PROBABILISTIC ARGUMENTS FOR MULTIPLE UNIVERSES

BY

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Abstract: In this paper, we discuss three probabilistic arguments for the existence of multiple universes. First, we provide an analysis of total evidence and use that analysis to defend Roger White's "this universe" objection to a standard fine-tuning argument for multiple universes. Second, we explain why Rodney Holder's recent cosmological argument for multiple universes is unconvincing. Third, we develop a "Cartesian argument" for multiple universes. While this argument is not open to the objections previously noted, we show that, given certain highly plausible assumptions about evidence and epistemic probability, the proposition which it treats as evidence cannot coherently be regarded as evidence for anything. This raises the question of whether to reject the assumptions or accept that such a proposition cannot be evidence.

1. Introduction

Is there evidence for the existence of other physical universes? A surprisingly large number of philosophers and scientists believe that there is. Impressed by the various "cosmic coincidences" that are required to make life possible, they claim that the existence of life is not only evidence for multiple universes, it is *strong* evidence for multiple universes. Further, a seductive "fine-tuning argument" for the truth of this claim can be constructed. If we use 'Multiverse' to refer to the hypothesis that more than one physical universe exists, the argument can be sketched as follows.

In order for life to exist in a physical universe, some of the free physical parameters of that universe must be fine-tuned. To say that a physical parameter is "free" is to say that it does not follow from currently accepted physical theory;[1] and to say that such a parameter must be "fine-tuned" for life is to say that the range of values of that parameter that do

not entail the physical impossibility of life (assuming the values of the other parameters are held constant) is very small compared to some non-arbitrarily chosen theoretically possible range of values of that parameter.[2] Since currently accepted physical theory does not make any particular value more likely than any other, nor is there any other reason to suppose that any value is antecedently more likely than any other, it follows that the existence of life in a physical universe is antecedently much more probable on the assumption that Multiverse is true than it is on the assumption that Multiverse is false.[3] Hence, the existence of life in a physical universe is evidence for the truth of Multiverse in the sense that it raises the probability that Multiverse is true, and it is *strong* evidence for the truth of Multiverse in the sense that it increases the ratio of the probability that Multiverse is true to the probability that Multiverse is false many-fold.[4]

More than one critic has suggested that, by focusing on the mere existence of life, this sort of argument neglects the important fact that we know life exists, not just in some universe or other, but also in *this* universe, in the physical universe that we inhabit. The existence of life in this universe is no more probable if it is one of many physical universes than if it is the only universe. Thus, as our credence ought to be governed by our *total* evidence, the significance of fine-tuning arguments of the sort exemplified above is completely undermined. Let's call this objection the 'this universe objection' or 'TUO' for short. Drawing on Ian Hacking (1987), Roger White (2000) has recently provided a powerful defense of TUO, but others remain skeptical. Neil Manson and Michael Thrush (2003) challenge the requirement of total evidence presupposed by White's version of TUO, claiming that other obviously correct inferences to multiplicity would be undermined if such a requirement were universally enforced. Another critic of TUO is Rodney Holder (2002). Unlike Manson and Thrush, Holder accepts White's requirement of total evidence, but claims that Multiverse is confirmed even if care is taken to satisfy that requirement.

In this paper, we aim to advance the discussion of these matters and, in so doing, to identify a new problem for probabilistic theories of evidence. We begin by providing a new analysis of TUO, one that clarifies the debate between White and his critics and, more importantly, establishes conclusively that TUO suffices to refute one version of the fine-tuning argument for Multiverse. We then explain why Holder's argument for Multiverse is unconvincing. Next, we develop a new argument for Multiverse, one that is not vulnerable to TUO and that does not appeal to fine-tuning. This argument, however, faces a serious problem because the alleged evidence to which it appeals is one's own existence. We show that, given certain plausible assumptions about evidence and epistemic probability, Cartesian propositions (i.e. "I exist" and propositions entailed by "I exist") cannot coherently be regarded as evidence for anything. This raises the question of whether to reject the assumptions or accept that Cartesian propositions

cannot be evidence. We call this "the problem of Cartesian evidence" and conclude that the prospects for a successful probabilistic argument for Multiverse may well turn on the solution to this problem.

2.   *White's defense of TUO*

In an important recent article, Roger White (2000) provides an unusually clear and careful defense of TUO. To appreciate the strength of that defense, it is important to be clear about which fine-tuning argument White is criticizing. White actually considers two such arguments (and there are others that he does not consider). We shall discuss only the first, which is very similar to the argument sketched at the beginning of this paper. There are, however, some minor differences. For example, whereas the hypothesis we call "Multiverse" states that more than one physical universe exists, White's Multiverse hypothesis states that the number of physical universes that exist is large. We will use 'M_w' to stand for White's hypothesis.

Now consider the following statement:

E*:   Some universe is life-permitting.

White notes that on a standard formulation of the positive relevance criterion of confirmation, E* reports evidence for M_w relative to background knowledge K if and only if $P(M_w/E^*\&K) > P(M_w/K)$ and that is so if and only if $P(E^*/M_w\&K) > P(E^*/{\sim}M_w\&K)$. White assumes that, for some finite number n, the total number of distinct configurations of free physical parameters that a universe could have is n, and the probability of any particular universe's having any particular configuration is 1/n (regardless of which configurations other universes happen to have).[5] White uses 'α' to refer to our physical universe and assumes that K includes the fact that α exists, but not the fact that α is life-permitting. Given these assumptions and given that not every possible configuration of free physical parameters is life-permitting (i.e. not every configuration is such that life is physically possible in a universe that instantiates that configuration), it seems clear that $P(E^*/M_w\&K) > P(E^*/{\sim}M_w\&K)$ and hence that $P(M_w/E^*\&K) > P(M_w/K)$. It appears, then, that E* confirms M_w.

