# Is the Fine-Tuning Evidence for a Multiverse?

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According to our best current science, the laws of physics and the initial conditions of our universe are fine-tuned for the possibility of life. That is to say, for life to be physically possible, certain parameters in basic physics – for example, the strength of gravity, or the mass of the electron – had to have values falling in a certain range, and that range is an incredibly narrow slice of the values those parameters might have had.[1] Some philosophers deny that the fine-tuning is evidence of anything in particular, except perhaps our good fortune. But a significant number of scientists and philosophers believe that the fine-tuning is evidence for the multiverse hypothesis, the theory that our universe is just one of a very large number of universes.[2] The basic argument is as follows. If there is just one universe, it's incredibly improbable that the right numbers for life would have come up by chance. But if there are many universes, exemplifying different values in the relevant parameters, then the existence of a fine-tuned universe becomes much more likely.

Other philosophers have objected to this line of reasoning on the following grounds: What we have evidence for is that *our* universe is fine-tuned, and no matter how many universes there are, it doesn't make it any more likely that *our* universe will be fine-tuned. Manson and Thrush (2003) dubbed this the 'this universe' objection. They also point out that whether or not the objection holds depends in part on the identity conditions of universes, an issue which they argue is not sufficiently settled to allow us to assess the force of the 'this universe' objection.

Surprisingly, what neither the proponents of the 'this universe' objection nor Manson and Thrush consider is the specific multiverse hypothesis for which there is independent empirical support and which is consequently most often appealed to by many scientists hoping to explain the fine-tuning, namely that which is rooted in eternal inflation combined with string theory.[3] Whilst Manson and Thrush are correct that it is unclear what *in general* makes a universe a universe, I will argue that matters are somewhat clearer in the context of this concrete theory. More specifically, I will attempt to show that the most natural way of construing the identity conditions of the universes in this multiverse hypothesis do indeed seem to make it susceptible to the 'this universe' objection.

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[1] For detailed accounts of fine-tuning, see Leslie 1989: ch. 2, Rees 2000, Davies 2006, Lewis and Barnes 2016.
[2] Scientists defending this position include Susskind (2005), Greene (2011), Tegmark (2014); philosophers include Leslie (1989), Smart (1989), Parfit (1998), Bradley (2009).
[3] For attempts to account for the fine-tuning in these terms, see Susskind (2005), Greene (2011), Tegmark (2014).

In section I, I will outline the 'this universe' objection, as articulated by Roger White. In section II, I will raise the issue of cosmic identity conditions before laying out the much-discussed eternal inflation + string theory multiverse model. In section III, I will argue that, on the most plausible view of the identity conditions of this specific multiverse theory, the 'this universe' objection survives.

## I

Fine-tuning arguments are not the only way to defend a multiverse hypothesis, but I want here to focus solely on the question of whether fine-tuning supports the multiverse hypothesis. Hence when I refer to 'multiverse theorists' in what follows, I mean those who appeal to the fine-tuning as evidence for a multiverse hypothesis, including those who also offer other forms of evidence.

The 'this universe' objection originates from Ian Hacking (1987), who applied it to John Wheeler's 'oscillating universe' theory. However, Roger White (2000) later gave a particularly detailed form of the objection, arguing that it applies to all forms of the multiverse and not just Wheeler's. I will focus here on White's version of the objection.

Following Hacking, White accuses multiverse theorists of committing the *inverse gambler's fallacy*. In the regular gambler's fallacy, the gambler has had a long night of bad rolls of the dice; given that it's unlikely that in a long series of rolls there would fail to be at least one double six, the gambler reasons, there's a really good chance she'll get a double six on the next roll. The fallacy lies in the fact that the chance of getting a double six on the next roll is not made any more likely by the results of previous rolls. In the inverse gambler's fallacy, the gambler walks into a casino to see a double six being rolled; given that rolling a double six is more likely if one has rolled many times, the gambler infers that the dice must have been rolled a number of times already. Again, the error arises from the mistaken belief that rolling a six *on a particular occasion* – in this case the occasion the gambler has just witnessed – is rendered more likely by the results of previous rolls.

