is symmetrical with RoS.

But what does this show? Only that if an incompatibilist presentist of the non-spatial variety wants to assert that temporal presentism and temporal presentism alone is correct by proposing some new feature of space-time, she must be careful that her argument and mechanism establish presentism but do not allow for spatial presentism.²⁹ This is yet another burden that the incompatibilist presentist must carry. The symmetry between RoS and RoSP suggests that incompatibilist presentists must establish a physical basis for temporal asymmetry so that spatial presentism does not become as viable and defensible a position as presentism itself, for reconciliation between spatial and temporal presentism must lead to point presentism, which is an unappealing position for reasons previously discussed.

²⁹ This is, of course, assuming that the presentist in question is not a point presentist or some new form of presentist who wishes to tie the conception of the “now” together with some more evolved conception of the “here.”

5 Conclusion

Though the traditional formulations of the Putnam, Rietdijk and SSC's RoS argument for the block universe may leave the argument open to attacks by philosophers of language and presentists, we have reformulated the argument with more specific definitions that make eternalism the likely victor over presentism. Thus, the task before the presentist in defending herself has become even grander; she must (1) find a way to dispel the RoS argument, (2) show why presentism is more likely than eternalism, and (3) integrate temporal asymmetry as fundamental to her argument lest her argument run the risk of establishing an obviously false view (spatial presentism) as well as it establishes her temporal presentism.³⁰ It is clear from our previous discussion that the most common presentist argument that "space and time are not perceived to act in the same way" is not sufficient to shoulder the weight of a full presentist defense, and thus a more developed presentist argument addressing all of our concerns must be proposed before presentism can escape from the jaws of the RoS argument. Even the retreat into the position of Savitt and Dorato that there is no significant difference between presentism and eternalism seems a difficult one to hold in light of our definitions for definiteness and distinctness. And so, in conclusion, we echo Saunders in stating that while eternalism in itself may not have been conclusively proven correct by our arguments, the burden falls upon the presentist to show why eternalism is not much more probable.³¹

6 Appendix A: Against the Dynamical Interpretation of Special Relativity

A number of philosophers have defended a dynamical interpretation ("constructive" in Einstein's language) of SR of late (e.g. Brown [2]). In the following passage Calender [4] claims the latter interpretation is a potential problem for the RoS argument for BU:

In my opinion, by far the best way for the tensor to respond to Putnam et al. is to adopt the Lorentz 1915 interpretation of time dilation and Fitzgerald contraction. Lorentz attributed these effects (and hence the famous null results regarding an aether) to the Lorentz invariance of the dynamical laws governing matter and radiation, not to space-time structure. On this view, Lorentz invariance is not a space-time symmetry but a dynamical symmetry,

³⁰ We would like to note at this point that there is an obvious reason why spatial presentism has never caught on in the philosophy of time: it does not agree with our perceptions of reality. However, if one wants to dismiss spatial presentism on these grounds but remain a presentist, one's workload is not lessened since one must now provide a link between these particular experiences and reality.

³¹ We would like to thank Mark Stuckey, Michael Cifone, David Baker, Gordon Belot, and the audience at the 3rd International Ontology of Space-time Conference at Concordia University in 2008 for comments on previous versions of this paper.

and the special relativistic effects of dilation and contraction are not purely kinematical. The background space-time is Newtonian or neo-Newtonian, not Minkowskian. Both Newtonian and neo-Newtonian space-time include a global absolute simultaneity among their invariant structures (with Newtonian space-time singling out one of neo-Newtonian space-time's many preferred inertial frames as the rest frame). On this picture, there is no relativity of simultaneity and space-time is uniquely decomposable into space and time. Nonetheless, because matter and radiation transform between different frames via the Lorentz transformations, the theory is empirically adequate. Putnam's argument has no purchase here because Lorentz invariance has no repercussions for the structure of space and time. Moreover, the theory shouldn't be viewed as a desperate attempt to save absolute simultaneity in the face of the phenomena, but it should rather be viewed as a natural extension of the well-known Lorentz invariance of the free Maxwell equations. The reason why some tensors have sought all manner of strange replacements for special relativity when this comparatively elegant theory exists is baffling (2006, 3).

See also Harvey Brown's book *Physical Relativity* [2] and his essay "Minkowski Space-time: A Glorious Non-Entity" [3] co-authored with Oliver Pooley for a more developed argument for this stance.