Notice that when the argument is stated this way, *fine*-tuning is not essential to it. The conclusion will follow so long as not every possible configuration of free physical parameters is life-permitting. Of course, if the issue is, not whether there is evidence for M_w, but whether there is *strong* evidence for it then fine-tuning plays an essential role in the argument. White himself models the claim that fine-tuning is required for life as the claim that n is large and that only one configuration of free physical

parameters is life-permitting. Given this further assumption, it follows that $P(E*/M_w\&K)$ is much greater than $P(E*/\sim M_w\&K)$, and hence that E* reports strong evidence for M_w (in the sense of "strong evidence" mentioned earlier).

One could, of course, criticize the assumptions in this argument, many of which are highly controversial. But White does not do that. Instead, he points out that we know, not just that E* is true (that some universe or other is life-permitting) but also that E is true:

E: α is life-permitting.

And while $P(E*/M_w\&K) > ! P(E*/\sim M_w\&K)$, $P(E/M_w\&K) = P(E/\sim M_w\&K) = 1/n$. It is not obvious, however, exactly what White concludes from this. He points out that E entails E*. And this is certainly significant. But in explaining why this is significant, White states rather vaguely that, "in the confirming of hypotheses, we cannot, as a general rule, set aside a specific piece of evidence in favor of a weaker piece" (p. 264). White supports this "requirement of total evidence" with some examples and it certainly has great intuitive appeal, but he never explains why, exactly, E's failure to raise the probability of M_w justifies ignoring the fact that E* does raise the probability of M_w. Thus, his defense of TUO, though admirably clear and highly plausible, is not fully developed.

White's reliance on examples rather than on analysis to explain and support his requirement of total evidence leaves an opening for Manson and Thrush to challenge White's defense of TUO by providing their own example, an example that, in their opinion, refutes White's requirement of total evidence:

Suppose that we are given a one-kilogram sample of matter and are told to determine how many uranium atoms it contains, if any. Unfortunately, our Geiger counter is broken. Luckily for us, however, we have at our disposal an amazing resource: a uranium oracle. This gifted individual knows the state of each and every uranium atom, and even has names for them. We leave the oracle in a room with the sample and come back an hour later. The oracle tells us that just one uranium atom decayed: Fred. From the fact that Fred decayed we deduce that one uranium atom decayed. Can we proceed to use half-life calculations to estimate the number of uranium atoms in the sample?

Not if we are required to reason from the fact that Fred decayed rather than the fact that some uranium atom or other decayed. Since the presence of other uranium atoms makes it no more likely that Fred should have decayed, the fact that Fred decayed doesn't confirm the hypothesis that the sample contains the calculated number of uranium atoms. Indeed, we are not even entitled to conclude that there is more than one uranium atom in the sample. The extra information that it was Fred blocks such inferences, even though the extra information itself is quite compatible with the conclusion that there are many uranium atoms. Whatever the obligation to consider our total evidence amounts to, it should not block inferences of the above sort. (Manson and Thrush, 2003, p. 74)

Manson and Thrush conclude that, in some cases, a weaker statement can confirm a hypothesis even if a stronger statement that is known to be true does not. This, they believe, shows that White's requirement of total evidence is false as it stands.

3. *A new analysis of TUO*

Our position is that there is no need to replace White's requirement of total evidence, but there is a need to make it more precise. What, exactly, does it mean to say that, in the confirming of hypotheses, we cannot set aside a stronger piece of evidence for a weaker? Does this imply that if a stronger piece of evidence does not confirm a hypothesis, then the weaker evidence does not confirm it either? That is how Manson and Thrush interpret White. On that interpretation, however, White's requirement of total evidence seems to be inconsistent with the principle of probabilistic confirmation that he assumes is true, for White does not deny that the weaker piece of evidence can raise the probability of a hypothesis even if the stronger piece does not.

The following equation, which is a theorem of the probability calculus, will help us to sort all this out. Let e* be some piece of evidence and e be some stronger piece of evidence – i.e., e entails e* but not vice versa. Then e is logically equivalent to (e*&e), which means that

$$\frac{P(e/h\&k)}{P(e/\sim h\&k)} = \frac{P(e^*\&e/h\&k)}{P(e^*\&e/\sim h\&k)} = \frac{P(e^*/h\&k)}{P(e^*/\sim h\&k)} \times \frac{P(e/e^*\&h\&k)}{P(e/e^*\&\sim h\&k)}.$$

This equation implies that, if the stronger piece of evidence e neither confirms nor disconfirms h relative to k (i.e. the first and second ratios equal one), but the weaker piece of evidence e* does confirm h relative to k (i.e. the third ratio is greater than one), then the stronger piece of evidence must disconfirm h relative to (k&e*) (i.e. the fourth ratio must be less than one). Indeed, if the third ratio equals m, then the fourth ratio must be 1/m. In other words, e must favor ~h over h relative to (e*&k) by exactly the same amount that e* favors h over ~h relative to k. (Since epistemic probabilities are relative to background knowledge, probabilistic confirmation must also be relative to background knowledge.) In the argument White considers, E* does confirm M_w relative to K, and E neither confirms nor disconfirms M_w relative to K. But those two claims are compatible only because E disconfirms M_w relative to (E*&K), thereby offsetting E*'s confirmation of M_w. This is why E's failure to raise the probability of M_w justifies "ignoring" the fact that E* does raise the probability of M_w.