White accuses the multiverse theorist of committing the same fallacy. Just as the gambler sees a remarkable roll of the dice and infers on that basis that there must have been many other, less remarkable rolls, so the multiverse theorist sees the striking fine-tuning of our universe and thus concludes that there must be many other universes with less striking numbers in their physics. And just as the gambler's inference is unwarranted given that other rolls do not alter the odds that *the roll she witnessed* will be a double six, so the multiverse theorist's inference is unwarranted given that the presence of other universes doesn't make it any more likely that *this universe* will be fine-tuned.

The most common suspicion concerning the 'this universe' objection is that it ignores the selection effect introduced by the fact that we couldn't have perceived a universe that was not fine-tuned. Whilst it is trivially true that this selection effect exists, its impact on our evidential situation is more controversial. One might think the following analogy supports the fine-tuning theorist:

> Joker Scenario A – You wake up in a room in an apartment block, having been kidnapped by the Joker (from Batman). The Joker tells you that, in the other rooms of this apartment block there is an indeterminate number of monkeys with typewriters, somewhere between 1 and $10^{500}$. He goes on to say that, whilst you were asleep, he waited an hour to see if any of the monkeys wrote English. Given that one did, he's going to release you. If none of them had, you would have been killed whilst unconscious.[4]

Of course, you may be tempted to think the Joker is lying, but let's suppose you have good reason to think he's telling the truth. The case seems to mirror the selection effect we find in the fine-tuning case. In reality, given that we exist, the universe must have been fine-tuned; in the analogy, given that you exist, a monkey must have written English. Moreover, it seems in this case that you do have good evidence that there are many monkeys, as your evidence – the fact that you exist and so a monkey must have written English – is more likely on the assumption that there are many monkeys than on the assumption that there is only one. By analogy, one might be tempted to conclude that the fact that we observe a fine-tuning universe is evidence that there are many universes.

In response, White distinguishes two selection effects:

> *The mere selection effect* – If we exist, there is a fine-tuned universe
> *The converse selection effect* – If there is a fine-tuned universe, we exist.

According to White, the real situation with respect to fine-tuning exemplifies the mere selection effect but does not exemplify the converse selection effect. That's because, on the assumption that there is a multiverse, it could have been that the next universe down was fine-tuned rather than ours, with some other folk existing instead of us. White makes the point vivid by imagining what would have had to be the case for the inverse selection effect to obtain. If we were once disembodied spirits, floating around the multiverse looking for a fine-tuned universe to slip into, *then* it would have been the case that: so long as there's a fine-tuned universe, we're going to exist. In the absence of something like that, argues White, we should conclude that there is no converse selection effect.

[4] White adopts and adapts analogies from P. J. McGrath (1988) involving a person who will be woken if a double six is rolled. My two Joker scenarios make essentially the same point but, I hope, more vividly.

In Joker Scenario A described above, both mere and converse selection effects obtain. Given that you exist, a monkey must have written English (mere selection effect); and if a monkey had written English, you were inevitably going to exist (converse selection effects). But if we White is right that this doesn't match the real world, then, in order to properly assess our evidential situation, we're going to need an analogy that matches the real-world situation in which the mere selection effect holds but not the converse selection effect. The following development of the thought experiment would seem to fit the bill:

> <u>Joker Scenario B</u> – You wake up to find yourself in a room in an apartment block sat opposite the Joker and a *single* monkey on a typewriter: call it Joey. The Joker tells you that Joey has just written English within one hour and hence you are to be released; if Joey hadn't written any English, you would have been killed whilst unconscious. The Joker adds that there are an indeterminate number of prisoners in the other rooms of the building – anywhere from 0 to $10^{500}$ – each with their own monkey, and each with their fate dependent on whether that particular monkey writes English within an hour.

We now have a case where the mere selection effect holds (given that you exist, a monkey must have written English) but not the converse selection effect (just because a monkey writes English, it doesn't follow that you will exist, as it could have been that someone's else monkey wrote English). If White is correct that the inverse selection effect doesn't hold in the actual fine-tuning case, then Joker Scenario B gives a better analogy for the reality of fine-tuning than Joker Scenario A.

