The Normalizability Objection to Fine-Tuning Arguments

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In this paper, I lay out the so-called normalizability objection to fine-tuning arguments as proposed by Timothy and Lydia McGrew and Eric Vestrup. After stating the objection, I canvass some replies that have so far appeared in print. My aim is that presenting these replies in cumulative-case fashion will serve to at least assuage the force of the normalizability objection.

Introduction

"The Holy Grail of modern physics," write John Barrow and Frank Tipler, "is to explain why [the constants of nature]—quantities like the ratio of the proton and electron masses for example—have the particular numerical values they do."[1] Explaining the evidence Barrow and Tipler mention—evidence of *fine-tuning* of the universe—can be thought of not just as the Holy Grail of modern physics, but all of science; and indeed all of life. This is because evidence of fine-tuning reveals with literally astronomical precision the conditions on which all of life—or at least intelligent life—depends. Therefore explaining this evidence, it is thought, is tantamount to explaining our existence. To this effect many have argued that the evidence of fine-tuning constitutes powerful evidence for cosmic design. I am sympathetic to design arguments of this type. However, they have been met with some serious objections. Chief among them is the so-called "normalizability" objection. In this paper, I first summarizing the normalizability objection as originally stated by Timothy and Lydia McGrew and Eric Vestrup. Following this I canvass five possible replies to the normalizability objection in an effort to assuage its force.

1. The Normalizability Objection

1.1. Fine-Tuning

The fine-tuning argument for the existence of God (FTA), as the name suggests, draws its support from evidence that suggests that the fundamental constants and laws of our universe are fine-tuned for the existence of intelligent life. By "fundamental constants and laws of the universe" one is referring to things the fine structure constant, or electromagnetic interaction α, gravitation α_G, the weak nuclear force α_W, and the proton-to-electron mass ratio m_p/m_e, or density Ω_0 and speed H_0 of expansion of the universe. What it means to say these are "fine-tuned" is made clear by examples. Changes in either α_G or electromagnetism by one part in 10^{40} would have precluded the existence of stars like the sun, and, as a consequence, planets. A change in either α_G or α_W by only one part in 10^{100} would have prevented a life-permitting universe. If m_p increased by just 0.2%, hydrogen would be unstable and life would not have formed; if it had been a hair's breadth weaker, nothing but helium would have been synthesized in the universe. At 10^{-43} seconds after the Big Bang, referred to as Plank Time, Ω_0 had to be within about 10^{60} of critical density to "flatten" space (known as the "flatness problem"). Roger Penrose famously calculated that the exact entropy condition suitable for the formation of life, by chance alone,

[1] John Barrow and Frank Tipler, *The Anthropic Cosmological Principle* (Oxford, 1988), p. 5.

to be $10^{10(123)}$.[2]

Rob Collins, the premier defender of the fine-tuning argument, proposes a more technical definition of “fine-tuning” as follows:

> we can think of the claim that a parameter of physics is ‘fine-tuned’ as the claim that the range of values, *r*, of the parameter that is life-permitting is very small compared with some non-arbitrarily chosen theoretically ‘possible’ range of values *R*. The degree of fine-tuning could then be defined as the ratio of the width W of the life-permitting region to the comparison region.[3]

The examples of fine-tuning above will be just those values Collins thinks fall within *r*. The range of values in *r*—those conducive to the existence of intelligent life—are then compared to a much larger range of values, *R*, that are not life conducive.

1.2. The Normalizability Objection

In their paper “Probabilities and the Fine-Tuning Argument,”[4] Timothy and Lydia McGrew and Eric Vestrup present what appears to be a particularly damning objection to FTAs. Discontent with the stories and analogies defenders of the FTA often rely on, the McGrews and Vestrup and set out to “state the FTA in a more rigorous form.”[5] But in so doing, they conclude that the particular use of probabilities in the FTA makes it formally incoherent. This is because the probabilities are not “normalizable”—a necessary feature of coherent probability judgments.

