Paradoxes of Time Travel to the Future

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David Lewis's "The Paradoxes of Time Travel" (1976) set the stage for most contemporary philosophical discussions of time travel. Lewis's views on time travel, including what constitutes time travel, the abilities of and constraints on time travelers, and the impossibility of genuinely changing the past, are now considered the default metaphysical interpretations of the topic. The threads of Lewis's view are unified by eternalism, the view that past, present, and future times exist and are equally real.

This paper brings two fresh perspectives on Lewis's theory of time travel. The first new perspective is that many key aspects and theoretical desiderata of Lewis's theory can be captured in a framework that does not commit to eternalism about time. The second new perspective is that implementing aspects of Lewisian time travel in a non-eternalist framework provides theoretical resources for a better treatment of time travel to the future. While time travel to the past has been extensively analyzed, time travel to the future has been comparatively underexplored. I make progress on this topic. Along the way, I discuss Lewis's lesser-known time travel oeuvre, especially his volume of correspondence and lectures on the topic collected in Beebee and Fisher (2020) and Janssen-Lauret & MacBride (forthcoming). Lewis's body of unpublished work on time travel yields fruitful insights into his broader thinking on the subject.

Exploring aspects of Lewis's theory in other ontologies of time is a worthwhile endeavor for many reasons. One reason is that such a project advances the study of time travel more generally: Lewisian time travel is so often interpreted as a "package deal" that it has become unusual to assess the plausibility of the features of Lewis's theory independently of one another. Another reason is scholarly: in looking at alternative implementations of Lewis's system, we can better understand how Lewis's canonical paper led to the current state of play of the literature. Finally, unearthing and discussing Lewis's lesser-known views on the topic is of intrinsic interest for historians of 20th Century Philosophy and fans of Lewisalia alike. It is not well-known, for example, that

Lewis's 1971 Gavin David Young Lectures (hereafter: GDY) contain a sustained discussion of his explicit repudiation of the now-popular notion of hypertime. Looking afresh at his reasons for rejecting hypertime sheds new light on the subject.

Here is the plan. In Section 1, I give a brief overview of Lewis's theory of time travel, with a focus on its apparent interdependence with the eternalist theory of time. I lay out numerous central features of his theory. In Section 2, I describe what is often taken to be a competing theory of time travel: time travel in hypertime. In sections 3-5, I develop problems for different aspects of Lewis's theory. The problems fall into several different categories. Some of the problems are internal to Lewis's own theory of time travel. Other problems arise where Lewis's theory falls short of his own theoretical desiderata. For example, Lewis was keen to capture "the sort of time travel that is recounted in science fiction."[1] But the very model that Lewis rejects achieves more in this respect than his own view. Or so I will argue.

I shall propose that several of the problems can be solved by implementing key features of Lewisian time travel in a non-eternalist framework. Time travel involving hypertime meets many of the goals of Lewis's theory, including a good working definition of time travel, an account of time travel as real travel, the ability to handle the Grandfather Paradox, and the repudiation of "second time around" time travel. In several instances, I weave these threads together into a more general suggestion: time travel without eternalism can better handle cases of time travel to the future, and it can do so while retaining most aspects of the Lewisian picture.

1. Lewisian Time Travel

Lewis is an adherent of *eternalism*, the doctrine that past, present, and future times are all equally real. Most eternalists deny the ontological privilege of the present and eschew ontological differences between times. For eternalists, dinosaurs are no less real than iPhones. According to Lewis, "The world—the time traveler's world, or ours— is a four-dimensional manifold of events. Time is one dimension of the four, like the spatial dimensions except that the prevailing laws of nature discriminate between time

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[1] (1976: p. 1)

and the others—or rather, perhaps, between various timelike dimensions and various spacelike dimensions." (1976, p.145)[2]

Eternalism structures several central aspects of Lewis's theory of time travel. Lewis defines time travel as a "discrepancy between time and time". Personal time is time "for the time traveler" or "on the time traveler's watch". External time is time "for everyone else". Suppose that 30-year-old Tamika takes one year to travel from 2020 to 2010. In the Lewisian picture, one year has passed in Tamika's personal time, and 10 years have passed in external time. Time travelers, like all people and objects, are to be viewed as "worms" spread out in the eternalist temporal block, extended in time as well as in space. Time travelers like Tamika have disconnected parts across the block: she will, for example, have multiple temporal parts located in 2010.

Lewis also intends to capture time travel as a real sort of *travel* of the sort depicted in science fiction.[3] That this is a desideratum of his theory is made clear in his early lectures on the topic, where he derides a competing theory as "not at all like time travel." (GDY, p. 4) The Lewisian picture is also to be contrasted with models of "branching" time travel, according to which multiple versions of a time traveler exist on different branches. Lewis dislikes this model for many reasons, including that it does not contain travel to the time traveler's "original past". (GDY, p. 54)

Lewis's Grandfather Paradox (1976) famously takes aim at whether a time traveler to the past, Tim, can kill his own grandfather. It is easy to imagine Tim's specific act of killing his grandfather: he has the weapon and the training, and he can pull the trigger. But were Tim to kill his own grandfather, Tim's father would not have existed, and thus Tim himself would not have existed. Tim's grandfather did not in fact die, and cannot die in the past, because Tim exists. Tim, it seems, both can and can't kill his grandfather.