First, Brown [2, p. 7] himself is clear that he is not defending either the ether or a preferred-frame, unlike Lorentz himself. We grant that SR is neutral about the ontology of space-time, but we think there are good reasons for preferring the kinematical over the dynamical interpretation, though we cannot pursue them here.³² We do want to note that we are not convinced of Callender's claim that the dynamical interpretation of SR necessarily refutes the RoS. At least in the case of Brown, who again, does not claim to be defending absolute simultaneity, while his arguments may lead to space-time relationalism, they do not obviously entail the falsity of RoS as such. So until someone provides a cogent argument from space-time relationalism to the falsity of the RoS, our argument remains intact. Second, even granting an absolute frame, Brown's dynamical interpretation does not obviously save the presentist since she must still face some of the problems raised in Sect. 4.4. For example, even if there is an absolute space-time and a universal moment of the present, there is no reason to believe, as per Callender's objection discussed in Sect. 4.4, that such a present lines up with human experience of the present. What is more, as long as Lorentz contractions and dilations exist, one observer traveling at relativistic velocities may observe his present to be different from the present of those around him. Does that mean that, since he is dealing with past or future versions of these other beings, that they are not real since they are not actually experiencing the present simultaneously with the relativistic observer? There seems to be a suggestion of some sort of frame-dependent solipsism, which would constitute an anti-realism that presentists would reject as readily as eternalists.

Finally, if we are to take seriously the implication that quantum mechanics (our best theory of matter) is to special relativity what statistical mechanics is to

³² See Michel Janssen's "Drawing the line between kinematics and dynamics in special relativity" in the Phil. Sci. archive (reference number 3895) for good arguments favoring the kinematical interpretation. See also Petkov [15] where the kinematic interpretation of Minkowski space-time realism has consequences not easily or obviously accounted for by the dynamical interpretation.

thermodynamics, then had not quantum mechanics better be able to explain (in some robust sense of the word) the key features of SR such as Lorentz invariance? Obviously, this condition has not been met and merely interpreting Lorentz invariance to be restricted to dynamical laws only hardly does the trick.

7 Appendix B: Objection to RoS Argument by Meta-Time

One of the points we believe we have established in this paper is that the eternalist perspective does not require any meta-time or generally any 5th dimension to be coherent; however, one might object that our R-value, R-relation language itself begs the question against eternalism and refutes our repeated assertion that no eternalist meta-time is necessary. The objection might go as follows: Suppose that one is committed to simply a binary ontology of R-values such that an R-value of 1 represents “real” and an R-value of 0 represents “unreal”. The eternalist perspective here seems straightforward (all R-values are 1, or, perhaps less likely, all R-values are 0), but the presentist perspective is not so straightforward. At time t_1 , only events at time t_1 have an R-value of 1 while all other space-time events have an R-value of 0. At time t_0 , only events at t_0 have an R-value of 1 while all other space-time events have an R-value of 0. Thus, if t_1 is not the same as t_0 (that is, as long as space-time has a temporal dimension), R-values must change with time, meaning that there must be some sort of extra dimension posited to account for this notion of change. Thus, one might object that the only way for one to meaningfully capture the presentist perspective using R-values is to assume some sort of meta-time, and thus the eternalist is only right if one assumes meta-time, which is to give the eternalist his conclusion from the start. Thus, the RoS argument seems to both beg the question and assume meta-time.

Our response to this objection is to note that the objector has taken a fairly narrowly view of R-values (though, to be fair, this naïve view is essentially the one we advocate in this paper for the sake of simplicity). There is no reason why R-values cannot be tweaked to suit the presentists’ notion of reality. Let us allow a different kind of R-value, then, one more in keeping with predicates such as Goodman’s infamous “grue”. We now define a series of R-values that can take any value we would ascribe to events occurring at a certain time from the beginning of time to the end of time. Each R-value represents the predicate “is real at time x and is unreal elsewhere” where “ x ” is the R-value of the event. Such an R-value scheme is static; there is no meta-time required to account for changes in R-values because no matter what time we perceive it to be, the R-value of every event will remain the same. Thus, by re-characterizing R-values in terms of the time of various events, we can avoid this objection to the RoS argument.³³

³³ One might wonder about how we would treat the perspectives of presentists who expect the present to have a certain duration instead of being instantaneous. The answer would be to transform the R-value into an R-vector, with the first entry representing the time at which the event

Still, there remains a further issue: time alone is not enough to provide us with proper R-values, especially not in the relativistic context we assume for the RoS argument to go through. Since time is a frame-dependent quantity, it seems that, by allowing grue-like R-values that are based on temporal coordinates, we are forced to give up on the objectivity and frame-independence of R-values. What this shows, however, is not that R-values are not objective but that time itself is not the proper quantity to base an R-value on. Instead, the R-value used for the presentist ought to be the proper time or the space-time interval from some fixed point. Such quantities retain the essential character of our R-value time-dependence while still providing the objectivity we seek from an R-value. Thus, if the presentists' R-values are defined as the proper time at which a given event is real, then the R-value has the character we expect and the RoS argument goes through without begging the question or assuming meta-time.