Working with Joker Scenario B as the correct analogy, what can we infer from the evidence of fine-tuning? It seems clear that in Joker Scenario B, you have no reason to think there are any other monkey-prisoner pairs, or at least that the evidence pertaining to your survival gives you no reason to think this. The fact that you survived entails that *your monkey* wrote English. But whether or not there are other monkey-prisoner pairs has no bearing on the likelihood of your monkey writing English. By analogy, White wants to conclude, the fine-tuned evidence gives us no reason to think there are other universes. All we know is that *our universe* is fine-tuned, and whether or not there are other universe has no bearing on the likelihood of our universe being fine-tuned. Assuming there is no converse selection effect, reflection on the above analogies seem to support the 'this universe' objection.

As well as defending his position with analogies similar to those outlined above, White offers a deeper analysis of what's going on here.[5] Consider the likelihood principle, defined as follows:

[5] White gives his analysis first, and then goes on to employ thought experiments corresponding to my Joker scenarios in discussing the selection effect. I hope my order is exegetically more effective.

Likelihood Principle: E is evidence for $H_1$ over $H_2$ if and only if $P(E|H_1) > P(E|H_2)$.[6]

Whether or not the fine-tuning supports the multiverse hypothesis over the single universe hypothesis depends, at least in part, on how we construe the evidence of fine-tuning. Two possibilities suggest themselves:

E1: A universe is fine-tuned.
E2: U is fine-tuned (where 'U' rigidly designates the universe we live in).

Let us call the multiverse hypothesis M and the hypothesis that there is just one universe S. White argues for the following two claims:

- E1 supports M over S, because $P(E1|M) > P(E1|S)$. The more universes there are, the more likely it is that one of them will be fine-tuned.
- E2 does not support M over S, because $P(E2|M) = P(E2|S)$. No matter how many other universes there are, it makes it no more likely that U – as opposed to some other universe – will be fine-tuned.

If White is right about the above, the crucial question is whether our evidence should be construed as E1 or E2. At this point, White (2000: 264) brings in the following principle:

Total Evidence Requirement (TER): '…in the confirming of hypotheses, we cannot, as a general rule, set aside a specific piece of evidence in favor of a weaker piece.'

White (2000: 264) offers the following case in support of TER:

> Suppose I'm wondering why I feel sick today, and someone suggests that perhaps Adam got drunk last night. I object that I have no reason to believe this hypothesis since Adam's drunkenness would not raise the probability of me feeling sick. But, the reply goes, it does raise the probability that someone in the room feels sick, and we know that this is true, since we know that you feel sick, so the fact that someone in the room feels sick is evidence that Adam got drunk. Clearly something is wrong with this reasoning.

What has gone wrong with this reasoning, according to White, is that TER has been disrespected: the stronger evidence – that a specific individual, namely White himself, is feeling sick – has been set aside in favour of a weaker piece of evidence – namely that someone in the room feels sick. White accuses multiverse theorists of the same mistake: setting aside a stronger piece of evidence – that a specific universe, namely U, has been

[6] White lays out more detailed formalism, employing the whole of Bayes theorem. For our purposes here, it suffices to convey the core of the argument with reference to the likelihood principle.

fine-tuned – in favour of a weaker piece of evidence – namely that some universe has been fine-tuned.

There are a number of different objections philosophers have raised to White's argument. Some, for example, have questioned TER (Epstein 2017). What I want to focus on here is how the identity conditions of universes impacts on the argument. Therefore, I will assume, for the sake of discussion, that White is correct that the evidence of fine-tuning should be construed not as 'a universe is fine-tuned' but as 'U is fine-tuned.'

## II

A crucial claim for the 'this universe' objection is that the observation that U is fine-tuned does not support M over S, because the probability that U is fine-tuned on M is equal to the probability that U is fine-tuned on S; call this claim 'C'. White more or less takes C to be obvious. Why should the existence of other universes distinct from U make it any more likely that U would be fine-tuned?

Manson and Thrush point out, however, that there are at least some theories of the identity conditions of a universe which, if true, cast doubt on C. They consider, for example, the view that each set of possible parameters defines a cosmic essence. On this understanding of what a universe is, it's plausible that M raises the probability that U exists. The more universe there are, the more likely it is that the cosmic essence that essentially defines U will be instantiated.