Lewis's preferred solution to the Grandfather Paradox is that Tim's "ability" to kill Grandfather is to be relativized to a particular set of facts. According to Lewis:

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[2] Lewis's attraction to systematic parallels more generally (e.g., between time and modality) might explain his attraction to the parallel between time and space given by the eternalist picture. Thanks to Anthony Fisher for this point.

[3] Aside from Lewis's reference to this point in his (1976), see also Letter 224 (pp. 441-442) and Letter 231 (p. 454) in Beebee and Fisher (2020).

[Tim] can and he can't [kill Grandfather], but under different delineations of the relevant facts. You can reasonably choose the narrower delineation, and say that he can; or the wider delineation, and say that he can't. But choose. What you mustn't do is waver, say in the same breath that he both can and can't, and then claim that this contradiction proves that time travel is impossible. (1976, p. 151)

Tim can kill his grandfather in one sense of "can"—the sense connected to the "local" set of facts of Tim stalking his grandfather in the past-- but not in another sense, the one connected to the broader set of facts that includes Tim's eventual conception. Eternalism is a fitting foundation for this solution since there is just one set of perennial, tenseless facts. From a bird's eye-view, nothing in the eternalist manifold changes with the inclusion of time travel.

There are two distinct but related paradoxes in "the" Grandfather Paradox. The first paradox involves the question of the time traveler's ability to kill his own Grandfather specifically—that is, to remove the antecedent for his own existence. Lewis's contextualist solution is directed at this paradox. The second paradox involves the inconsistency of any sort of change to the past.[4] Such a change would involve "second time around" alteration of the eternalist block. Smith (1997) names the supposition that time travel can result in a real change in past events—attendance at a party that one did not initially attend, for example—the "second time around fallacy".

For Lewis, avoiding real change is to be avoided as much in the future as to the past. According to Lewis:

"Not that past moments are special; no more can anyone change the present or the future. Present and future momentary events no more have temporal parts than past ones do. You cannot change a present or future event from what it was originally to what it is after you change it." (1976, p. 150)

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[4] See Casati and Varzi (2001) for a relevant discussion of visiting the past versus changing the past.

Since past and future events already exist in the manifold, a time traveler genuinely changing a future moment also counts as a Second Time Around fallacy. Lewis's solution to the first paradox is bolstered by this solution to the second paradox: there can be no true changing the past in any form, because all moments already exist. Tim will not fail to Grandfather just because it is Grandfather; Tim will also fail to kill Grandfather because doing so would constitute a genuine change to the past.

Finally, Lewis holds that the same time traveler diachronically persists through time travel. Time travel doesn't make the time traveler a different person, even if their temporal stages are spread out non-standardly in the eternalist block. Lewis is careful to distinguish between "counterfeit" time travel, or the appearance of apparent time travelers who are just similar-but-different-people, from real time travel, in which the same person is simply diffused across the eternalist manifold.

As I will suggest, many of these central features of Lewis's theory of time travel face challenges because they are connected to his commitment to eternalism. But many of these challenges can be faced down in a non-eternalist framework. Within such a framework, one can retain many of the attractive features of the Lewisian system while also gaining some extra advantages.

2. Time Travel involving Hypertime

First, it will be helpful to say a bit about A-theoretic time travel (or "hyperkinetic" time travel, as Lewis sometimes called it.) The titular commitment of A-theoretic time travel involves temporal passage, or genuine metaphysical differences between the present moment and other sorts of moments. The A Theory of time is often taken to be part of a package deal with presentist, growing block, and moving spotlight theories of time, all of which posit some sort of temporal passage. The B Theory of time, according to which there is no temporal passage and reality is tenseless, is often taken to be a package deal with eternalism, Lewis's preferred view.

A-theoretic time travel often makes use of the notion of *hypertime*, roughly, a temporal manifold against which another temporal manifold is measured. (From here on,

I will just use "hypertime" to mean Lewis's "hyperkinesis".)[5] The exact ontological nature of hypertime varies from theory to theory, but the general idea is that hypertime is an extra temporal dimension within which the location of the objective present shifts. If there is no time travel, events in time and events in hypertime proceed in lockstep. Where there is time travel, events in a time traveler's life are non-linearly ordered in time but linearly ordered in hypertime.

