Philosophy and
Phenomenological Research

Philosophy and Phenomenological Research
Vol. XCIX No. 2, September 2019
doi: 10.1111/phpr.12514

Self-Locating Evidence and the Metaphysics of Time

DAVID BUILES
Massachusetts Institute of Technology

For most metaphysical debates, ordinary observational evidence seems to be irrelevant. Intuitively, ordinary observational evidence can neither confirm nor disconfirm the existence of abstract objects, the existence of tropes or universals, the existence of arbitrarily scattered mereological fusions, etc. Arguments for these views tend to be at a very abstract, theoretical level. They are rarely of the following form: conditional on metaphysical theory X, we should expect to observe O_1. Conditional on ~X, we should expect to observe O_2, with $O_1 \neq O_2$. We have in fact observed O_1, so we should raise our credence in X. The goal of this paper is to argue that ordinary observational evidence *can* directly confirm or disconfirm the two major positions in the metaphysics of time, Presentism and Eternalism, in exactly this way. There are cases where we should expect to observe different things depending on whether Eternalism or Presentism is true.

Presentism is the view that only present things exist, and so reality is three-dimensional. Eternalism is the view that objects from both the past and the future exist just as much as present objects, and so reality is four-dimensional. I will be considering an orthodox version of Eternalism according to which no time is objectively privileged as having the primitive property of *being present*. I will be setting aside the Growing Block theory, according to which only past and present objects exist, and the Moving Spotlight theory, according to which all past, present, and future objects exist but a specific time, the present, is objectively privileged.

If my thesis is right, that Presentism and Eternalism make different observational predictions, it puts pressure on a certain skeptical view about the entire debate between Eternalists and Presentists. According to one kind of skeptic, the debate between Eternalists and Presentists is 'merely verbal'.[1] Note that if 'exists' means 'exists now', then it's trivial that, say, 'Dinosaurs exist' is false, contra the Eternalist. If 'exists' means 'once existed or now exists or will exist', then it's trivial that 'Dinosaurs exist' is true, contra the Presentist. The skeptic then argues that it's very unclear what 'exists' could possibly mean that makes the dispute over 'Dinosaurs exist' interesting and non-trivial.[2] However,

[1] Sider (2006) aptly characterizes this skeptical view and argues against it.

[2] For a recent defense of the view that there is no fact of the matter between Eternalism and Presentism, see Balaguer (2014). The genuineness of the presentism/eternalism debate is also discussed in Crisp (2003, 2004) and Ludlow (2004).

if I am right that both views make different observational predictions, then even hard-core logical positivists will accept that the debate is substantive!

There are two main existing arguments regarding Presentism and Eternalism that are roughly empirical in character (although they are not at all as direct as the above template), so it is worth saying why the arguments in this paper are of an entirely different character than these. First, some authors have argued that general facts about our conscious experiences spell trouble for Eternalism, because our conscious experience can only be accounted for by a theory that recognizes 'objective becoming'. These sorts of arguments are highly contentious, and my arguments will not appeal to any controversial claims regarding conscious experience.[3] Another very popular argument in favor of Eternalism appeals to Special and General Relativity, according to which, on the standard interpretation, there are no objective facts about which events are simultaneous with which others. There are two worries about this style of argument that my arguments will avoid. First, there is some controversy about whether Quantum Gravity, which is supposed to supersede Special and General Relativity, will posit objective facts about which events are simultaneous with which others.[4] Second of all, one can make Special and General Relativity consistent with Presentism by positing a privileged reference frame (for example, see Prior (1972), Crisp (2007), and Markosian (2004)).[5] Call this version of Presentism, which takes on board Special and General Relativity by positing a privileged foliation of space-time, Presentism*. There doesn't seem to be any ordinary observational evidence that can directly confirm Presentism* over Eternalism. My arguments avoid the first problem because they don't presuppose any controversial assumptions about a finalized physics. My arguments avoid the second problem because I will provide an explicit case where ordinary observational evidence *can* confirm or disconfirm Presentism* over Eternalism (Section 3).

Here is a roadmap for the paper. In Section 1, I will review some necessary basic distinctions (de dicto/de se and centered/uncentered worlds), and I will introduce the three basic ways of dealing with self-locating evidence by considering the three main responses to the classic Sleeping Beauty problem. In Section 2, I give the intuitive reason why self-locating evidence should be relevant to the debate between Presentism and Eternalism. In Sections 3-5, I present three distinct cases which cumulatively show that everyone should believe that self-locating evidence can be brought to bear on Presentism* vs Eternalism (in a relativistic setting) and Presentism vs Eternalism (in a classical setting). Lastly, in Section 6, I conclude with some morals of my argument.