To see this "cancellation effect" in action, compare the hypothesis that exactly one physical universe exists, which we will call "Universe" or "U" for short, with the hypothesis that exactly two physical universes exist,

which we will call "Biverse" or "B" for short. Keep in mind that, for White, K includes the information that α exists. Now consider the following equation:

$$\frac{P(E/B\&K)}{P(E/U\&K)} = \frac{P(E^*\&E/B\&K)}{P(E^*\&E/U\&K)} = \frac{P(E^*/B\&K)}{P(E^*/U\&K)} \times \frac{P(E/E^*\&B\&K)}{P(E/E^*\&U\&K)}.$$

The first ratio is equal to one. Why, after all, should the probability that α is life-permitting depend on whether there is one or two universes? Indeed, White is explicit in holding that the relevant factors determining whether a universe is life-permitting are "randomly set" and that such universes, like dice, "have no memories." So it seems that E confirms neither B over U nor U over B. Of course, if the first ratio is equal to one, then so is the second, since it is obvious that E and (E*&E) are logically equivalent. Yet E* does confirm B over U. To see that it does, suppose that the probability of a given universe being life-permitting is 1/2. Then, given White's assumptions, P(E*/B&K) = 3/4 and P(E*/U&K) = 1/2, and hence the third ratio equals 3/2. But if everything we have said so far is correct, then it follows that the fourth ratio must be equal to 2/3. And indeed it is. For given only K (which includes the information that α exists), the probability that α is life-permitting is only 1/2. And given both B and K, there are four equally likely possibilities: both α and the other universe are life-permitting, only α is life-permitting, only the other universe is life-permitting, and neither α nor the other universe is life-permitting. But given E* (that at least one universe is life-permitting) in addition to B and K, the fourth of these possibilities is ruled out leaving three equally likely possibilities, two of which are possibilities in which α is life-permitting. Hence, the numerator of the fourth ratio is equal to 2/3. Further, (E*&U&K) entails E. For if at least one universe is life-permitting, exactly one universe exists, and α exists, then α must be life-permitting. So the denominator of the fourth ratio equals 1, and hence the fourth ratio equals 2/3. Thus, while the fact that some universe is life-permitting does confirm B over U relative to K, this confirmation is exactly offset by the fact that α's being life-permitting confirms U over B relative to (E*&K). And it should be obvious that replacing B with M_w will not affect this result.

This sort of analysis can also be used to show that Manson and Thrush's alleged counterexample to White's requirement of total evidence is not genuine. Notice, first of all, that there are two important disanalogies between the argument for multiple uranium atoms and the fine-tuning argument for multiple universes considered by White. In the latter, the evidence, when fully stated, is just that this universe is life-permitting. In the uranium argument, we learn from the oracle, not just that Fred decayed, which Manson and Thrush correctly point out is not made any more likely by the presence of other uranium atoms in the sample, but

also that Fred is in the sample and that no other uranium atom decayed. Since Fred is no more likely to be in the sample than any other uranium atom, its presence is much more likely on the assumption that there are multiple uranium atoms in the sample ("multiatom") than on the assumption that there is only one ("uniatom"). Of course, given that Fred is in the sample, the fact that no other uranium atom decayed is more likely on uniatom than on multiatom. But since the half-life of uranium is very long and the oracle's report covers only an hour, this evidence favoring uniatom is very weak, much weaker than the evidence favoring multiatom provided by Fred's presence in the sample. Overall, the evidence strongly favors multiatom over uniatom. In fact, the degree of support it provides for multiatom is exactly the same as that provided by the weaker claim that exactly one atom decayed.

This can be demonstrated by making use of the same theorem we used to analyze White's requirement of total evidence:

$$\frac{P(E/M_a\&K)}{P(E/U_a\&K)} = \frac{P(E^*\&E/M_a\&K)}{P(E^*\&E/U_a\&K)} = \frac{P(E^*/M_a\&K)}{P(E^*/U_a\&K)} \times \frac{P(E/E^*\&M_a\&K)}{P(E/E^*\&U_a\&K)}.$$

Here 'M_a' and 'U_a' stand for multiatom and uniatom, respectively, while the two evidence statements are:

E*:   Exactly one uranium atom decayed.
E: Exactly one uranium atom decayed and that atom is Fred.

E is, of course, equivalent to the conjunction of "Fred is in the sample," "Fred decayed," and "No other uranium atom decayed;" but formulating E as the conjunction of E* and "that atom is Fred" makes the proof that E and E* are equally strong evidence for multiatom very simple, as we will now show. Notice that in the uranium case, unlike the fine-tuning case, the numerator of the fourth ratio in the equation above is equal to the denominator: given that exactly one uranium atom decayed, it is no more likely to be Fred if there are many uranium atoms in the sample than if there is only a single uranium atom in the sample. This means that the fourth ratio equals one, which implies that the first ratio equals the third, which proves that the support provided by the stronger piece of evidence for multiatom is equal to that provided by the weaker piece of evidence, contrary to what Manson and Thrush claim. A more detailed analysis would also prove that the stronger piece of evidence can be used just as effectively as the weaker to estimate the number of uranium atoms in the sample, again contrary to what Manson and Thrush claim.