A-Theoretic models of time travel involve the growing block theory of time, the moving spotlight theory, or presentism.[6] In Peter van Inwagen's (2010) and Goddu's (2003) models of time travel in a growing block universe, for example, the time traveler relocates herself to an earlier point in the growing block, and annihilates the slices of time between her points of temporal departure and arrival. A new, non-paradox-containing block can be regenerated after the temporal relocation of the time traveler. For example:

> (Missed Party) Jamila regrets her non-attendance at a party in 1980. She travels
> from 2021 to 1980, arriving so that she can attend the party. Jamila "rewinds"
> the objective present to 1980, annihilating every portion of the growing block
> between 1980 and 2021. Reality then progresses "anew" from Jamila's arrival
> in 1980.

In this example, the temporal block "loses" 41 years before regenerating from 1980, while hypertime proceeds as normal.

Annihilation of a portion of the block is not an essential feature of A-Theoretic time travel. According to the model of A-Theoretic time travel set out in Bernstein (2017), a time traveler can move around in time by relocating the objective present for everyone. That model can be implemented in presentism, growing block theory, and moving spotlight theory. In those theories, no portions of existence are eliminated.

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[5] The term "hyperkinetic" originates with D.C. Williams. See the Williams's "The Nature of Time" in Fisher (2018), p. 184. Thanks to Anthony Fisher for this tip. See also Fisher (2015) for exposition and discussion of the correspondence between Lewis and Williams about the nature of time.

[6] For examples of time travel involving the growing block, see Goddu (2003), Hudson and Wasserman (2010), and van Inwagen (2010). For a unique model of time travel involving presentism, see Keller and Nelson (2001). (I set aside Keller and Nelson's specific model in this paper.) For a model of branching time travel with hypertime, see Samaram (ms).

Rather, the time traveler shifts the location of the present moment in hypertime without affecting the quantity of overall temporal existence.

Goddu's, van Inwagen's, and Bernstein's models share a commitment to an objective present that moves non-standardly through hypertime. On each of these A-Theoretic views, locations in time are repeated, but hypertemporal locations are linear and hyperchronological. Suppose that Jamila's initial non-attendance at the party occurs at t1, that her regret over her non-attendance occurs at t2, and that her departure from the future to the past occurs at t3. Jamila's "second time around" attendance at the party then occurs at t1 (occurring a second time), and her happiness at attending the party occurs at t2 (occurring a second time), like so:

t1/ t2/ t3 /t1/ t2

But these repetitive locations in time occur in linear hyperchronological order:

t1/ ht1   t2/ ht2/   t3/ ht3   t1/ht4   t2/ht5

Events in hypertime appear in order, even when events are repeated in time due to time travel.

A-Theoretic time travel to the future works slightly differently than A-Theoretic time travel to the past, especially in a growing block framework. If the A-Theoretic time traveller travels to the future faster or slower than time's normal rate of passage, she will speed up or slow down temporal passage for everyone in her universe. The time traveler also speeds up the generation of the growing block, since she speeds up the hyper-process in virtue of travelling at a non-standard rate of temporal passage. For example, if a time traveller takes one hyperhour to travel ten hours into the future, she thereby speeds up temporal passage for all of reality: the existence of future portions of the block is generated sooner than if the time traveler had not travelled. If a time traveller takes ten hyperhours to travel one hour into the future, she thereby slows down temporal passage for all of reality: the block will generate slower than if she had not travelled at all. In these cases, non-time-travelers presumably remain blissfully ignorant of these changes.

Given Lewis's commitment to eternalism, it is easy to see why he would deny hypertime simply on the basis of the latter's inclusion of temporal passage. The associated presentist and growing block views of time deny the ontological parity of the past, present, and future, a key tenet of eternalism. Lewis also has independent reasons for denying hypertime, as explicitly laid out in GDY:

> "I don't buy the supposed connection between hyperkinetic theories and the possibility of time travel. In the first place, abnormal hyperkinesis is not at all like time travel; in the second place, the hyperkinetic theory deserves to be rejected as unparsimonious; and in the third place, the reasons given for believing in hyperkinesis are mistaken." (p. 4)

Lewis also views a commitment to hypertime as giving rise to an infinite regress of temporal manifolds:

> "Hyperkinesis is unparsimonious because it posits two temporal dimensions in place of one; and that for no purpose except to explain the phenomena of pastness, presentness, and futurity. What's worse, it gives us a 5-dimensional manifold, and the original arguments against the manifold theory, if they were good against the 4-manifold (which they weren't, as we'll see) are just as good against the 5-manifold including hypertime. We're therefore led to posit hyper-hypertime, with respect to which the 5-manifold changes; and so on ad infinitum." (p. 5)

I won't defend hypertime against the latter charges in this limited space. But I will argue that Lewis was too quick to deny hypertime as a tool for modeling time travel, and that A-theoretic models of hypertime can solve some problems created by Lewis's own theory.[7] *Contra* Lewis, hypertime provides a better notion of time travel as real *travel*

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[7] Lewis throws down the gauntlet to the hypertime theorist even more explicitly in his letter to Meiland: "I don't find your two-dimensional theory inconsistent or paradoxical. I only wonder why it's needed, since I think a one-dimensional manifold theory is adequate to represent all ordinary facts about time, adequate to represent the possibility of time travel in which the past is unchanged and even adequate – if branching is

than the eternalist version. Further, a theory of time travel with hypertime is in many cases better equipped to handle and account for time travel to the future.