A probability range is normalizable if all of its variables can sum up to one:

$$\sum_{x \in R} \Pr(x) = 1$$

Moreover, probability ranges must also obey the *Principle of Indifference*, which states that for any probability range *R* with *n* variables, any variable e_i is equally likely as another. So where $R = \{e_1, e_2, e_3, \ldots e_n\}$,

$$\sum_{n \in R} \Pr(e_n) = 1$$

i.e., $\Pr(e_1) + \Pr(e_2) + \Pr(e_3) + \ldots \Pr(e_n) = 1$. Since each of variables e_i is equally likely as any other, $\Pr(e_i) = 1/n$.[6] But, argue the McGrews and Vestrup, the probabilities in FTAs cannot be normalizable *and* obey the Principle of Indifference. This is because “the field of possible values for the parameters appears to be an interval of real numbers unbounded at least in the upward direction. There is no logical restriction on the strength of the strong nuclear force, the speed of light, or the other parameters in the upward direction.”[7] The problem now is obvious: if the probabilities are unbounded in the

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[2] For a nice presentation and discussion of fine-tuning, see William Lane Craig, “Design and the Anthropic Fine-Tuning of the Universe,” in Neil Manson (ed.), *God and Design* (Routeledge, 2003),pp. 155-161. Examples of evidence of fine-tuning abounds. Throw a rock at any article or book on this and see the references.

[3] Rob Collins, “Evidence for Fine-Tuning,” in Neil Manson (ed.), *God and Design* (Routeledge, 2003), p.179.

[4] Timothy McGrew, Lydia McGrew, and Eric Vestrup, “Probabilities and the Fine-Tuning Argument,” in Neil Manson (ed.), *God and Design* (Routeledge, 2003), pp. 200-208.

[5] Ibid., p. 202.

[6] n multiplied by $\Pr(e_1) = 1$, hence $\Pr(e_1) = 1/n$. Since $\Pr(e_i) = \Pr(e_1)$, $\Pr(e_i) = 1/n$.

[7] McGrews and Vestrup, “Probabilities and the Fine-Tuning Argument,” p. 201.

upward direction, there are an infinite number of variables in the probability range. But if there are an infinite number of variables, there is no way for each variable together to sum up to one. "If they have any sum," say the McGrews and Vestrup, "it is infinite."[8] This spells disaster for statements of the FTA that rely on the claim that it is unlikely that the fundamental constants and laws of our universe fall into a certain probability range as opposed to other possible probability ranges. According to the McGrews and Vestrup, the culprit giving rise to the problem is The Principle of Indifference: "Working from bare logical possibilities, it seems unreasonable to suggest that any one range of values for the constraints is more probable *a priori* than any other similar range—we have no right to assume that one sort of universe is more probable *a priori* than any other sort."[9] They conclude that this problem demonstrates, in one fell swoop, that there is no coherent way to state the FTA.

2. Assorted Replies

The normalizability objection to FTAs is a powerful one. My purpose in this section is not to articulate a novel reply to the McGrew's and Vestrup, but only to canvass some of the replies that have appeared in the literature so far.

2.1. Rejecting Countable Additivity

In considering the normalizability objection, Alvin Plantinga notes that the real culprit giving rise to the normalizability problem is not the Principle of Indifference, but another principle often used in probability judgments: *countable additivity.*[10] Countable additivity stipulates that for a countable set of alternatives, the probability of any disjunction of the alternatives is equal to the sum of the probabilities of the alternatives: $\{e_1, e_2, e_3 \ldots e_n\}$, $\Pr(e_1 \vee e_n) = [\Pr(e_1) + \Pr(e_n)]$. Presumably, an infinite probability range can be normalizable without violating the Principle of Indifference by assigning each variable a probability of zero but their infinite disjunction a probability of one. But the McGrews and Vestrup clearly have in mind a probability range in which the values of each variable together all *add up* to one.[11] Thus, the problem can be seen to follow more readily from countable additivity; for the sum of the range to be, if anything, infinite, each variable must have a finite, positive probability. So the real culprit responsible for giving rise to the normalizability problem is countable additivity, not the Principle of Indifference.