Of course, Manson and Thrush could revise their case so that it is more closely analogous to the fine-tuning case. This would require (i) letting Fred's presence in the sample be known prior to the oracle's report, just as the existence of our universe is part of the background knowledge in

the fine-tuning argument White discusses, and (ii) having the oracle inform us only that Fred decayed and not also that no other atom decayed. This would make half-life calculations impossible, but the question of whether the oracle's report supports multiatom over uniatom could still be asked. In this modified case, the weaker piece of evidence that some atom decayed is more likely on multiatom than on uniatom, while the stronger piece of evidence that Fred decayed is not. Instead of providing a counterexample to White's requirement of total evidence, however, these results provide added support for that requirement and for our analysis of it. For surely the "this atom objection" to this argument for multiatom is successful. If we already know that Fred is in the sample, then merely learning that Fred decayed provides no new evidence at all that there are multiple uranium atoms in the sample. In this case, the statement that some atom or other decayed is more likely on multiatom than on uniatom, but given that some atom or other decayed (and that Fred is in the sample), the statement that Fred decayed is more likely on uniatom than on multiatom – the ratios are exactly the same and so the evidence for multiatom is exactly offset by the evidence for uniatom.

4.   The cosmological argument for Multiverse

In a very ambitious recent paper, Rodney Holder (2002) claims to establish two theses: first, that White's version of TUO fails, and second, that both Multiverse and theism are confirmed by the evidence of fine-tuning. His arguments for these theses, however, are not convincing. We shall restrict our attention to what Holder says about Multiverse.

For simplicity's sake, Holder assumes that there are only 100 possible physical universes: $U_1, U_2, U_3, \ldots U_{100}$. The improbability of fine-tuning is modeled by assuming that only ten of these universes are life-permitting, specifically $U_1, U_2, U_3, \ldots U_{10}$. U_1 is identified as "our universe." Holder's Multiverse hypothesis, which we will call "M_h," states that all possible physical universes actually exist.[6] Like White, Holder considers two alternative items of evidence, but he admits that they "are framed rather differently from [White's]":

E_1:   A fine-tuned universe exists (i.e. U_1 or U_2 or U_3 or . . . or U_{10} exists)
E_2:   Our universe exists (i.e. U_1 exists).

Also like White, Holder maintains that E_2 should be employed instead of E_1 because it is the stronger piece of evidence. In other words, Holder accepts White's requirement of total evidence.

It is important to recognize that Holder takes E_2 to assert, not just that our universe exists, but also that it has a variety of relevant features. For

example, the fact that our universe is fine-tuned for life is clearly supposed to be a part of E_2, since Holder claims that E_2 entails E_1. And when Holder considers the probability of E_2 on theism, he lowers his estimate on the grounds that our universe contains evil.[7] Furthermore, unlike White's α, Holder's U_1 is not a universe that merely happens to contain us. (Recall that on White's model, the probability that α is life-permitting is $1/n$ where n is very large.) Holder states that "when and where our universe occurs are not essential properties of it: that it is fine-tuned and produces ourselves are" (p. 309).

Holder's argument concerning M_h appears to proceed as follows. E_2 (the existence of our universe) is certain on the assumption that M_h is true (that all possible physical universes exist); but the probability of E_2 on the assumption that Universe is true (that exactly one physical universe exists) is only $1/100$. Thus, E_2, the stronger piece of evidence, confirms Multiverse over Universe. Holder takes this to contradict White's conclusions, but this is a mistake, for White takes the existence of our universe to be a part of the background information K. Further, he does this presumably for the good reason that he is interested in evaluating a *fine-tuning* argument for Multiverse. He does not address the question of whether the mere existence of our universe confirms Multiverse over Universe.

Holder repeatedly describes his project as that of showing that Multiverse and theism are confirmed by the evidence of fine-tuning. In reality, however, fine-tuning plays no role in his reasoning. For given Holder's simple model, the existence of U_1 would be 100 times more probable on M_h than on Universe whether it was one of only ten life-permitting universes or one of 100 life-permitting universes. In fact, the existence of any universe would be more probable on Multiverse than on Universe even if that universe were not life-permitting. (Of course, we couldn't observe such a universe, and so its existence could not be evidence for us). Insofar as it is the mere existence of a particular universe, rather than its being fine-tuned, which does the work in Holder's argument, it seems more appropriate to think of Holder's argument as a *cosmological* argument for Multiverse, one which takes as its putative evidence the existence of our physical universe.

Of course, even if Holder is mistaken in thinking that he has shown that the fine-tuning of our universe favors Multiverse over Universe, an interesting question remains: does Holder succeed in showing that the existence of our universe favors Multiverse over Universe? Holder himself discusses some of the reasons why all may not be "well with the many universes hypothesis in its various forms" (p. 310). For example, one crucial problem that is obscured by what Holder himself calls his "highly simplified" analysis (p. 296) is that the number of possible physical universes is uncountably infinite. This makes the notion that there is a non-zero "probability" that *this* universe exists given Universe highly problematic. Let's suppose, however, that this problem (and the other problems Holder

mentions) can be solved. What, then, should we say about Holder's cosmological argument?