1. Centered and Uncentered Worlds

Since my arguments will be appealing to self-locating evidence, we must first recall some basic distinctions. Following Lewis (1979), distinguish between *de dicto* beliefs and *de se* beliefs. De dicto beliefs characterize what reality is like in non-indexical terms. They are the sort of information that you would find in a complete 'map' of reality. Examples of de dicto beliefs include the belief that the earth orbits the sun, the belief that smoking

[3] For a rebuttal of some of these arguments, see Skow (2011).

[4] For some reason to think that it might posit such facts, see Monton (2006).

[5] It is worth noting, however, that there are some models of General Relativity for which this trick won't work (e.g. models with closed time-like curves can't have a privileged foliation of Cauchy slices).

causes cancer, and the belief that there are more than a billion humans. If two agents have the same de dicto belief, either both are right or both are wrong. However, we don't just have beliefs about which 'map' of reality is the correct one. We also have beliefs about our own location on the map. These are our *de se* beliefs. Examples of de se beliefs include the belief that I am now in California or that I am near a bank. They are the sort of information characterized by the 'you are here' sign on a map. Contrary to de dicto beliefs, if two people believe the de se content expressed by 'I am in Australia', one might be right and one might be wrong.

The content of de dicto beliefs may be represented using uncentered propositions, or sets of uncentered worlds. Uncentered worlds are maximal non-indexical specifications for a way reality can be. The content of de se beliefs may be represented using centered propositions, which are sets of centered worlds. I will take centered worlds to be ordered pairs consisting of an uncentered world w together with the spatiotemporal location of an individual in w.

There are three main updating rules that have been proposed for how one's credences ought to change in response to self-locating evidence, which correspond to the three most popular responses to the classic Sleeping Beauty problem. First, recall the setup of the case:

> Sleeping Beauty: Beauty is a perfectly rational agent who is told that the following events will occur. On Sunday, she will be put to sleep. A fair coin will then be tossed. If it lands Heads, she will be awakened on Monday morning. Later, in the evening, she will be told that it is Monday, and then she will be let go. If the coin lands Tails, as before, Beauty will be awakened on Monday morning, and then she will be told that it is Monday later that evening. However, instead of being let go, she will be given a memory-loss drug that will make her forget all of her memories of Monday, and she will be put back to sleep. She will then be awakened on Tuesday, and then she will be let go. Her wakings on Monday and Tuesday will be indistinguishable. When she first awakens on Monday morning, what should her credence be that the coin landed Heads? When she is subsequently told that it is Monday, on Monday evening, what should her credence be that the coin landed Heads?

According to Thirders, Beauty's credence should be 1/3 in the morning and 1/2 in the evening (e.g. Dorr 2002, Elga 2000, and Titelbaum 2008). According to Lewisian Halfers, Beauty's credences should be 1/2 then 2/3 (e.g. Lewis 2001 and Bradley 2011). According to Double Halfers, Beauty's credences should be 1/2 in the morning and evening (e.g. Bostrom 2007 and Meacham 2008). For details about how to generalize these three positions to three generalized updating rules, see Briggs (2010), Meacham (2008), and Pettigrew (MS).

These three different views will respond differently to the cases I will present below. For each case, I will make sure to explain why each of the three positions responds in the way that it does. In my explanations, I will crucially be appealing to the bolded principles below.

First, consider the Double Halfer. The Double Halfer treats centered and uncentered information very differently. For the Double Halfer, one's credence in an uncentered proposition should only change when one receives evidence that rules out uncentered possibilities. In other words, the Double Halfer endorses what Titelbaum (2008) calls the Relevance Limiting Thesis:

> **Relevance Limiting Thesis**: Evidence that does not rule out any uncentered possibilities should not change one's credence in any uncentered proposition.

However, Double-Halfers will endorse the following principle:

> **Uncentered Elimination**: For any two incompatible and jointly exhaustive uncentered propositions H_1 and H_2, if E eliminates some uncentered possibilities in which H_1 is true (which are assigned some non-zero credence) but does not eliminate any uncentered possibilities in which H_2 is true, then upon learning E one's credence in H_2 should increase and one's credence in H_1 should decrease.[6,7]

Second, consider the Thirder and Lewisian Halfer. The updating rules that generalize the Lewisian Halfer and Thirder position treat centered and uncentered information similarly. For my purposes, I only need the following claim:

> **Standard Conditionalization**: For any two propositions H_1 and H_2 that are mutually exclusive and jointly exhaustive, and any other proposition E (which may be a centered proposition), if $Cr(E \mid H_1) < Cr(E \mid H_2)$, then updating on E should raise one's credence in H_2 and lower one's credence in H_1.[8]

2. The Intuitive Case

I will be arguing that self-locating evidence can be brought to bear on the debate between Eternalists and Presentists. At first, this seems like an extremely strange result. Surely self-locating evidence can't be brought to bear on other metaphysical issues like the existence of abstract objects or the correct view of mereology. Why should the metaphysics of time be any different? The crucial observation is that *Presentists and Eternalists disagree about whether facts about what time it is are merely indexical facts.* Given that different updating procedures handle indexical and non-indexical information very differently, it should come as no surprise that some updating procedures can tease Presentism and Eternalism apart.