After locating the real culprit, Plantinga casts on it an eye of suspicion: "If we don't reject infinite multitudes, perhaps the most sensible way to proceed is to give up countable additivity."[12] Plantinga gives an example of how this would look with respect to the FTA. It "seems to fit well with intuition," says Plantinga, to say "the velocity of light could fall within each of infinitely many mutually exclusive and jointly exhaustive small intervals; the probability that it falls within any particular one of these intervals is zero, but of course the probability that it falls within one or another of them is one."[13] Plantinga's intuition seems to have been right; it is precisely countable additivity that other replies to the McGrews and Vestrup have targeted. For example, Robin Collins has observed that countable

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[8] Ibid., p. 203.
[9] Ibid., p. 204.
[10] Alvin Plantinga, *Where the Conflict Really Lies: Science, Religion, and Naturalism* (forthcoming Oxford, 2011), p. 204. All citations are to this unpublished manuscript.
[11] McGrews and Vestrup, "the sum of the logically possible disjoint alternatives adds up to one." p. 203
[12] Plantinga, *Where the Conflict Really Lies*, p. 208.
[13] Ibid., p. 208-209. Robin Collins also suggests this solution in Collins, "How to Rigorously Define Fine-Tuning" p. 12. This is a penultimate draft of a chapter in his forthcoming book *The Well-Tempered Universe: God, Fine-Tuning, and the Laws of Nature*.

additivity derives its specious plausibility from "a fundamental principle of the probability calculus called *finite additivity*. When finite additivity is extended to a countably infinite number of alternatives, it is called *countable additivity*, which is the principle that McGrew and Vestrup implicitly invoke."[14] But as Collins goes on to show, countable additivity "has been very controversial for almost every type of probability, with many purported counterexamples to it."[15] Noting this fact, I think, significantly wavers the strength of the normalizability objection.

2.2. Proves too Much

Suppose countable additivity is, in the end, a legitimate principle in probability judgments dealing with infinite magnitudes. It still seems that we are justified in thinking something is awry in the normalizability objection. If sound, the normalizability problem would undermine even the most obviously justified inferences to design. To illustrate, Plantinga imagines a scenario in which the night sky displays the words "I am the Lord God, and I created the universe." Plantinga asks us to further imagine that these words "are visible from any part of the globe at night; upon investigation they appear to be a cosmic structure with dimensions 1 light year by 20 light years, about 40 light years distant from us."[16] The words must therefore fall within what Plantinga calls a "message-permitting range"—a range that allows the message to be visible to us from any part of the globe. "Not just any length will be 'message-permitting,'" says Plantinga, for "holding its distance constant, if the structure is too short it won't be visible to us. But the same goes if it is too long; e.g., if it is so long that we can see only a minute and uninterpretable portion of one of the letters. Therefore there is a 'message permitting' band such that the length of this structure must fall within that band for it to function as a message."[17] Surely this is would constitute an enormously powerful argument for design. But not if the McGrews' and Vestrupt's objection is sound. Plantinga explains:

> For think about the parameters involved here…What are the logical constraints on the length of this structure? None; for any number *n*, it is logically possible that this structure be *n* light years long. … But if the structure can be any length whatever, this parameter, like those involved in the FTA, can fall anywhere in an infinite interval. This means that if we honor [the principle of indifference], the relevant probability measure isn't normalizable: we can't assign the same positive probability to each proposition of the form *the message is n light years long* in such a way that these probabilities sum to 1.[18]

That the McGrews and Vestrup's objection would undermine even a design inference as obvious as this indicates that the objection proves too much. Something must be wrong with it.