3. Lewis's Definition of Time Travel

One persistent issue in the time travel literature is how best to capture and define the very notion of time travel. Recall Lewis's definition of time travel as a discrepancy between personal time and external time. This definition is vulnerable to several difficult questions about the nature of personal time. For example: is a quantitative discrepancy between personal and external time necessary or sufficient for time travel? What, exactly, *is* personal time?[8] How far does personal time extend "around" the time traveler?

Lewis is careful to deny the ontological substantivity of personal time: personal time does not constitute its own substantive temporal manifold. Nor can it be, since the eternalist manifold is characterized by the ontological parity of all times. Rather, personal time is just constituted by the speed and apparent direction of the bodily processes of the time traveler as compared with the rest of the world. These regularities in bodily processes, including the apparent direction of causation, also play the role of the temporal arrow. Of personal time, Lewis writes:[9]

> "It isn't really time, but it plays the role in his life that time plays in the life of a common person. It's enough like time so that we can—with due caution— transplant our temporal vocabulary to it in discussing his affairs." (1976, p. 146)

The Lewisian personal time/ external time discrepancy can be viewed as encompassing

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permitted – to represent the possibility of something close to Wellsian time travel." (Letter 233. To Jack W. Meiland, 13 December 1972, in Beebee and Fisher (2020), pp. 456-457)

[8] See Bernstein (2015), Gilmore (2016), Carroll et. al (2017) and Richmond (2018) for extensive discussion of the notion of personal time. See Sider (2005) for discussion of a substantive notion of Lewisian personal time. See Daniels (2014) for an argument that Lewisian time travel can be refined in order to accommodate time travel in a relativistic setting.

[9] That Lewis uses the phrase "plays the role" is reason to think that he views personal time as a theoretical term, following his doctrine of T-terms laid out in his (1970) and (1972). Many thanks to Anthony Fisher for this point.

two "mismatches".[10] First, there is the mismatch between the speed of the time traveler's bodily processes and the processes in the external timeline. Second, there is a mismatch between the apparent direction of the time traveler's bodily processes and the rest of the timeline.

Not all cases of time travel involve both types of mismatch. Some cases have one or the other. The first and most obvious case of this problem is when there is no quantitative discrepancy between personal time and external time. For example:

> Straightforward Travel: Tamika pushes the button on her time machine, which will take her backwards in time one hour. The time machine travels at a rate of one hour in personal time per one hour of external time.

If time travel occurs at a rate of one hour in personal time per one hour in external time, there is no quantitative discrepancy between time and time. Yet, intuitively, this case counts as time travel. The mismatch in the direction of bodily processes marks off personal time even where there is no quantitative discrepancy with external time. Since Tamika's temporal slices age "forward" one hour while she moves backwards in time, the case is to be considered time travel.

Cases of time travel to the future, on the other hand, often involve a mismatch in the speed of the time traveler's bodily processes compared with the rest of the timeline, but not a mismatch in the direction of the bodily processes. For example:

> Slow Travel: Mykaela pushes the button on her time machine, which will take her forward in time one year. The time machine travels at a rate of one hour in personal time per one year of external time.

In this case, Mykaela's bodily processes occur at a different speed than the external timeline, though they occur in the same direction as the external timeline. The case counts as time travel because of the single mismatch.

But there are some cases of time travel that involve neither mismatch. Consider:

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[10] Here I focus primarily on cases of continuous time travel.

Reverse Aging: 21-year-old DeShawn presses the button on his time machine, and takes twenty years in personal time to travel back twenty years in external time. However, the time machine ages him backwards at a rate of one year per year, such that his body and bodily processes match those of a one-year-old baby upon his arrival in the past.

In this case, there is no quantitative discrepancy between personal time and external time. Nor do DeShawn's bodily processes play the role that time plays "in the life of a common person," since the bodily processes happen in the opposite direction than they should. But, intuitively, Reverse Aging is a case of time travel even with neither mismatch.[11]

A related problem is that personal time and external time are not stable concepts *because* they rely on mere mismatches. In many canonical time travel examples, the time traveler constitutes the temporal minority, and the rest of the universe constitutes the temporal majority. In a letter to Jack Meiland, Lewis wrote of personal time:

My personal time is indeed meant to be the personal time of one definite person (or person-like animal, robot, deity,...) just as distance-down-the-track is distance-down- the-track on my personal railway line R. No persons, no personal time, no railways, no distance-down-the-line. So I wouldn't like to let the v-axis "represent personal time in general". (Letter 234. To Jack W. Meiland, 6 January 1973, in Beebee and Fisher (2020), pp 460-461

Just one time traveler has bodily processes that do not match the speed or direction of the ontological majority on the external timeline.