Here is an example. Suppose I know that there are three agents that are subjectively indistinguishable from each other that are located at different times and places in the world. I know that I am one of the three agents, but I don't know which I am. Two of them are simultaneous with each other and live in the year 2000 (perhaps I know one lives on Earth and the other lives on Twin Earth), and a third will live a thousand years after the first two, in the year 3000. For the Eternalist, this situation is described by having one uncentered four-dimensional possibility with three different epistemically possible centers of me. For the Presentist, this description is inadequate. For the Presentist, reality is three-dimensional, not four-dimensional. So, there are *two* distinct three-dimensional

---

6 Both **Relevance Limiting Thesis** and **Uncentered Elimination** are consequences of the updating rule that generalizes the Double Halfer position. For details, see Briggs (2010) and Meacham (2008). Briggs calls the generalized rule the 'Halfer Rule' and Meacham calls the generalized rule 'Compartmentalized Conditionalization'. Both rules are equivalent.

7 Purely for the sake of simplicity, in the cases below I will be assuming that Presentism and Eternalism are jointly exhaustive.

8 **Standard Conditionalization** is a consequence of the updating rules that generalize the Thirder and Lewisian Halfer positions. In Meacham's (2008) terminology, this is because Thirders and Lewisian Halfers endorse 'Centered Conditionalization'. In Sleeping Beauty, Thirders and Lewisian Halfers use **Standard Conditionalization** when they increase their credence that the coin will land Heads when they are told that 'It is Monday' on Monday evening.

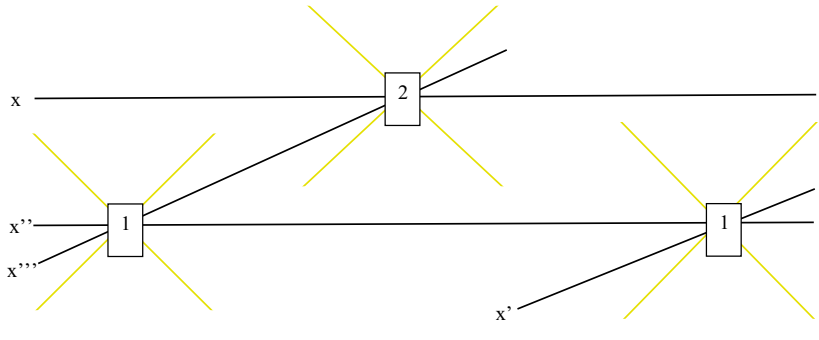
ways reality can be. I can either be in the three-dimensional uncentered possibility in which the year 2000 is present, or I can be in the three-dimensional uncentered possibility in which the year 3000 is present is actual. The first three-dimensional uncentered possibility has two epistemically possible centers of me, and the second uncentered world has one epistemically possible center of me. There just is no three-dimensional reality with three existing centers in it. In sum, *for the Presentist uncentered possibilities are three-dimensional (since reality itself is three-dimensional), and for the Eternalist uncentered possibilities are four-dimensional (since reality itself is four-dimensional).* Alternatively, we can put the difference as follows. For the Eternalist, facts about what time it is are purely *indexical* facts (and hence part of our de se beliefs). Facts about what time it is are just facts about what time the agent is located. However, for the Presentist, there is an *objective, non-indexical* distinction between what time *exists* and which times don't exist. Facts about what exists are paradigmatic de dicto facts.

Since Presentists and Eternalists differ on how to divide the world into its centered and uncentered parts and different updating procedures treat centered and uncentered information differently, it should come as no surprise that different updating procedures can tease apart Presentism and Eternalism. Even if this very abstract general point is currently unclear, hopefully it will become clearer when considering the three concrete cases below.