Manson and Thrush are not arguing that C is false. Their point is rather that there is such little consensus on the identity conditions of the universe that one cannot say with any confidence that U's identity conditions are such that C is true or such that C is false. This seems right to as far as it goes. But things look very different when we consider the specific details of the multiverse hypothesis most often appealed to by scientists attempting to account for fine-tuning, namely that rooted in eternal inflation and string theory. In what follows I will lay out some of the details of this multiverse hypothesis before returning in the next section to the question of cosmic identity conditions.

Cosmological Inflation (Guth 1981, 2000) is the theory that the early universe enjoyed a period of exponential expansion before moving to a slower rate of expansion. This inflationary period is posited to explain the large-scale structure of the current universe, for example, the fact that the universe is flat and that the cosmic microwave background radiation is evenly distributed. *Eternal* inflation (Steinhardt 1983, Vilenkin 1983) is a form of cosmological inflation according to which the inflationary period never ends for space as a whole, although it ends for regions of space. What we think of as 'our universe' is in fact just a region of space in which inflation has come to an end. According to eternal inflation, there are many such non-inflationary regions, or ‘bubble universes,’ separating by exponentially inflating space. Some physicists (Guth 2001) believe that once inflation is combined with quantum theory, eternal inflation is all but inevitable because of quantum fluctuations.

A crucial point that is often not explicitly made in discussions of fine-tuning is that eternal inflation alone does not account for the fine-tuning. That’s because eternal inflation is consistent with the parameters of physics being the same in all bubble universes, and if the parameters of physics were the same in all bubble universes, we would be left with the highly surprising fact that all bubble universes are fine-tuned. The puzzle of fine-tuning would remain untouched.

This is where string theory comes in. According to string theory, the fundamental constituents of reality are not particles but one-dimensional strings. Each string is located at a single point in spacetime, housed in a high-dimensional shape in which most of the dimensions are ‘curled up.’ The facts of physics, including the parameters we are concerned with in fine-tuning discussions, are fixed by the patterns of vibrations of the strings, which are in turn determined by the high-dimensional shapes in which the strings vibrate.

In fact, there is a very big number – around $10^{500}$ – of high-dimensional shapes which could in principle house the strings, each corresponding to a different possible universe with different kinds of particles and forces. This set of possibilia is referred to as the ‘string landscape.’ This opens up the theoretical possibility that different bubble universes might exemplify different options from the string landscape. We can call the theory that posits this theoretical possibility ‘landscape eternal inflation.’ Proponents of this theory speculate (Tegmark 2014: Ch. 6) that the high energies that exist during inflation are able to mould, somewhat randomly, the high-dimensional shapes contained in different regions of spacetime; as a result, different bubbles emerge from inflation with different particles and forces.

A second point often not make explicit in these discussions is that there are no empirical grounds for moving from eternal inflation to landscape eternal inflation. String theory is highly speculative. Moreover, even if we accept string theory, there is no empirical reason to think that different possibilities in the landscape are actually instantiated. It is quite coherent to suppose that eternal inflation and string theory are both true, but that each bubble universe contains exactly the same particles and forces, because each point in the entire multiverse contains the same high-dimensional shape. Call the theory expressing this possibility ‘homogenous eternal inflation’. There is no empirical reason to favour landscape eternal inflation over the simpler theory of homogenous eternal inflation, and all things being equal simpler theories are to be preferred.

Or rather, there is no empirical reason to favour landscape eternal inflation over homogenous eternal inflation *other than the fine-tuning* we observe in our universe. The reason some scientists take seriously landscape – as opposed to homogenous – eternal inflation is because it seems to provide a nice explanation of fine-tuning. If different particles and forces exist in different bubbles, such that a wide range of different parameter values show up in the physics of different bubbles, then it perhaps becomes not so surprising that our universe would happen, just by chance, to have fine-tuned parameters.[7]

In so far as scientists take *landscape* (as opposed to homogenous) eternal inflation seriously, then, it is because they believe that the fine-tuning provides evidential support for the move from homogenous eternal inflation to landscape eternal inflation. However, assuming White is correct that the relevant evidence is that *our universe* is fine-tuned – which in the context of eternal inflation is understood as the evidence that *our bubble* is fine-tuned – the crucial question is whether or not the assumption of landscape eternal inflation raises the probability that our bubble is fine-tuned.