But consider the following example:

Deep Space: A space traveler travels into the gravity well of a neutron star. While she has aged one year and one second on her journey into deep space, only

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[11] See Valaris and Michael (2015) for a discussion of causation as the appropriate ordering mechanism for temporal slices of time travelers.

one year has passed on earth. (The earth's gravitational pull makes time pass more slowly on earth's surface.)[12]

Intuitively, the deep space traveler is on "personal time" whereas earth is on "external time". But much of the universe is in fact on the same time as the deep space traveler. It is earth's gravitational pull that is slower than the rest of the universe. Consider also:

> Time Travel Disaster: A time travel scientist pushes the wrong button and sends everything in the universe but her lab forward in time 300 years.

Intuitively, the rest of the universe is on "personal time" and the scientist's lab is on "external time".[13] Lewis's majority/ minority contrast quickly reverses, and even dissolves, upon entertaining more complex time travel scenarios.

In sum, I see at least two broad problems with Lewis's definition of time travel. First, there can be intuitive cases of time travel with neither mismatch in speed nor a mismatch in direction of bodily processes. Second, the definition of personal time as mere comparative difference with external time renders the distinction unstable.

Now consider the personal time/ external time distinction within the A-Theoretic framework. Accounting for the discrepancy does not require eternalism. It can be captured by differences in temporal and hypertemporal durations between the time traveler's timeline and the "normal" timeline. Consider this modified version of Missed Party:

> Long Time Machine: Jamila regrets her non-attendance at a party in 1980. She travels from 2021 to 1980, taking 60 years in her time machine to travel 41 years into the past.

In this example, there is a mismatch between the hypertemporal and temporal duration of Jamila's journey: her own temporal stages age 60 years as measured in hypertime, but

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[12] Thanks to Daniel Nolan for this example.

[13] Lewis describes the notion of "extended personal time" as an attempt to deal with some of these issues.

she travels only 41 years according to the normal timeline. In this way, Lewis's discrepancy between personal time and external time can be recovered and reflected in the A-theoretic framework. It also provides an arguably more substantive notion of personal time. Personal time is not just a difference in the speed of bodily processes and the order in which those processes happen; it is measured in hypertemporal duration.

Moreover, the hypertime model provides a richer ontological basis for the discrepancy between personal time and external time than Lewis's own ontology. Rather than reliance on the two types of mismatch, the passage of personal time is reflected in hypertemporal duration. This notion of personal time is particularly helpful in capturing intuitive cases of time travel that contain neither mismatches in speed nor mismatches in the direction of bodily processes. Reverse Aging, for example, counts as time travel because there is a discrepancy between DeShawn's hypertemporal and temporal durations.

Interestingly, Lewis admits that the personal time/ external time discrepancy can be implemented in the hypertime model. In a 1972 letter to Jack Meiland, Lewis writes:

"But I also wonder whether your theory is really any different from mine. Your horizontal time dimension plainly corresponds to my external time; and your vertical time dimension seems very like what I call the personal time of a given time traveler (or of a normal person). Am I right to think, for instance, that you disallow travel in vertical time just as I would disallow travel in personal time, so that the only time travel in your model is change of horizontal time with respect to vertical time? You say, and I do not, that vertical or personal time is a second time dimension, but I wonder how much this disagreement amounts to." (Letter 233. To Jack W. Meiland, 13 December 1972, in Beebee and Fisher (2020), pp 456-457)[14]

Indeed, the Lewisian notion of personal time and the contemporary notion of hypertime often reflect the same changes in the life of the time traveler. Without its marriage to eternalism, this aspect of Lewisian time travel can be easily implemented in a

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[14] The paper discussed in this correspondence was later published as Meiland (1974).

hypertemporal model.

4. <u>Time Travel as Real Travel</u>

Doing justice to the notion of time travel *as* travel is difficult in the eternalist framework. Though Lewis is invested in capturing the concept of real travel, it is hard to see how a mere mismatch between the speed of bodily processes of the time traveler and the speed of processes in the rest of the world accounts for the idea that the time traveler is truly shifting in the appropriate sense. Suppose that I slow down my bodily processes so that I age ten times slower than everyone else. Intuitively, this is not a case of time travel so much as an extremely effective anti-aging regimen. Yet the case counts as time travel on the Lewisian view, owing to the mismatch in speed of bodily processes and the appropriate causal relationships between my bodily stages.[15]

What satisfies the notion of real travel is obviously controversial. The eternalist holds that it is enough for real travel that a time traveler's stages are discontinuously spread out across the manifold. The opponent isn't satisfied by this notion. She claims: I don't travel in space just because I cut off a wisp of hair and place it across the room. A strange arrangement of parts doesn't mean I've gone anywhere. The A-theorist desires real temporal *movement*, not just temporal spread, and the former can only be recovered in a model with temporal passage.