Collins provides another reason for thinking the objection is 'counterintuitive' by itself.[19] Recall Collins' definition of fine-tuning above:

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[14] Robin Collins, "The Teleological Argument: An Exploration of the Fine-Tuning of the Universe," in William Lane Craig and J. P. Moreland (eds.), *The Blackwell Companion to Natural Theology* (Wiley-Blackwell, 2009), p. 250.

[15] See ibid. for examples. In "God, Fine-Tuning, and the Problem of Old Evidence," Bradley Monton notes that some probability theorists have developed "sophisticated yet natural" ways of handling infinite multitudes probabilistically. He cites Peter Vallentyne, "Standard Decision Theory Corrected," *Synthese* 122 (2000), pp. 261-290.

[16] Plantinga, *Where the Conflict Really Lies*, p.206.

[17] Ibid.

[18] Ibid.

[19] Collins, "The Teleological Argument for the Existence of God," pp. 251-252. Collins actually makes this point in response the McGrews' objection to the course-tuning argument, but I don't see why it could not be made with respect to the fine-tuning argument.

> we can think of the claim that a parameter of physics is 'fine-tuned' as the claim that the range of values, *r*, of the parameter that is life-permitting is very small compared with some non-arbitrarily chosen theoretically 'possible' range of values *R*. The degree of fine-tuning could then be defined as the ratio of the width *W* of the life-permitting region to the comparison region.[20]

We can short-hand this ratio as W_r/W_R.[21] It follows from this that the range of life-permitting values W_r becomes increasingly more narrow as the range of theoretically 'possible' rage of values W_R increases. In other words, As W_R increases, the strength of the FTA increases because the larger W_R gets, the more improbable it is that the values of the constants in our universe should fall within W_r. Now the McGrews and Vestrup in effect are claiming that because *R* is unbounded at least in the upward direction, the sum of the values within *R* will be infinite and hence not normalizable. But, Collins points out, the normalizability objection would have us draw from this the "counterintuitive conclusion" that the FTA gets stronger and stronger as the *R* increases, but "loses all probaitive force" once *R* is infinite. And this does seem counterintuitive.

2.3. Defining a Finite Parameter

The normalizability objection hinges on the claim that there is no logical upper-bound to the possible values *R* can take. Granted that there is no *logical* upper bound, perhaps *R* can be justifiably assigned an upper bound in another way to get around the normalizability objection. Collins does just this.[22] Collins argues that *R* can be justifiably given an *epistemic* upper bound by defining *R* in terms of what he calls the "epistemically illuminated region" (EI).[23] EI, according to Collins, is defined by the range of values a constant can take "for which we can make a reasonable estimate whether or not that value [of the constant] is (intelligent) life-permitting."[24] EI will often specify a finite range of physically significant values a constant can assume. And *prima facie* this makes good sense; EI, as a finite range of what we know to be physically significant values, can then serve in a convenient way to determine our relevant background knowledge regarding the probability of life-permitting universes. Collins offers the following illustration to further justify this procedure:

> Suppose we had a dart board that extended far into the distance, but the entire dart board was not illuminated: only some finite region around the bull's eye was illuminated, with the rest of the dart board in darkness. We thus neither know how far the dart board extends nor whether there are other bull's eyes on it. If we saw a dart hit the bull's eye in the illuminated (IL) region, and the bull's eye was very, very small compared to the IL region, we would take that as evidence that the dart was aimed, even though we cannot say anything about the density of bull's eyes on other regions of the board.[25]

A probabilistic interpretation of this illustration will show the hypothesis that the dart hit the bull's eye by design is strongly confirmed over the hypothesis that the dart hit the bull's eye by chance. Thus, even if the non-illuminated region of the dart board extends out to infinity, this would not render