3. A Relativistic Case for Everyone

The following case distinguishes Presentism* and Eternalism for everyone: Thirders, Lewisian Halfers, and Double Halfers. It is set in the context of Special Relativity:

> Three Relativistic Rooms: Suppose there are three indistinguishable rooms. You know that you are in one of the rooms, and the other two rooms have subjective duplicates of you inside them. Two of the rooms have a '1' on the outside and the other has a '2' on the outside. You know that the rooms are each space-like separated from each other (so that any pair of rooms exists at the same time according to some inertial frame of reference), but there is no inertial frame of reference in which all three rooms exist at the same time. From your perceptual evidence, you know that you are in one of these rooms, but you don't know which room you are in.



In the figure above, the four black lines correspond to the four different kinds of candidates for the 'objective present' for the Presentist*, while the yellow lines correspond to light-cones centered on each of the rooms. Intuitively, the left-right direction corresponds to space, and the up-down direction corresponds to time. So, the vertical lengths of the rooms correspond

to how long in time the rooms exist for. For the Eternalist, the case involves one four-dimensional uncentered possibility with three centers in it. For the Presentist*, there are four different kinds of three-dimensional uncentered possibilities, corresponding to the four different kinds of candidates for the objective present. These four candidates are as follows:

(x) Only one '2' room exists.

(x') Only one '1' room exists.

(x'') Only two '1' rooms exist.

(x''') One '2' room exists and one '1' room exists.

First, let us consider the case from the point of view of the Double Halfer. Our crucial question for all of these cases will be the following: how should your credences change in Eternalism versus Presentism when you walk outside your room and observe which number is outside your room? Note that when you walk outside your room and observe your corresponding number, no uncentered Eternalist possibilities are eliminated. You will only eliminate either the '1' centers or the '2' center in the single uncentered Eternalist possibility. However, no matter what number you observe on your door, you *will* eliminate uncentered three-dimensional Presentist* possibilities. If you observe a '1', you will eliminate possibility (x). If you observe a '2', you will eliminate possibilities (x') and (x''). Therefore, no matter what you will see, you will not eliminate any uncentered Eternalist possibilities, and you will eliminate uncentered Presentist* possibilities. So, by **Uncentered Elimination**, no matter what you observe, your credence in Eternalism should increase and your credence in Presentism* will decrease, as desired.[9]

Next, we will be able to consider the case from the point of view of Thirders and Lewisian Halfers together. Given Eternalism, there is just one four-dimensional world with three centers in it. Almost everyone in the Sleeping Beauty literature accepts the following 'highly restricted' principle of indifference (Lewis 2001: 172):

> **Center Indifference**: If a single uncentered possibility has finitely many epistemically possible centers, one ought to divide one's credence equally among those centers.[10]

So, letting Cr be your credence function before you see the number outside your room, you should set Cr(There's a '1' on your door | Eternalism) = 2/3.

Next, what should the value of Cr(There's a '1' on your door | Presentism*) be? Conditional on Presentism*, you are ignorant about which kind of three-dimensional reality you are in. Suppose you have credences c_x, $c_{x'}$, $c_{x''}$, $c_{x'''}$ in the possibilities (x)-(x''') above. So, $0 \leq c_x, c_{x'}, c_{x''}, c_{x'''} \leq 1$ and $c_x + c_{x'} + c_{x''} + c_{x'''} = 1$. Then, the likelihood

[9] Yes, this is a reflection violation. Reflection violations are common place in self-locating cases. In the original Sleeping Beauty case, Thirders also face a reflection violation since on Sunday they know their credence that the coin will land Heads will drop when they wake up. Lewisian Halfers also know on Sunday that on Monday evening their credence that the coin will land Heads will rise to 2/3.

[10] The restriction to the finite case is to avoid conflicting with Countable Additivity. I will not be needing the countable version of the principle anywhere in this paper.

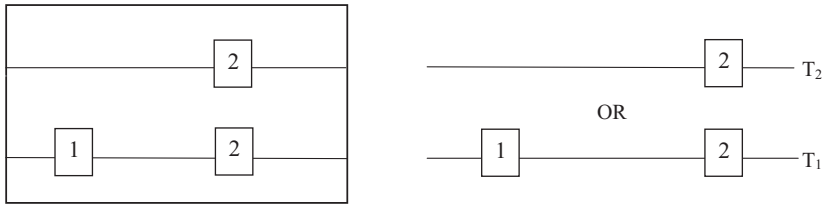
that there is a '1' on your door given these credences is $c_{x'} + c_{x''} + (c_{x'''}/2)$. This is true since given (x), there are no rooms with a '1' on them. So, the likelihood that your room has a '1' is 0. Given (x') or (x''), there are only rooms with a '1' on them, so the likelihood your room has a '1' is 1. Lastly, given (x'''), the likelihood is 1/2 that your room has a '1' on it since there is one room with a '1' and one room with a '2'. Since, in almost every case, $c_{x'} + c_{x''} + (c_{x'''}/2) \neq 2/3$, it follows that in almost every case Cr (There's a '1' on your door | Presentism*) $\neq$ Cr(There's a '1' on your door | Eternalism). Similarly, in almost every case, Cr(There's a '2' on your door | Presentism*) $\neq$ Cr (There's a '2' on your door | Eternalism). So, when you step outside your room and observe a particular number, after conditionalizing on you observing that number, Thirders and Lewisian Halfers agree that, in almost every case, your credences in Eternalism and Presentism* should change, by **Standard Conditionalization**.