The hypertime theorist holds that her A-theoretic model captures the notion of time travel rather than capturing bodily stasis. For if one is judging the A-theoretic hypertime/ time discrepancy against Lewis's personal time/ external time discrepancy, all that we find in the latter is two mismatches between the time traveler and the external timeline. A bird's eye-view of the eternalist manifold displays time travelers as non-conforming streaks with slower or faster bodily processes than the extant timeline. But

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[15] Lewis denies that this is a case of time travel because subatomic processes are not slowed down even if other biological processes are slowed down. In a 1977 letter to Jonathan Bennett, Lewis writes "I'm not sure about cryogenic procedures. They slow down different processes to different degrees, and the rates of the fundamental atomic processes [...] are unchanged. So it's not clear to me that if we take a functional analysis of personal time [...] we get a discrepancy between personal and external time." The latter Lewis quote can be found in Wasserman (2017) p. 13, which also has a discussion of the quote and Lewis's strategy for dealing with cases involving cryogenics.

these non-conforming streaks don't capture the notion of temporal portability in the way that time travelers within A-Theoretic Frameworks reflect. Lewisian time travelers do not truly move from time to time; they mostly exert control over their own physical processes. Even "discontinuous" time travelers, those who disappear and reappear in different portions of the block, do not travel so much as arrange their stages in non-standard ways.

In the hypertime model, however, time travelers incontrovertibly shift their temporal locations.[16] If they are travelling in a growing block universe, the shift is accompanied by annihilation of the portion of the block between the time traveler's departure and arrival. If they are travelling in a presentist universe, the shift is represented in the time traveler-controlled movement of the objective present across hypertime. If they are travelling in a moving spotlight universe, the shift is accompanied by controlled movement of the spotlight. In each case, time travel is more than a deviant arrangement of temporal parts: it is an actual shift of the time traveler.

Lewis does not think that time travel in hypertime counts as real time travel. In a short and mysterious paragraph in his most famous paper on the topic, he writes:

> "On closer inspection, however, [the hypertime] account seems not to give us time travel as we know it from the stories. When the traveler revisits the days of his childhood, will his playmates be there to meet him? No; he has not reached the part of the plane of time where they are. He is no longer separated from them along one of the two dimensions of time, but he is still separated from them along the other." (1976, p. 145)

The objection seems to be that A-theoretic time travelers do not participate in events that are truly past, and instead participate in some facsimile of the past.

In virtue of what does something count as the time traveler's "real" past?[17] For the

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[16] In the spirit of fair-mindedness, it is worth mentioning that the Lewisian framework easily accommodates the possibility of multiple time-travelers, since time travelers are just streaks with mismatches of bodily processes. A-theoretic theories of time travel, on the other hand, must reckon with the possibility of time travelers competing for control over the location of the objective present, or even the possibility of multiple objective presents.

[17] There is burgeoning debate on this topic. See Goddu (2011), Baron (2015), and Wasserman (2017: 130-

eternalist, there are two related criteria. First, the "real" past is just the one that occurs tenselessly and perennially before the time traveler's departure. If the childhood playmates did not talk to their older time traveling friend initially, this will forever be the case. Any apparent intrusion into the past is just a visit to a convincing copy, since a past that contains the visit from the second-time-around time traveler is not the very same past. The second and related criterion, more explicit in Lewis's answer, is that the time traveler not be separated by a "separate" dimension of time from the original events. For Lewis, the hypertemporal difference from the original event—the "other" dimension of time from which he is quantitatively separated from his original playmates— automatically implies that the temporal destination is different than what it originally was.

But the friend of A-Theoretic time travel will not accept either of the eternalist's criteria for what makes the time traveler's past the "real" one. Suppose that 38-year-old Dimitria revisits her group of childhood playmates in the year 1988. Little Dimitria was there as a child; adult Dimitria is now there as an adult. The past to which Dimitria returns is considered the same and genuine past *because* it is 1988, even if that past is hypertemporally separated from the time traveler.[18] For the friend of A-Theoretic time travel, the hypertemporal discrepancy between the time traveler and the past is irrelevant to the identity of the original past: identity of temporal locations is enough. Lewis's objection does not hit the A-Theoretic model where it hurts *for the A Theorist*. Indeed, by the A-Theorist's lights, time travelers in hypertime models seem to have more direct contact with the past, so conceived, than Lewisian time travelers: they return to the same place that they were not originally, rather than being perennially at that place.[19]

Ironically, Lewis's own famous notion of similarity could easily provide the resources to hold that the facsimile of the past counts as the real past. Consider the A-Theoretic time traveler who returns to the past to meet his playmates. His young friends are exactly as they were years ago. Had Lewis been amenable to hypertime, he might

139) for discussion. See Effingham (2020: pp.79-90) for discussion of a theory of multi-dimensional time that allows for genuine change to past events. See Markosian (2020: 152-158) for an argument against the possibility of time travel to the past in a dynamic theory of time.

[18] Lewis's insistence that hypertemporal separation implies that the time traveler's past isn't the "real" one is particularly strange given that hypertime can be seen as an implementation of his notion of personal time.