One final remark ought to be made, however: why should we not stop by just defining the presentists' R-values in terms of time instead of proper time? We lose objectivity in doing so but seem to better capture our intuitions about time and the present. The answer, we believe, comes back to what the R-values are to represent: reality and ontological status. It seems that, if anything ought to be frame-independent, it ought to be the ontological status of an event. If events are capable of having some frame-independent properties, such as a proper time coordinate, distance via the space-time interval, and the kind of event-definiteness and distinctness we previously discussed, then it would seem ridiculous to say that the fundamental ontological status of the event, which ought to be its most crucial, fundamental, essential property, is somehow less objective than these frame-independent properties. This disagreement may boil down to which intuitions are most important to capture: intuitions about reality, or intuitions about the behavior of time. Given the fact that human intuitions concerning time seem at best incomplete and at worst wrong in many cases, we believe that it is reasonable to prefer capturing the former intuition to capturing the latter. As such, we believe that defining presentist R-values in terms of proper time, as we suggest in this section, is the best way to nuance R-values so as to reconcile them with presentism: not only does it allow the RoS argument to follow as we've characterized it, it also reconciles our intuitions about reality with presentism in the most reasonable way possible.

switches from "unreal" to "real" and the second entry representing the time at which the event switches from "real" to "unreal" again. This vector scheme could account for even absurdly complex presentist/possibilist/historicist positions that have events blinking into and out of existence many, many times by simply characterizing each shift from real to unreal (and back again) in terms of the time at which the shift occurs and characterizing the R-vector of the event in terms of these times.

8 Appendix C: A “God’s Eye” View of Space-Time on Different Theories of Time

Fig. 3 Eternalist perspective on space-time

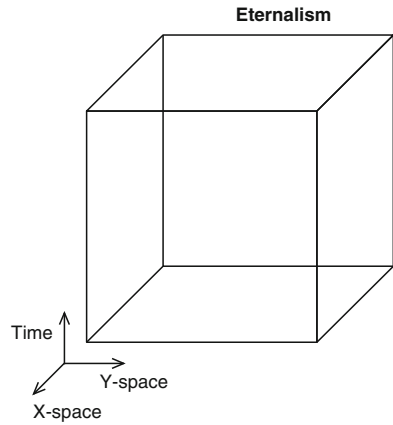


Fig. 4 Presentist perspective on space-time

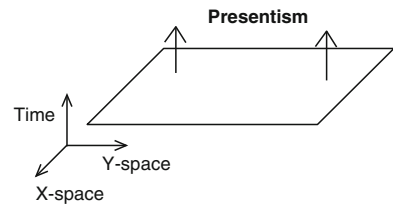
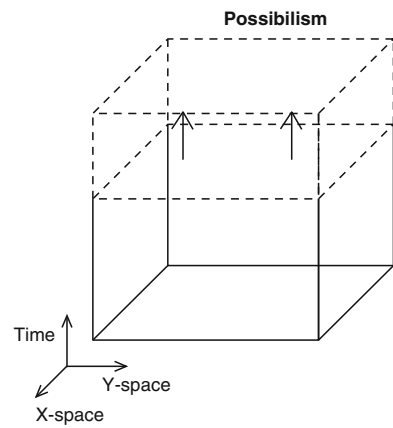


Fig. 5 Possibilist perspective on space-time



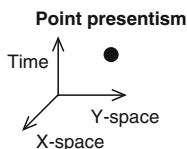


Fig. 6 Point presentist perspective on space-time. This perspective, idealized here as a single point in space-time, is the most difficult to represent visually since it should have an infinitesimal size. The single dot of the present is the only thing in space-time that exists on this view of space-time, making it a much more limited and precise view of the present than the more general form of presentism previously represented