4. A Finite Classical Case for Lewisian Halfers and Double Halfers

Next, consider the following Sleeping Beauty-like case in a classical, non-relativistic setting:

> Three Rooms: Suppose you are told that the following events will occur. On Sunday, you will be put to sleep and will never be woken up again. While you are asleep, three perfect sleeping duplicates will be made of you. These three duplicates will be placed in three different rooms, each of which are indistinguishable from the inside. Two of the duplicates will be woken up at noon on Monday, and then let go. The third duplicate will be woken up at noon on Tuesday, and then let go. The room which contains the duplicate that will be woken up on Tuesday has the number '2' written on the outside of the room. One of the rooms which contains a duplicate that will be woken up on Monday has the number '1' written on the outside, and the other room has the number '2' written on the outside.

Since all these rooms are indistinguishable, the duplicates will not know which room they are in when they wake up. For the Eternalist, there is only one four-dimensional uncentered possibility with three possible centers in it. For the Presentist, there are two three-dimensional uncentered possibilities, one with two centers and one with one center.



Eternalism Presentism

First, let us consider the situation from the perspective of the Double Halfer. Much of what was said in the last section still holds true. No matter what you observe when you walk outside your room and observe your corresponding number, you will not eliminate any Eternalist uncentered possibilities. However, if you observe a '1', you will eliminate

one Presentist possibility. In particular, you will eliminate the three-dimensional uncentered possibility in which there is only one '2' room. If you observe a '2' on the other hand, you will eliminate no uncentered possibilites. So, our verdict is as follows. For the Double Halfer, if you observe a '1', your credence in Eternalism should increase and your credence in Presentism should decrease (by **Uncentered Elimination**). If you observe a '2', your credences in Eternalism and Presentism should remain the same, since in either case you don't eliminate any uncentered possibilites (by **Relevance-Limiting Thesis**)

Next, let us analyze the case from the perspective of Thirders and Lewisian Halfers together. As before, everyone agrees that you should set Cr(There's a '1' on the outside of your room | Eternalism) = 1/3 and Cr(There's a '2' on the outside of your room | Eternalism) = 2/3, by **Center Indifference**.

The case under Presentism is trickier. For the Presentist, one uncentered possibility T_1 is the three-dimensional world in which it is Monday. Another uncentered possibility T_2 is the three-dimensional world in which it is Tuesday. In T_1, there are two relevant centers, and in T_2, there is only one relevant center. *Note that this is structurally identical to the Sleeping Beauty problem*. In Sleeping Beauty, there are also two relevant uncentered possibilities (corresponding to Heads and Tails), where one of the uncentered possibilities has one center and the other uncentered possibility has two centers. T_2 is similar to the possible world where Heads is flipped, since it only has one center, and T_1 is similar to the possible world where Tails is flipped, since it has two centers. Because of this structural similarity, I believe that Thirders and Lewisian Halfers should treat Three Rooms (given Presentism) similarly to Sleeping Beauty.

The one disanalogy between Sleeping Beauty and Three Rooms is that in Sleeping Beauty, there is an objective chance of 1/2 that the Heads (or Tails) world is actual because of the fair coin, but there are no objective chances at work in Three Rooms. In response, it should be noted that Sleeping Beauty need not involve any objective chances. For example, suppose on Sunday Beauty had credence 1/2 that it rained in Boston on Saturday, and the experimenter told her that he would wake her up either once or twice depending on if it rained in Boston on Saturday. The case should be treated similarly even though there is no objective chance involved. Thirders should think that on Monday Morning Beauty's credence in the proposition that it rained in Boston on Saturday should deviate from 1/2, and Lewisian Halfers should think it should stay at 1/2.