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[20] Rob Collins, "Evidence for Fine-Tuning," p.179.
[21] Collins, "How to Rigorously Define Fine-Tuning" p. 1.
[22] Although Collins makes clear that his project of defining *R* is *not* by itself an attempt to counter the normalizability problem. See Collins, "How to Rigorously Define Fine-Tuning."
[23] See Ibid., p. 3
[24] Ibid., p. 1
[25] Ibid., p. 9. The illustration is adapted from John Leslie, *Universes* (Routeledge, 1989), pp. 11, 199-202. Collins' whole procedure for justifying *R* in terms of EI is a bit more complicated.

probability judgments (and hypothesis confirmation) regarding the location of the dart meaningless. Thus, Collins proposes an epistemic counterpart to the Principle of Indifference he calls the *Restricted Principle of Indifference*. The Restricted Principle of Indifference states that when we have no reason to prefer any value of a constant over another, we should assign equal epistemic probabilities to equal ranges of possible values the constant could take, where the possible value in question directly corresponds to some physically significant value.[26] This principle allows for a "uniform probability distribution" over W_R, which makes W_R normalizable.

2.4. An Untoward Consequence?

One interesting consequence of the normalizability objection to FTAs, if it is right, is that it would undercut another favorite objection to FTAs—the so-called Many Worlds Hypothesis. If this is right, then one cannot endorse both the normalizability objection and the Many Worlds Hypothesis as objections to FTAs. Either one or both objections are mistaken.

According to the Many Worlds Hypothesis, there are an enormous number, most say an infinite number, of other, concretely existing space-time universes besides our own. Furthermore, each universe's fundamental laws and constants assume their own unique set of values. The idea is that the more universes there are, the more probable it is that any one set of values is actualized, and, as a result, the more probable it is that our universe's fundamental laws and constants have the values they do. But then the FTA is a non-starter. Given an infinite number of other universes, all of which express a unique set of values in their fundamental laws and constants, fine-tuning in some universes is *certain*. Ours is just one such universe. There are a number of other important objections to the Many Worlds Hypothesis,[27] but here I want to just think of it in light of the normalizability problem.

Recall that the McGrews and Vestrup argued that probabilities are not normalizable in cases where probabilities are unbounded in the upward direction (i.e., where there are an infinite number of variables in the probability range). But it is not clear to me why the same problem cannot be raised against the Many Worlds Hypothesis in the following way. With respect to *any* one universe among the infinite set $\{U_1, U_2, U_3, \ldots U_n\}$, say, U_1, there are an infinite number of other possible values U_1's fundamental laws and constants could have had; namely, the values of U_2, or U_3, or… U_n. But if this is the case, then again the probability range is infinite, and hence not normalizable.[28] The McGrews and Vestrup's own description of what leads to the normalizability problem with respect to a Single Universe Hypothesis makes it clear that it also can be applied to the Many Worlds Hypothesis. They write:

> Since the variables in question range over the reals, we may reasonably assume that there are infinitely many possible universes that are arbitrarily similar to ours though mathematically distinct—universes in which the constants differ from those in ours by amounts so small that the physical implications…It is

[26] Ibid., p. 3. See also Collins, "The Teleological Argument: An Exploration of the Fine-Tuning of the Universe," p. 234.

[27] For a sober and accessible look at the scientific status of the multiverse hypothesis, see George Ellis' recent cover story "Does the Multiverse Really Exist" in the August 2011 edition of *Scientific American*. For a trenchant critiques, see Collins (ibid.,), pp. 256-272 and William Lane Craig, *Reasonable Faith* (Crossway Books, 3rd ed. 2008), pp. 131-134; 145-150; 166-170.

[28] One might try to avoid this by arguing that it is a necessary fact that U_1's constants have the values they do. This does not work. If this were a necessary fact, the probability that U_1's constants have the values they do would be 1, which would vitiate the probability range, rendering it non-normalizable. The probability range cannot sum up to 1 if the probability of each independent variable is 1. Moreover, nothing seems logically impossible about U_1 swapping constants with, say, U_2. Note that according to the Many Worlds Hypothesis, each universe is a discrete spatiotemporal entity. Thus, these universes remain numerically distinct even if their values are altered.