[19] See Andreoletti and Torrengo (2019) for a discussion of the immutability of the past in eternalist frameworks.

have held that the first-time-around childhood playmates and the second-time-around childhood playmates were related by qualitative resemblance, much as he holds that cross-world counterpart relations are a matter of resemblance.[20] Just as crossworld counterparts are a substitute for transworld identity, crosstime inhabitants might be a substitute for genuine identity of the past. The resemblance strategy could be applied to presentist, growing block, and moving spotlight theories.

Finally, the friend of A-Theoretic time travel has a more satisfying model of genuine time travel to the future. For she can hold that the future is genuine because it was not yet in existence until the traveler ventured to it. Its unreality is precisely what gives it the openness the future ought to have, and what marks it off as different from the past. The traveler counts as travelling to the future because she does something ontologically substantive in doing so: she moves the location of the objective present for all of reality.

5. The Grandfather Paradox and the Survival Paradox

Recall Lewis's solution to the Grandfather Paradox, which holds that Tim both does and does not have the ability to kill Grandfather. Tim is unable to kill Grandfather relative to a broad set of facts that include Tim's conception; Tim is able to kill Grandfather relative to a local set of facts that includes Tim's unimpeded access to the trigger. This contextualist solution is Lewis's best option given his commitment to eternalism: Tim cannot actually change the past.[21]

One problem with Lewis's eternalist system, however, is that it *must* construe time travel to the future exactly how it construes time travel to the past. Consider the following example:

Bad News: Sophie, who departs the year 2000 in her time machine and arrives in 2025, plans to live out her years in the future from 2025 onwards. Googling herself upon her arrival in 2025, she discovers a reliable news report of her death

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[20] In his (1983), Lewis even hints at acceptance of intraworld counterparts.

[21] Lewis's systematicity is also on display here, as he applies contextualism to many philosophical problems.

in a plane crash in 2010. Does Sophie have the ability to live out her years in

2025, or is she destined to return to the past in order to die in 2010?[22]

In both the future-oriented and the past-oriented cases, the relevant question is whether

the time traveler has the ability to change an event that already occurred. In this way, the

future-oriented *Survival Paradox* is surfacely similar to the past-oriented Grandfather

Paradox.[23] As we easily imagine Tim stalking Grandfather, we can easily imagine Sophie

living out her years in 2025, refusing to go anywhere near a time machine that will send

her back in time to live out the events that cause her death in 2010. But Sophie's death

does occur in 2010. Are Sophie's abilities with respect to avoiding her death the same as

Tim's abilities with respect to killing his grandfather?

  We know what Lewis would say about numerous aspects of the Survival Paradox:

Sophie won't live out her years in the future, just as Tim won't kill Grandfather. As an

eternalist, Lewis is committed to the inevitability of Sophie's eventual re-entry into a

time machine and fatal airplane flight. For her death in 2010 already exists in the block: it

was always going to happen. If Sophie went to the future, it is because she was always

going to be there. There is no "second time around" change to the future, just as there is

no such change to the past. If someone time travels to a particular moment, it is and was

always the case that they were in that moment. As noted before, this holds for the past as

well as the future. Eternalism seems tailor-made for avoiding the second time around

fallacy, since all events that exist do so tenselessly and perennially.

  But time travel with hypertime can handle this desideratum of Lewisian time

travel as well. For though the time traveler moves the location of the objective present for

everyone, each of the time traveler's temporal parts occurs only once in hypertime. In

both Missed Party and in Long Time Machine, each time traveler's parts are represented

in a linear, hyperchronological succession in hypertime. There is repetition of events in

time, but there is no repetition of events in hypertime. Moreover, A-Theoretic time travel

avoids "second time around" as well as Lewis's own eternalist theory, since there is no

change to the original temporal manifold. In time travelling, the traveler causes the

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[22] For a television depiction of this sort of scenario, see *The Twilight Zone* Season 1 Episode 18, "The Last Flight".

[23] See Garrett (2016) pp. 251-252 for discussion of a similar case.

generation of new portions of existence in hypertime. Not only can hypertime time travelers change the past without paradox, but they can also change the future.[24]

 As to Sophie's abilities with respect to avoiding her death in 2010, Lewis's contextualist solution provides his answer. Relative to a broad set of facts that encompasses Sophie's 2010 death, Sophie does not have the ability to avoid getting back into the time machine in order to take the fatal flight. With respect to the narrower set of facts encompassing Sophie's moments in 2025, Sophie is able to avoid getting into the time machine for each of those moments.

Lewis's contextualist strategy handles the dissimilarity between the cases by stipulating different senses of ability. The sense in which it is impossible for Tim to kill his grandfather is not the same sense in which it is impossible for Sophie to live out her years in 2025. In the former case, Tim essentially prevents himself from existing. The difference is that Tim killing Grandfather is inconsistent with his own existence, whereas Sophie's survival is merely incompatible with the fact that the death does, in fact, occur.

But *should* the Grandfather Paradox and the Survival Paradox be treated similarly? No, I suggest. The relationship between Tim's stalking Grandfather and Grandfather's survival is different than the relationship between Sophie's reentry into the time machine and Sophie's death. The differences between the cases should be taken seriously, and Lewis's eternalist framework cannot accommodate the important differences.