To answer this question, we must first determine what Holder includes in the background information K. Holder states that "background knowledge is that which we take for granted in any situation (e.g. tautologies, the rules of logic) . . ." (p. 297). Taken at face value, however, this creates trouble for Holder. For surely "I exist" is something that each of us takes for granted in any situation. Indeed, like Holder's examples of background knowledge, "I exist" is something that each of us ought rationally to assume in any *possible* situation. It appears, then, that he is committed to including "I exist" in K. But in Holder's model, U_1 is distinguished from the other nine possible fine-tuned universes by its being the one and only possible universe that (essentially) produces us. As a result, on Holder's model, if I exist in some universe, then I must exist in U_1 and so U_1 exists. But this means that Holder's argument is subject to a fatal dilemma. On the one hand, if K includes the knowledge not just that I exist, but also that I exist in some universe, then the probability that U_1 exists is one on both Universe and M_h. On the other hand, if K includes the knowledge that I exist but not that I exist in a universe, then the probability that U_1 exists is the probability that I exist in a universe given that I exist, and there is no reason to suppose that the value of this conditional probability would be sensitive to the number of universes that exist. In either case, then, it appears that the probability of one's own universe (U_1) existing is the same on both Universe and M_h, and so Holder's argument appeals to an epistemic situation relative to which the alleged evidence (U_1 exists) does not favor his Multiverse hypothesis over Universe.

It may be objected on Holder's behalf that we are to assess the probability that U_1 exists relative to a hypothetical epistemic situation in which we do not know that U_1 is our own universe. We doubt, however, that such an assessment is possible. For one cannot assess the probability that U_1 exists unless one can individuate U_1 (i.e. uniquely pick out U_1 from among the infinite array of possible universes). But if one did not know whether U_1 is one's own universe, then one could not possibly individuate U_1. One could not do it qualitatively, for as Holder admits, our universe may be qualitatively identical to other possible universes. Nor could one do it in terms of the existence of some particular individual contained in U_1 since there would be no way to distinguish any such individual from exact copies in other possible universes.

But suppose that we are wrong and so it is possible for one to assess the probability that U_1 exists independently of one's knowledge that it is one's own universe. This would be, in effect, to treat U_1 as if it were some randomly chosen possible universe. On Holder's model, then, the antecedent probability that one's own universe is U_1 would be 1/100. Thus, whereas the existence of U_1 would confirm M_h, this confirmation would be subject

to precisely the sort of "cancellation effect" that we have seen is the Achilles' heel of at least some fine-tuning arguments for Multiverse. For a stronger piece of evidence is "U_1 is my universe." This proposition entails that U_1 exists and so is logically equivalent to the conjunction of C_1 and C_2 below:

C_1: U_1 exists.
C_2: U_1 is my universe.

Thus, keeping in mind that K includes my existence in some universe, we have:

$$P(C_1\&C_2/M_h\&K) = P(C_1/M_h\&K) \times P(C_2/C_1\&M_h\&K)$$
$$= 1 \times 1/100$$
$$= 1/100.$$
$$P(C_1\&C_2/U\&K) = P(C_1/U\&K) \times P(C_2/C_1\&U\&K)$$
$$= 1/100 \times 1$$
$$= 1/100.$$

C_1's confirmation of M_h over U relative to K is exactly offset by C_2's confirmation of U over M_h relative to ($C_1\&K$).

It appears, then, that if one's own existence is to be included in K, then Holder's argument is a clear failure. Of course, since Holder's evidence statement entails that one exists, he could explicitly remove such knowledge from K. If, however, the success of his argument actually turns on whether he does that, then this raises the suspicion that it is one's own existence and not the existence of a particular physical universe that is doing the real work in his argument. Let us turn, then, to the task of constructing an argument, based on the general structure provided by Holder, for the conclusion that one's own existence is evidence for Multiverse.

5.   *The Cartesian argument for Multiverse*

Consider the following argument.

    A. My existence is more probable on the assumption that Multiverse is true than it is on the assumption that Universe is true.

So, B. My existence is evidence favoring Multiverse over Universe (i.e. that I exist raises the ratio of the probability of Multiverse to the probability of Universe).

    C. My existence is at least as probable on the assumption that Multiverse is true as it is on the assumption that neither Universe nor Multiverse is true.

So, D.   My existence is evidence for Multiverse (i.e. that I exist raises the probability of Multiverse).

Premise A can be defended as follows: We have good reason to suppose that, given the right values for certain physical parameters, a universe can produce conscious life, i.e. biological subjects of mental states. Given, then, the standard assumption that the probability that a particular universe will have the right values for those parameters is independent of the number of universes, the more universes that exist, the greater the expectable number of actual subjects of mental states, and hence the more probable it is that I (a particular possible subject of mental states) exist.

It might be objected that if certain substance dualists are correct, then universes cannot produce conscious life because minds are not biological or even physical in nature. But even if we concede that there is some epistemic probability that no universe can produce conscious life, we can still argue for premise A as follows. Either a universe (with the right physical parameters) can produce conscious life or it cannot. Suppose that it can. Then for the reason stated above, my existence is more probable on Multiverse than it is on Universe. Suppose on the other hand that a universe cannot produce conscious life. Then my existence is no more probable on Universe than it is on Multiverse. Therefore, because there is some epistemic probability greater than zero that a universe can produce conscious life, it follows that my existence is more probable on Multiverse than it is on Universe.

It might also be objected that I am essentially tied to the particular universe that produced me and so it is a mistake to assume that adding people by adding universes increases the probability of my existence. Although it is by no means obvious that the premise of this objection is true,[8] let us concede that it is – i.e. let us assume that my generation is metaphysically possible in only one metaphysically possible universe. On this assumption, my existence is more probable on Multiverse than on Universe for the simple reason that the more possible universes that come into being, the more likely it is that one of them will be the only one in which my generation is metaphysically possible and hence the more likely it is that I will come into existence.