According to the generalized updating procedure for Thirding developed in Briggs (2010), Pettigrew (MS), and Meacham (2008), what really matters in Sleeping Beauty is that Beauty assigns 1/2 to Heads *conditional on the uncentered portion of her evidence* on Monday Morning. An agent's 'uncentered portion of her evidence' only consists in all of the *uncentered* worlds that the agent has ruled out. For example, Beauty's uncentered portion of her evidence is the same on Sunday night and on Monday morning, since Beauty does not rule out any uncentered worlds on Monday morning. Beauty only learns the indexical fact 'it is now either Monday or Tuesday' when she wakes up, which does not rule out any uncentered worlds. Thirders then think that this additional indexical fact should *decrease* Beauty's credence in Heads given only the uncentered portion of her evidence. Lewisian Halfers believe that this additional indexical fact should *not* change Beauty's credence in Heads given only the uncentered portion of her evidence.

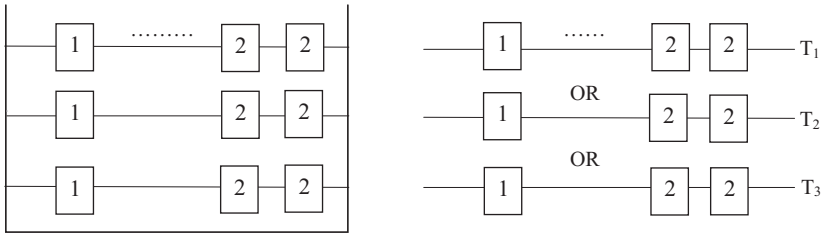
So, to make the Sleeping Beauty case analogous to our Three Rooms case, I will stipulate that *when the duplicates wake up their credence in T_1 conditional on the uncentered portion of their evidence is 1/2* (analogously, when Beauty wakes up her credence in Tails conditional on the uncentered portion of her evidence is also 1/2). It's worth mentioning that this stipulation is extremely natural. Since the uncentered portion of the duplicate's evidence is roughly *there is a room with an agent having experiences like such-and such*, this evidence is entirely neutral between T_1 and T_2. Given that this uncentered evidence doesn't favor either T_1 or T_2, natural indifference reasoning would suggest that the agent's credence in T_1 conditional on this evidence should be 1/2 anyway.

So, I have argued that, given this stipulation, the Sleeping Beauty case and our Three Rooms case should be treated similarly. In particular, the Thirder should believe that the Presentist should have credence 1/3 in T_2 and 2/3 in T_1, since, roughly speaking, the Thirder 'weighs' uncentered possibilities by how many relevant centers it has (similarly, the Thirder assigns 1/3 to Heads and 2/3 to Tails in Sleeping Beauty). This would have the consequence that the Thirder should think that Cr(There's a '1' on the outside of your room | Presentism) = 1/3 (using **Center Indifference**), which is the same as the Eternalist conditional credence above. However, the Lewisian Halfer should believe that the Presentist should have credence 1/2 in T_1 and 1/2 in T_2 (similarly, the Lewisian Halfer assigns 1/2 to Heads and 1/2 to Tails in Sleeping Beauty). This will have the consequence that the Lewisian Halfer should think that Cr(There's a '1' on the outside of your room | Presentism) = 1/4. So, since Cr(There's a '1' on the outside of your room | Eternalism) > Cr(There's a '1' on the outside of your room | Presentism), if you see a '1' on the outside of your room when you exit you should increase your credence in Eternalism over Presentism. If you see a '2' on the outside of your room when you exit, you should increase your credence in Presentism over Eternalism (by **Standard Conditionalization**).

5. An Infinite Classical Case for Thirders and Lewisian Halfers

The following is a case that, I believe, distinguishes Presentism and Eternalism for both Thirders and Lewisian Halfers:

> Infinite Rooms: Suppose you know that the world is such that there are infinitely many times $t_1 < t_2 < t_3 < \ldots$, where for each t_i there are three indistinguishable rooms, one with a '1' on the outside and two with a '2' on the outside. All of the rooms across different times are also indistinguishable, and they each have subjective duplicates of you. You don't know what time it is or what room you are in.



Eternalism Presentism

From the perspective of a Double Halfer, you will not change your credences in Presentism or Eternalism no matter what you see, because no matter what you see you will not eliminate any uncentered possibilities (by **Relevance-Limiting Thesis**).