The first difference between the cases is that the Grandfather Paradox involves self-defeat whereas the Survival Paradox involves self-perpetuation. Tim cannot kill his grandfather because the existence of his grandfather is a prerequisite for Tim's own existence. But Sophie's survival in 2010 is not a prerequisite for her arrival in 2025, since the latter occurs in the personal time of the time traveler. This is due to a causal difference between the cases: Tim's grandfather is a necessary part of the causal chain leading to Tim's existence, and thus his arrival in the past, whereas Sophie's death in 2010 is plausibly causally independent of her arrival in 2025. Sophie essentially branches from, and skips over, the causal process leading to her death. The inconsistency generated

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[24] See Bernstein (2017) for discussion of determinism in hypertime models. If these models are deterministic, then the time traveler is not genuinely free to change the future. However, this problem is just a more specific instance of the problem of free will, not a particular problem for the theory.

by Tim removing his own causal prerequisite is different than the inconsistency generated by Sophie's death and survival.

The myriad coincidences that are present in the Grandfather Paradox are harder to explain in the Survival Paradox. Arguably, the coincidences and conspiracies are less plausible in the future-oriented case than in the past-oriented case. The universe must conspire for Tim to fail to kill Grandfather, throwing in Tim's path a jammed weapon or the famous slippery banana peel. But the necessary conspiracy looks more elaborate and less likely in the future-oriented version of the case: the universe must conspire to put Sophie back into the time machine. There goes Sophie, quietly living out her years in 2025, remaining ever-vigilant about her distance from the time machine. But here and there, various circumstances conspire to put her nearer to the time machine, so that she might enter and eventually take her fateful flight. Sophie's death requires a more fanciful conspiracy than the survival of Grandfather, who simply requires a slip of Tim's trigger finger or an ill-timed slip on a banana peel.

One reason the Survival Paradox is troubling is that Lewis holds that Tim's numerous failures are due to bad luck. In a 1977 letter to Jonathan Bennett, Lewis writes:

> "I think it is possible that *any amount* of failure, and even any amount of failure unified by a pattern of frustration in trying to depart from the scenario, is explained by miscellaneous bad luck and nothing else. It is possible – it is true at some worlds – it is true in stories that represent such worlds. So a thorough story about time travel *does not* need to include something special, and unitary, as a defense against 'paradoxes'. Of course a thorough story can include a special, unitary defense—what I called a 'chaperone to protect the past'—and this could work in one of the ways you consider. But I think the most interesting sort of thorough story is one in which the traveler's repeated attempts to depart from the scenario are frustrated by nothing but miscellaneous bad luck." (Letter 240. To Jonathan Bennett, 29 March 1977, in Beebee and Fisher (2020), pp 470-72)

The problem is that Tim's numerous failures to kill grandfather are much easier to classify as minor strokes of bad luck than the forces conspiring to place Sophie back into

the time machine. There is more pressure to accept an improbable 'chaperone' as the explanation in the future-based case than in the past-based case. Even given the theoretical and conceptual strangeness of time travel, it would be best to avoid accepting such an outlandish posit.

The explanatory burden generated by the Survival Paradox is borne out by further differences between the past and future-based cases. The Grandfather Paradox involves the ability to act (to kill Grandfather), whereas the Survival Paradox involves the ability to omit (to fail to reenter the time machine and return to one's place of death). It is easy to conceive of obstacles to a "positive" action like pulling a trigger; it is arguably more difficult to independently justify obstacles to the particular omissive activities in the example, like Sophie refusing to leave her home.[25]

A-Theoretic time travel nicely handles the difference between the Grandfather Paradox and the Survival Paradox due to the built-in asymmetry between the past and future. The A-theorist need not treat the cases the same way: the time traveler in the past-facing case has one set of abilities and the time traveler in the future-facing case has another set of abilities. The time traveler can legitimately intervene in the past thanks to her ability to rewind the block to her desired point of intervention. And the time traveler can fast-forward the generation of the block to her desired point of intervention in the future. In both cases, changes to the past and future do not generate the same inconsistencies that they do in the eternalist manifold: time travel to the past is legitimate "second time around" time travel, and time travel to the future brings about the very existence of the world the time traveler seeks to change.

6. Conclusions

This discussion has suggested that many central aspects of David Lewis's theory of time travel can be preserved in a non-eternalist framework, and that the non-eternalist framework is in many ways preferable to Lewis's own theory. Though Lewis explicitly repudiates hypertime across his writing, letters, and lectures on the topic, time travel with

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[25] One solution is for Lewis to simply concede this point, since time travel is so strange in the first place. Perhaps accounting for such intuitions is, in his oft-used phrase, "spoils to the victor."

hypertime provides a rich ontological basis for implementing many of Lewis's own ideas about time travel, and it is better able to handle cases of time travel to the future.[26]

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