It remains to defend premise C. This premise compares the probability that I exist on the assumption that Multiverse is true to the probability that I exist on the assumption that there is no physical universe. It can be supported by the reasoning which supported premise A. To the extent that universes are capable of producing conscious subjects, my existence is more probable on the assumption that more than one universe exists than on the assumption that none exist; and to the extent that universes are incapable of producing conscious subjects, my existence is no less probable on the assumption that more than one universe exists than on the assumption that none exist.[9]

If this reasoning is cogent, then one's own existence confirms Multiverse to some degree. And unlike fine-tuning arguments for Multiverse, this Cartesian argument for Multiverse does not appear to be vulnerable to any appeal to total evidence. We cannot, for example, appeal to the fact that I know not just that I exist, but that I exist in this universe. For as we have seen in our discussion of Holder's cosmological argument for Multiverse, given that I exist, the probability that a particular universe exists *and that it is my own universe* is no higher on Universe than it is on Multiverse.

6.   *The problem of Cartesian evidence*

Although appeals to total evidence do not threaten our argument for Multiverse, we believe that another objection is a serious threat. For it appears that premise A can be defeated by reasoning as follows: "It is impossible to be rational and yet to be less than absolutely certain of one's own existence. Thus, since epistemic probability is rational degree of belief, it follows that it is logically impossible for me to be in an epistemic situation relative to which P(I exist) < 1. But then, relative to any epistemic situation that is relevant for assessing whether "I exist" is evidence for me, P(I exist/Multiverse) = P(I exist/Universe) = 1 and so premise A is false."

Such reasoning threatens not just our Cartesian argument for Multiverse, but any Cartesian argument for Multiverse. For standard probabilistic theories of evidence are committed to one or both of the following criteria of evidence:

Positive Relevance Criterion: e is evidence that confirms h IFF P(h/e) > P(h).

Likelihood Criterion: e is evidence that favors h1 over h2 IFF P(e/h_1) > P(e/h_2).[10]

On either criterion, it appears that "I exist" cannot be evidence. For if it is logically impossible for me to be in an epistemic situation relative to which P(I exist) < 1, then it is logically impossible for me to be in an epistemic situation relative to which P(h/I exist) > P(I exist) or P(I exist/h_1) > P(I exist/h_2).

It might be supposed that the objection here is merely exploiting a version of the "problem of old evidence" (Glymour, 1980). Given that epistemic probability is relative to an epistemic situation, on either of the above criteria, it might seem that the following principle is true:

Q: e is evidence (that confirms h or favors h_1 over h_2) for s ONLY IF s is in an epistemic situation relative to which P(e) < 1.

Q is clearly false as it holds that something of which one is certain cannot be evidence, and so any probabilistic theory of evidence that entails Q cannot be correct. However, the problem we are raising is quite distinct from this version of the problem of old evidence. For as we show below, probabilistic accounts of evidence that seem able to avoid commitment to Q still appear to entail the following principle:

R: e is evidence (that confirms h or favors h_1 over h_2) for s ONLY IF it is logically possible for s to be in an epistemic situation relative to which $P(e) < 1$.

R does not preclude the possibility of old evidence, but it does preclude the possibility of "Cartesian evidence," that is, it precludes the possibility that "I exist," or any proposition entailed by "I exist," is evidence.[11] Thus, the general problem we are raising, *the problem of Cartesian evidence*, is the problem of whether to deny that Cartesian evidence exists or to reject standard probabilistic accounts of confirmation.[12]

The most common approaches to solving the problem of old evidence involve, not surprisingly, evading commitment to Q. The old evidence e is subtracted in some suitable way from s's epistemic situation and e is said to be evidence only if, relative to the revised epistemic situation, the relevant inequality holds. There are a variety of possible solutions of this sort because there are a variety of ways to "subtract" old evidence from an epistemic situation. So-called "Historical Solutions" appeal to the holding of the relevant inequality relative to some actual historical epistemic situation of the relevant agent prior to learning that e is the case.[13] Focusing on the positive relevance criterion, we can formulate these sorts of proposals as follows:

The Historical Positive Relevance Criterion: Where s knows that e, e is evidence that confirms h for s IFF prior to s's coming to know e, P(h/e) *was* greater than P(h).

The dominant alternative to the historical solution appeals instead to the relevant inequality holding relative to an appropriate counterfactual epistemic situation which does not include knowledge of e:[14]

The Counterfactual Positive Relevance Criterion: Where s knows that e, e is evidence that confirms h for s IFF in the relevant counterfactual situation, P(h/e) is greater than P(h).

Though these proposals do not entail Q and so allow for old evidence, they do not allow for Cartesian evidence. They appeal to either a past epistemic situation or a counterfactual epistemic situation relative to

which $P(h/e) > P(h)$. But, if it is logically impossible for s to be in an epistemic situation relative to which $P(e) < 1$, then relative to *any* actual or counterfactual epistemic situation of s, $P(h/e) = P(h)$ for any h.[15] So, if epistemic probability is rational degree of belief in a given epistemic situation, then it would seem R is true and Cartesian evidence does not exist.