Next, let us consider the case from the perspective of Thirders and Lewisian Halfers. This time, Thirders and Lewisian Halfers will agree on all of the conditional probabilities. We will start with the case of Presentism since it is easier. What should the value of Cr(There's a '1' on the outside of your room | Presentism) be? Well, conditional on Presentism, *you know for certain that there are exactly three rooms*, and that one of them has a '1' on it and the other two have a '2' on them. So, it seems natural to set Cr (There's a '1' on the outside of your room | Presentism) = 1/3 and Cr(There's a '2' on the outside of your room | Presentism) = 2/3. This natural thought also follows from **Center Indifference** together with the standard axioms of probability (including the axiom of Countable Additivity). Let T_i be the uncentered proposition that time t_i is the objective present. Then, in the context of this setup, Presentism is equivalent to $T_1 \vee T_2 \vee T_3 \vee \ldots$ Note that the T_i are mutually exclusive. By **Center Indifference**, Cr(There's a '1' on the outside of your room | T_i) = 1/3 for any *i*. From the probability axioms, it therefore follows that Cr(There's a '1' on the outside of my room | Presentism) = Cr (There's a '1' on the outside of your room | $T_1 \vee T_2 \vee T_3 \vee \ldots$) = 1/3, as desired.

What should the value of Cr(There's a '1' on the outside of your room | Eternalism) be? It's hard to say. You have credence 1 that there exists infinitely many rooms that you could be in that have a '1' on them, and you have credence 1 that there exists infinitely many rooms that you could be in that have a '2' on them. If one were to naively apply **Center Indifference** (ignoring its restriction to finite cases), then one would get the result that your credence should be undefined, since 'infinity / (infinity + infinity)' doesn't make any sense. In the absence of any such norm to follow, one natural thought is that 'anything goes' in a situation like this. In particular, perhaps it is permissible to assign any credence at all to Cr(There's a '1' on the outside of your room | Eternalism). If this is correct, then the difference between Presentism and Eternalism is secured, since the likelihood of observing a '1' conditional on Presentism is determinately 1/3, while the likelihood of observing a '1' conditional on Eternalism can be anything. So, in almost every case, these likelihoods will differ.

However, you might think that you should have credence 1/3 even under Eternalism, because it's most 'natural' or 'simple' to group up the rooms in terms of the time slices they are at. Using this grouping, one can use a limiting frequency argument to justify staying at 1/3. This would probably be the position endorsed by Cian Dorr and Frank Arntzenius (forthcoming), according to their 'compromising approach'. Roughly speaking, the compromising approach says that reasonable credences will be 'generated by taking a weighted average of the credences that result from the different simple [groupings], in which the simpler ones get weighted more heavily' (29). This view, together with the claim that the above grouping is the only simple grouping there is for the case, would entail that your credence should be 1/3. The proposal raises obvious follow up questions about the nature of naturalness and simplicity. However, rather than following this line, one can concoct a case where even the compromising approach ought to say that your credence should not be 1/3.

Let us modify the case to account for the *spatial* positions of the rooms as follows. Suppose there are countably many planets p_1, p_2, p_3, ... that are 'lined up' in a row. Stipulate that the case is such that each planet only ever has one of the rooms in

question, where p_i has a room with a '2' on it if and only if i is divisible by 10. If the case is modified like this, everyone should admit that one natural credence function for the Eternalist to have is 9/10, for the very same reasons that 1/3 is natural. Namely, we can group the rooms up in terms of what planet they are on, and then we can just do a limiting frequency argument. Surely the compromising approach will give *some* non-zero weight to this credence. In which case, the Eternalist ought to have a credence strictly between 1/3 and 9/10 that they will observe a '1'. Therefore, they will have a different likelihood of observing a '1' than the Presentist, as desired.

6. Some Morals

Let us take a step back from these cases and review the upshot of all of this. I have argued that, unlike most metaphysical debates, Eternalism and Presentism make different observational predictions. In other words, there are cases where ordinary observational evidence (like looking at a number on a door) should make one increase (or decrease) one's credence in Eternalism over Presentism. I have done this by considering three different cases which cumulatively show that Thirders, Lewisian Halfers, and Double Halfers should all agree both that Presentism and Eternalism make different observational predictions and that Presentism* and Eternalism make different observational predictions (note that all three of the cases are needed for this conclusion). I take this result on its own to be intrinsically interesting and counter-intuitive. However, I believe it also has some important morals.

First, if the above arguments are sound, suspicions that the debate between Eternalism and Presentism is 'merely verbal' are not justified. Theories that are mere notational variants cannot be directly confirmed or disconfirmed in different ways by ordinary empirical, observational evidence. Therefore, the debate in the metaphysics of time is substantive.

Second, I have argued that there is a quite strong connection between the metaphysics of time and puzzles about self-locating credences. This has the result that puzzle cases in the literature on self-location are often under-described. The three cases above show that one's credences in a particular self-locating case are sensitive to one's credences in Presentism and Eternalism. In effect, it seems that most of the self-location literature has implicitly assumed that the agents all have credence 1 that Eternalism is true. For example, in Sleeping Beauty, authors typically describe the case as having two uncentered possibilities (Heads and Tails), with one uncentered possibility having two epistemically possible centers and the other uncentered possibility having one epistemically possible center. This is simply false if Presentism is true. If Presentism is true, there are three uncentered possibilities (Heads and Monday, Tails and Monday, and Tails and Tuesday), each of which has one epistemically possible center.