References

1. Bourne, C. *A Future for Presentism*. New York: Oxford University Press, 2007.
2. Brown, H. *Physical Relativity: Space-time Structure from a Dynamical Perspective*. Oxford: Oxford University Press, 2005.
3. Brown, H. and O. Pooley. "Minkowski Space-time: A Glorious Non-Entity" in *The Ontology of Spacetime*, Ed. D. Dieks. Utrecht, the Netherlands: Elsevier, 2006. pp 67–89.
4. Callender, C. "On Finding 'Real' Time in Quantum Mechanics" (draft) *Absolute Simultaneity*. Eds. W.L. Craig and Q. Smith. Oxford: Oxford University Press, 2007.
5. Craig, W. L. *Time and Eternity: Exploring God's Relationship to Time*. Wheaton: Crossway Books, 2001.
6. Craig, W. L. and Q. Smith. *Einstein, Relativity, and Absolute Simultaneity*. London: Routledge, 2007.
7. Dainton, B. *Time and Space*. Montreal: McGill-Queen's University Press, 2001. p. 119.
8. Dolev, Y. *Time and Realism: Metaphysical and anti-Metaphysical Perspectives*. Cambridge: MIT, 2007.
9. Dorato, M. "Absolute becoming, relational becoming and the arrow of time: Some non-conventional remarks on the relationship between physics and metaphysics". *Studies in the History and Philosophy of Modern physics*, 37, 2006. pp 559–576.
10. Dorato, M. "The Irrelevance of the Presentist/Eternalist Debate for the Ontology of Minkowski Spacetime" in *The Ontology of Spacetime*, Ed. D. Dieks. Utrecht, the Netherlands: Elsevier, 2006. pp 93–109.
11. French, S. and D. Krause. *Identity in Physics: A Historical, Philosophical and Formal Account*. Oxford: Oxford University Press, 2006.
12. Ladyman, J. et al. *Everything Must Go: Metaphysics Naturalized*. Oxford: Oxford University Press, 2007.
13. Monton, B. "Presentism and Quantum Gravity" in *The Ontology of Spacetime*, Ed. D. Dieks. Utrecht, the Netherlands: Elsevier, 2006, pp 263–280.
14. Petkov, Vesselin. "Is There an Alternative to the Block Universe View?" in *The Ontology of Spacetime*, Ed. D. Dieks. Utrecht, the Netherlands: Elsevier, 2006. pp 207–228.
15. Petkov, V. "On the Reality of Minkowski Space". *Foundations of Physics* 37, 2007. pp 1499–1502.
16. Putnam, H. "Time and physical geometry". *Journal of Philosophy*, 64, 1967. pp 240–247.
17. Rietdijk, C. "A rigorous proof of determinism derived from the special theory of relativity". *Philosophy of Science*, 33, 1966. pp 341–344.
18. Rovelli, C. "Relational Quantum Mechanics". Aug 1996. quant-ph/9609002.
19. Saunders, S. "How Relativity Contradicts Presentism" in *Time, Reality, and Experience* Ed. Craig Callender. Cambridge: Cambridge University Press, 2002. pp 277–292.
20. Savitt, S. "Presentism and Eternalism in Perspective" in *The Ontology of Spacetime*, Ed. D. Dieks. Utrecht, the Netherlands: Elsevier, 2006. pp 111–127.

21. Savitt, S. "Being and Becoming in Modern Physics", The Stanford Encyclopedia of Philosophy (Fall 2007 Edition), Edward N. Zalta (ed.), forthcoming URL = <http://plato.stanford.edu/archives/fall2007/entries/spacetime-bebecome/>
22. Sider, T. *Four-Dimensionalism*. Oxford: Oxford University Press, 2001.
23. Silberstein, M. et al. "An Argument for 4D Blockworld from a Geometric Interpretation of Non-relativistic Quantum Mechanics." In *Relativity and the Dimensionality of the World*, Ed. V. Petkov. Heidelberg: Springer, 2007. quant-ph/0605039.
24. Silberstein, M. et al. "Why Quantum Mechanics Favors Adynamical and Acausal Interpretations such as Relational Blockworld over Backwardly Causal and Time-Symmetric Rivals" in a focus issue of *Studies in the History and Philosophy of Modern Physics on Time-Symmetric Approaches to Quantum Mechanics*. H. Price and G. Bacciagalupi, Editors. Volume 39, Issue 4, 2008. pp. 732–747.
25. Silberstein, M. and M. Cifone. "Static for Dynamism: Special Relativity and the Block Universe", International conference on the ontology of space-time, Concordia University. Montreal, Quebec, Canada, 2004. May 11–14.
26. Stein, H. "On Einstein-Minkowski Space-Time". *The Journal of Philosophy*, 65, 1968. pp 5–23.
27. Stein, H. "On Relativity Theory and Openness of the Future". *Philosophy of Science*, 58, 1991. pp 147–167.
28. Stuckey, M. M. Silberstein, and M. Cifone. "Reconciling Spacetime and the Quantum: Relational Blockworld and the Quantum Liar Paradox" in *Foundations of Physics*, Volume 38, Number 4, 2008. pp. 348–83.