7.   *Arguments for Cartesian evidence*

It might be thought that some popular examples in the literature on the "anthropic principle" support rejecting R in favor of Cartesian evidence. Consider, for example, the case of the 12 marksmen in the firing squad who each fire 12 shots and miss me (Swinburne, 1990). Intuitively, it is quite clear that in such a situation I would have evidence that they intended to miss. But this intuition is easy to accommodate without admitting that the mere knowledge that I exist is evidence. For example, the fact that all 144 shots missed me is evidence that the marksmen intended to miss. Still, one might suggest that after the firing squad fires, my existence is also evidence for this hypothesis. But surely my existence *at some time or other* is not evidence in this case. Of course, it may be that my existence at a particular time (e.g. after the firing squad fires) is evidence. If it is evidence, however, it is not Cartesian evidence, since "I exist" does not entail that I exist at any particular time. Moreover, R is perfectly compatible with the suggestion that, for example, my existence after the firing squad fires is evidence. For relative to my epistemic situation prior to the firing squad's firing, the probability that I exist after the firing squad fires is less than one. So nothing in the firing squad case provides reason to reject R.

There are, of course, other cases in which "I exist" *appears* to provide evidence for some hypothesis. But in considering cases of this sort, we have consistently found that one can locate some other statement that can instead be taken as the evidence while treating "I exist" as background knowledge. To further illustrate this point, consider the following case of apparent Cartesian evidence:

> I find myself in the presence of a closed box and in communication with God. God tells me that the box contains a ball that is either black or white. He also tells me that one hundred years ago he used a random number generator to determine what color of ball to place in the box. The generator was designed to randomly select a number from zero to 100. A zero or a one would result in a black ball being placed in the box. Any other number would result in a white ball being placed in the box. With this information in hand, I now know that the probability of the ball being white is 99/101. But then God gives me additional information. He tells me that the number that he used to determine the

color of the ball was also used to determine whether or not to bring me into existence. If the number zero had been selected by the generator, then in addition to placing a black ball in the box, he would not have brought me into existence. If any other number was selected, my existence was guaranteed. Clearly the probability that the box contains a white ball is now 99/100.

While it is tempting to suppose that my own existence is the evidence that raises the probability that the ball is white from 99/101 to 99/100, there is an alternative interpretation to consider. Notice that I already knew of my existence prior to communicating with God. It is quite natural, then, to suppose that it is the additional information God provides about the relationship of my existence to the number generated that raises the probability that the ball is white rather than the bare fact that I exist, which can continue to be treated as background knowledge. This additional information can be represented as a conjunction of the following two propositions:

G1: My existence depended on a single, specific number not being selected by the random number generator.
G2: That number is zero.

Learning G1 does not alter the probability that the ball is white. But taking that information as background knowledge, learning G2 raises the probability that the ball is white from 99/101 to 99/100. Bayes' theorem shows how G2 can serve as the required evidence:

$$P(\text{the ball is white}/G2) = \frac{P(\text{the ball is white}) \times P(G2/\text{the ball is white})}{P(G2)}$$

$$= \frac{99/101 \times 1/100}{1/101}$$
$$= 99/100$$

P(G2) = 1/101 because the zero is one of 101 numbers that God might have chosen to be the one that (if selected by the number generator) would have ruled out my existence. But P(G2/the ball is white) equals 1/100 rather than 1/101. For given that the ball is white, the number that was selected by the number generator was a number between 2 and 100. And given that I exist, that number could not have been the number that would have ruled out my existence. Thus, given that the ball is white and that I exist, the probability that the number that would have ruled out my existence is between 2 and 100 is 98/100, and the probability that it is zero (like the probability that it is one) is 1/100. (Notice that "I exist" plays a role in the evidential reasoning, as background knowledge often does, without actually being the evidence.)

Of course, there may be better candidates for Cartesian evidence that we have not considered. We are not here denying the existence of Cartesian evidence. We are only claiming that the plausibility of R is a significant reason to doubt the existence of such evidence, and we are cautioning anyone who thinks they have a clear example of Cartesian evidence to consider whether their case cannot be interpreted as one in which "I exist" is background information and some other statement is the evidence.[16]

8.   Conclusion: can there be evidence for Multiverse?

If what we have been arguing is correct, then none of the probabilistic arguments for Multiverse that we have considered here are convincing. For we have defended the "this universe objection" to common fine-tuning arguments for Multiverse, grounding that objection in an analysis of the requirement of total evidence. We have also shown that Holder fails to produce a persuasive cosmological argument for Multiverse. A Cartesian argument of the sort developed in Section 5 seems to us to be the most promising probabilistic argument for Multiverse, but success here requires rebutting a strong *prima facie* case against the existence of Cartesian evidence and no one has yet provided such a rebuttal.[17]

Furthermore, if relative to any logically possible epistemic situation, the epistemic probability of "I exist" is equal to one, two further conclusions can be drawn. First, Holder's cosmological argument for Multiverse, which we have shown to fail if "I exist" is taken to be a part of K, cannot be rescued by removing "I exist" from K. Second, the success of any evidential argument for Multiverse will require an evidence statement E and background knowledge K such that, relative to an epistemic situation in which E is not known, $P(E/I \text{ exist } \& K)$ is less than one. This requirement is violated when it is taken as background knowledge, as it is by many, that a universe's being life-permitting or fine-tuned is a necessary condition of our existing and it is then claimed that the existence of such a universe or the fine-tuning of our universe is evidence for some hypothesis.[18]

Is there evidence for the existence of other physical universes? We have yet to see a compelling argument that there is.

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NOTES

[1]   This definition is taken from Manson and Thrush (2003, p. 69). Free physical parameters include the values of the constants in various physical laws (e.g. the gravitational constant), the masses of elementary particles like the proton, and various facts about the initial conditions of the big bang.

[2]   This definition of 'fine-tuning' is taken from Collins (2003, p. 179).