Lastly, I suspect that many readers will be suspicious of the argument in this paper because of its counterintuitive conclusion. It just seems wrong that looking at numbers on doors should be able to give one evidence about the metaphysics of time! Perhaps, since authors in the Sleeping Beauty literature seem to be presupposing Eternalism, the three updating procedures considered here should only be considered valid under Eternalism.[11] If this is right, then we are in need of a completely general self-locating updating procedure that is valid under different hypotheses about the metaphysics of time. One

[11] Thanks to an anonymous referee for this suggestion.

might then hope that the true general updating procedure, whatever it is, will not have the consequence that Presentism and Eternalism make different observational predictions. At the very least, then, I hope that the arguments in this paper motivate the development of such an updating procedure.[12]

References

Arntzenius, Frank & Dorr, Cian. Forthcoming. Self-locating Priors and Cosmological Measures. In Khalil Chamcham, John Barrow, Simon Saunders & Joe Silk (eds.), *The Philosophy of Cosmology*. Cambridge University Press.

Balaguer, Mark. 2014. Anti-Metaphysicalism, Necessity, and Temporal Ontology. *Philosophy and Phenomenological Research* 89, no. 1: 145–167.

Bostrom, Nick. 2007. Sleeping Beauty and Self-Location: A Hybrid Model. *Synthese* 157, no. 1: 59–78.

Bradley, Darren. 2011. Self-Location Is No Problem for Conditionalization. *Synthese* 182, no. 3: 393–411.

Briggs, Rachael. 2010. Putting a Value on Beauty. In Tamar Szabo Gendler and John Hawthorne (Eds.), *Oxford Studies in Epistemology, Volume 3*. Oxford University Press, 3–34.

Crisp, Thomas. 2003. Presentism. In *The Oxford Handbook of Metaphysics*, edited by Michael J. Loux and Dean W. Zimmerman. Oxford University Press.

——. 2004. Reply to Ludlow. *Oxford Studies in Metaphysics* 1: 37–46.

——. 2007. Presentism, Eternalism and Relativity Physics. In W. Craig and Q. Smith (Eds.), *Einstein, Relativity and Absolute Simultaneity*, New York: Routledge: 262–278

Dorr, Cian. 2002. Sleeping Beauty: In Defence of Elga. *Analysis* 62, no. 4: 292–296.

Elga, Adam. 2000. Self-Locating Belief and the Sleeping Beauty Problem. *Analysis* 60, no. 2: 143–147.

Lewis, David. 1979. Attitudes de Dicto and de Se. *Philosophical Review* 88, no. 4: 513–543.

——. 2001. Sleeping Beauty: Reply to Elga. *Analysis* 61, no. 3: 171–76.

Ludlow, Peter. 2004. Presentism, Triviality, and the Varieties of Tensism. *Oxford Studies in Metaphysics* 1: 21–36.

Markosian, Ned. 2004. A Defence of Presentism. *Oxford Studies in Metaphysics* 1, no. 3: 47–82.

Meacham, Christopher J. G. 2008. Sleeping Beauty and the Dynamics of de Se Beliefs. *Philosophical Studies* 138, no. 2: 245–269.

Monton, Bradley. 2006. Presentism and Quantum Gravity. In *The Ontology of Spacetime*, edited by Dennis Dieks.

Pettigrew, Richard. Unpublished Manuscript. Self-Locating Belief and the Goal of Accuracy.

Prior, Arthur N. 1972. The Notion of the Present. In *The Study of Time*, edited by J. T. Fraser, F. Haber, and G. Muller, 320–323. Springer Verlag.

Sider, Theodore. 2006. Quantifiers and Temporal Ontology. *Mind* 115, no. 457: 75–97.

[12] Thanks to David Balcarras, Brendan Farmer, Caspar Hare, Agustin Rayo, Haley Schilling, Miriam Schoenfield, Ginger Schultheis, Brad Skow, Jack Spencer, Trevor Teitel, Roger White, an anonymous referee, and the members of MIT's MATTI Graduate Student Workshop.

Skow, Bradford. 2011. Experience and the Passage of Time. *Philosophical Perspectives* 25, no. 1: 359–387.

Titelbaum, Michael G. 2008. The Relevance of Self-Locating Beliefs. *Philosophical Review* 117, no. 4: 555–606.