## III

We have been framing C as:

> C: The observation that U is fine-tuned does not support M over S, because P(U is fine-tuning|M) = P(U is fine-tuned|S)

What we are now interested in is whether moving from homogenous eternal inflation (HEI) to landscape eternal inflation (LEI) raises the probability that U is fine-tuned, where U is our bubble universe; call the claim that it does not C*.

> C*:  The observation that U is fine-tuned does not support LEI over HEI, because P(U|LEI) = (P(U|HEI)

Assessing either C or C* requires forming a view as to the identity conditions of U. The advantage we have when considering C* is that we have a detailed conception of what U is: a bubble universe within a broader space of eternal inflation. What are the identity conditions of a bubble universe, that is to say, what makes a given bubble universe the particular bubble universe it is? Although Manson and Thrush do not consider eternal inflation in any detail, they do suggest that 'with cosmogenic models whereby universes grow out of inflating "bubbles" in a pre-existing hyperspace, perhaps the bubbles can be

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[7] Although White disputes that the fine-tuning is evidence for the multiverse, he accepts that if we assume – perhaps on independent evidence – that there is a multiverse (of the right kind), the fine-tuning is not surprising. Section VI of his paper offers an account of what makes an event surprising, which makes sense of this.

distinguished in terms of their positions in this hyperspace' (Manson & Thrush 2003: 77). This does indeed seem to be the most plausible way view about the identity conditions of bubbles in eternal inflation. Just as it's plausible following Kripke (1980) that I am essentially defined in terms of the sperm and egg from which I originated, so it's plausible that our bubble universe is essentially defined in terms of the region of space which stopped inflating to create this bubble. Call LEI combined with this view about the identity conditions of bubbles 'EO-LEI' (EO for 'essential origins').[8]

According to EO-LEI, our bubble ends up not being essentially fine-tuned. For recall, on LEI, random processes fixed the high-dimensional shapes contained in the region of space that became our universe when it stopped inflating. Those random processes happened to result in U having fine-tuned parameters, but those random processes might easily have rendered U non-fine-tuned. And crucially, at the time those random processes were moulding the high-dimensional shapes which would ultimately determine the physics in U, how many *other* regions of space were being randomly moulded had absolutely no bearing on how likely it was that the region of space that would become U would turn out fine-tuned. In his paper, White is not working with a specific scientific model of the multiverse, but in fact the assumptions he makes about universe formation fit perfectly with EO-LEI:

> The events which give rise to universes are not causally related in such a way that the outcome of one renders the outcome of another more or less probable. They are like independent rolls of a die (White 2000: 263).

Could we not combine LEI with the 'cosmic essence' view of Manson and Thrush outlined earlier? On this view (call it 'CE-LEI' for 'cosmic essence' LEI), U is entirely essentially defined by its parameter-values. Call the region of space which stopped inflating to become our universe 'the seed.' CE-LEI entails the following two propositions:

> P1: In another possible world in which random processes had moulded the seed to have different parameter-values, a universe non-identical with U would have resulted.
> P2: Any bubble universe (actual or merely possible) with the same physics as U is identical with U.

P2 is implausible. Just because another bubble universe ends up having the same physics as ours, that clearly doesn't make it numerically identical to our universe. Despite having the

[8] Manson and Thrush (2003:77) say that this kind of multiverse raises the question of what determines that identity conditions of regions in the larger space. It doesn't seem to me that we need to answer this question in order have grounds for holding that the identity conditions of the bubbles are determined by their location in the larger space. Moreover, either an account in terms of the relational properties of a given region, or one involving the postulation of haecceities at regions or points, would seem to be adequate.

same physics, these bubbles have different locations in the multiverse, and, by Leibniz's law, identical things cannot have different properties.

What about a hybrid of EO-LEI and CE-LEI? According to H-LEI – 'H' for 'hybrid' – U is essentially defined *both* by its location in the multiverse *and* by its parameter-values. Hence, P1 is true but P2 is false. On EO-LEI, we can take it that the seed is identical with U: a single entity merely changes state as its high-dimensional shapes are fixed and it stops inflating. On H-LEI, however, the seed and U cannot be identical, which can be demonstrated in the following:

1. Assuming H-LEI, in any non-actual world in which the universe U* which results from the seed has different physics, U is not identical with U* (this follows from P1).
2. Given that U is not identical with U*, the seed cannot be identical with both U and U* (by the transitivity of identity).
3. Either the seed is identical with both U and U* or it is identical with neither U nor U* (it would be arbitrary to say it's identical to one but not the other).
4. Therefore, the seed is identical with neither U nor U*.