[3]   For doubts about the various formulations of the "fine-tuning" claim and their connections to probability claims, see McGrew, *et al.* (2001).

[4]   A theist might object to this argument by claiming that, if we assume that a perfect supernatural person (i.e. God) exists, then the conclusion that life is more probable on Multiverse than on the denial of Multiverse cannot be reached from the premise that life requires fine-tuning. For no matter how much fine-tuning is required for life, the total number of universes that an omnipotent and omniscient being would need to create in order to accomplish her goal of producing a universe with life remains the same: exactly one. Thus, the likelihood of God's creating life does not depend on how many universes she creates. We will avoid entanglement with the difficult metaphysical and axiological issues concerning what God or any other supernatural being would or would not be likely to do by assuming in this paper that metaphysical naturalism is true, that nothing that is neither a part nor a product of a universe (or of any other physical system) can affect a universe. It is worth mentioning, however, that the argument for (the confirmation of) Multiverse that we develop in Section 5 would, if it could overcome the objection discussed in Section 6, succeed even on the assumption that God exists.

[5]   This assumption may be false on the Multiverse theory proposed by Smith (1990) and Smolin (1992).

[6]   Defining 'M_h' in this may very well have the unfortunate implication that M_h is self-contradictory. For it appears that some of the features shared by distinct possible physical universes are such that it is impossible for more than one *actual* physical universe to have them.

[7]   Perhaps Holder does this because he believes this is required to satisfy White's requirement of total evidence. After all, on one interpretation of that requirement, E_2 should be taken to include everything we know since that is the strongest piece of evidence we possess! Yet Holder does not consider many other features of our universe that seem to be either more or less likely on theism than on one of Holder's alternative hypotheses. This lack of clarity on his part makes it difficult to interpret his argument with confidence.

[8]   Whether it is true depends on how universes and their constituents are to be individuated. Suppose, for example, that universes are individuated by their fundamental constituents (e.g. by the identities of the fundamental particles that they contain). Then given the truth of origin essentialism, we must say that even though someone qualitatively identical to me could have come into existence in any universe, my generation is impossible in any possible universe that does not (and hence cannot possibly) contain the "material" from which I arose. But as distinct possible universes might have some (though not all) fundamental constituents in common, my generation may be possible in more than one possible universe. Or suppose that universes are not individuated by their fundamental constituents, but rather by the temporal and spatial location (in some suitable "space" which might accommodate multiple universes) of the big bangs from which they arose. Then origin essentialism may be consistent with the possibility of my generation in any possible universe whatsoever. If, on the one hand, the material from which I arose could have been produced by any possible big bang, regardless of the "location" of the big bang, then my generation may be possible in any possible universe. If, on the other hand, both universes and their fundamental

constituents are individuated by the location of the big bangs from which they arose, then origin essentialism implies that there is only one possible universe in which my generation is possible.

[9] It should be noted, however, that if K includes or renders certain the proposition that at least one universe exists (i.e. that either Universe or Multiverse is true), then premise C is false because the probability of my existence on the assumption that neither Multiverse nor Universe is true is undefined. But this difficulty can be overcome by replacing C with the premise that I know with certainty that at least one universe exists.

[10] We mean for this formulation allow for a reading of 'favoring,' such as that utilized in our Cartesian argument for Multiverse, which involves increasing the relative probability of h_1 to h_2 and a different reading, such as that used by "Likelihoodists" (for example Edwards, 1972), which explicitly does not.

[11] Notice that there are two ways that some putative evidence e can run afoul of R. The first is for P(e) to be equal to one for any logically possible epistemic situation of s. The second is for P(e) to lack *any* value (even zero) for any logically possible epistemic situation of s with respect to which P(e) is not equal to one. It is our position that the attempt to use "I exist" as evidence runs afoul of R in the first of these two ways because an agent cannot rationally fail to be certain of her own existence. But even if it is possible for an agent to occupy an epistemic situation in which rationality does not require her to be certain of her own existence, then this must be because in that epistemic situation "I exist" is ungraspable and so has no epistemic probability at all. But then the attempt to use "I exist" as evidence contravenes R in the second way.

[12] Sober (2005) also seems to question whether "I exist" can favor one hypothesis over another (at least in certain contexts). But his arguments on this issue seem to us to bear little resemblance to the arguments we offer in the remainder of this section.

[13] See, for example, Horwich (1982, pp. 52–53).

[14] See, for example, Howson & Urbach (1989, pp. 404–405).

[15] Some might be tempted here to utilize the counterfactual approach conjoined with an appeal to the notion that some counterfactual conditionals with impossible antecedents (so-called 'counterpossibles') are non-trivially true and others non-trivially false. A detailed discussion of this possibility is beyond the scope of the present paper and has, to our knowledge, not been offered by any defender of the Counterfactual Criterion.

[16] Pust (forthcoming) develops the ideas of Section 6 in much more detail, defends the further claim that the correct conclusion to draw is that Bayesians cannot allow for "Cartesian evidence," and demonstrates the implications of this result for a number of other philosophical arguments.

[17] At least one other issue would also have to be resolved in favor of premise A. For it would have to be shown that one's own existence can have a non-zero probability even though the number of possible subjects of mental states is uncountably infinite.

[18] Indeed, something like this requirement forms the basis for various versions of the anthropic principle. (Carter, 1974) One might even see our discussion in Section 6 as offering an *explanation* of exactly why any condition taken to be necessary for our existence as conscious observers cannot serve as evidence for us, just as some versions of the anthropic principle maintain.

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