Thus, on H-LEI, we say either that the seed ceases to exist to be replaced U, or (more plausibly) the seed continues to exist but comes to constitute a new entity U. This is an ad hoc multiplication of entities. By far the more natural assumption is that the seed *becomes* U, as an embryo becomes, in the fullness of time, an adult. The only possible motivation for holding otherwise is to avoid the 'this universe' objection. But this would get things the wrong way around. We should be trying to work out the most plausible way of taking the identity conditions of U and *then* judging whether the 'this universe' objection applies, rather than queering the pitch by allowing our desire to avoid this objection to shape our view of U's identity conditions.

## Conclusion

I have not considered every response that has been raised to the 'this universe' objection, nor every version of the multiverse hypothesis. I have rather focused on the most popular scientific theory of the multiverse – landscape eternal inflation – and considered whether its identity conditions undermine the 'this universe' objection. I hope to have shown that they do not.

**References**

Bradley, D.J. (2009) 'Multiple universes and observation selection effects,' *American Philosophical Quarterly*, 46: 61–72.

Davies, Paul C.W. (2006) *The Goldilocks Enigma: Why is the Universe Just Right for Life?,* London. Allen Lane.

Epstein, Peter (2017) ‘The fine-tuning argument and the requirement of total evidence,’ *Philosophy of Science* 84: 4, 639-658.

Greene, Brian (2011) *The Hidden Reality: Parallel Universes and the Deep Laws of the Cosmos*, New York: Vintage.

Guth, Alan H. (1981) ‘Inflationary universe: A possible solution to the horizon and flatness problems,’ *Physical Review D*, 23: 2, 347.

Guth, Alan, H. (2000) ‘Inflation and eternal inflation,’ *Physics Reports*, 333: 555–574.

Guth, Alan, H. (2001) ‘Eternal inflation,’ in *Proceedings of ‘Cosmic Questions’ Meeting*, the new York Academy of Sciences Press, 950: 66.

Hacking, Ian (1987) ‘The inverse gambler’s fallacy: the argument from design. The anthropic principle applied to Wheeler Universes,’ *Mind* 96: 383, 331–340.

Kripke, Saul (1980) *Naming and Necessity*, Cambridge, MA, Harvard University Press.

Leslie, John (1989) *Universes*, London: Routledge.

Lewis, Geraint J. and Luke A. Barnes (2016) *A Fortunate Universe: Life in a Finely Tuned Cosmos*, Cambridge: Cambridge University Press.

Manson, Neil A. & Michael J. Thrush (2003) ‘Fine-tuning, multiple universes, and the ‘this universe’ objection,’ *Pacific Philosophical Quarterly*, 84: 1, 67–83.

McGrath, P. J. (1988) ‘The Inverse Gambler’s Fallacy and Cosmology—A Reply to Hacking,’ *Mind* 97: 265–268.

Parfit, Derek (1998) ‘Why anything? Why this?’ *London Review of Books*, January 22: 24–27.

Rees, Martin (2000) *Just Six Numbers: the Deep Forces that Shape the Universe*, New York: Basic Books.

Smart, J.J.C. (1989) *Our Place in the Universe: A Metaphysical Discussion*, Oxford: Blackwell.

Steinhardt, Paul J. (1983) ‘Natural Inflation,’ in Gibbons, G. W., Hawking, S. W. & Skilos, S. T. C. (Eds.) *The Very Early Universe*, Cambridge University Press, 251-66.

Susskind, Leonard (2005) *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design*, New York: Back Bay Books.

Tegmark, Max (2014) *Our Mathematical Universe: My Quest for the Ultimate Nature of Reality*, New York: Knopf.

Vilenkin, Alexander (1983) ‘Birth of inflation universes,’ *Physical Review D*, 27: 12, 2848-2855.

White, Roger (2000) “Fine-tuning and multiple universes”, *Noûs* 34(2): 260–267.