> certainly incumbent on anyone who would contest this possibility to explain why *only* this universe, and not one arbitrarily similar to it, could sustain life.[29]

Whereas the Single Universe Hypothesis maintains that there are infinitely many sets of values that could have obtained in this universe, the Many Worlds Hypothesis maintains that every possible set of values actually do obtain in some universe or another. The only difference between the two hypotheses, with respect to the probability range, is the number of members in the set that obtains. But the range of possible values any one universe's constants could assume, for both hypotheses, is infinite. Even if one construes the Many Worlds Hypothesis to postulate a large but finite number of other universes, the number postulated will have to be, *ex hypothesi*, however many is needed to increase the probability of fine-tuning in our universe.[30] This shows that the number of universes, according the Many Worlds Hypothesis, is logically "unbounded at least in the upward direction." And this is precisely the problem the normalizability objection targets.

Thus, the normalizability problem is as much a problem for the Many Worlds Hypothesis as it is for FTAs. If one is committed to evaluating the probability of fine-tuning by appealing to the Many Worlds Hypothesis, then one must be committed to thinking there is something wrong with the normalizability objection. On the other hand, if one is convinced by the normalizability objection to FTAs, then one must also be convinced that this is a problem for the Many Worlds Hypothesis.[31] My own suspicion is that this should heap further doubt on the soundness of the normalizability objection.[32]

2.5. Relevant Probabilities

A final response to the normalizability objection to FTAs I will mention is suggested by Bradley Monton and (again) Collins.[33] Both Monton and Collins point out that the McGrews and Vestrup are working with objective or mathematical probability, which is not the same type of probability that defenders of the FTA typically work with. The FTA is best stated using *epistemic* (Collins) or subjective (Monton) probability. Mathematical or logical probability is an interpretation of probability where the probabilities in question are assigned definite and discrete values in accordance with *a priori* reasoning. Epistemic probability, on the other hand, "is the sort of probability used in science and everyday life."[34] Epistemic probability is an interpretation of probability where the probabilities in question are assigned certain ranges of accuracy, roughly corresponding to degrees of justification or rational belief for a given hypothesis. Interestingly, both Collins and Monton think the normalizability

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[29] McGrews and Vestrup, "Probabilities and the Fine-Tuning Argument," p. 202.

[30] Avoiding arbitrariness will seem to demand postulating an infinite number of other universes. An infinite number of other universes would also constitute a *simpler* Many Worlds Hypothesis than one which postulated a large but finite number of other universes. For a defense and nuance of this application of the criterion of simplicity, see Richard Swinburne, *The Existence of God* (Oxford, 2nd ed. 2004), p. 55. To be clear, Swinburne's actual claim is that "hypotheses attributing infinite values of properties to objects are simpler than ones attributing large finite values…But note that the preference for the infinite over the large finite applies only to degrees of properties and not to numbers of independent entities." (idem.). But we can still make use of Swinburne's point by seeing the number of universes postulated as a property of the mechanism that generates the universes.

[31] Del Ratzsch has informed me that he makes a similar observation in "Saturation, World Ensembles and Design," *Faith and Philosophy*, 22/5 (2005), pp. 667-686.

[32] It is doubtful to me that the high-level theoretical physicists who back the Many Worlds Hypothesis lack the mathematical foresight to see that the normalizability problem arises, if it in fact does.

[33] Bradley Monton, "God, Fine-Tuning, and the Problem of Old Evidence," *British Journal of Philosophy of Science* 57 (2006), p. 409. Collins, "How to Rigorously Define Fine-Tuning," p. 13.

[34] Collins, Ibid., p. 13.

objection fails to target the FTA construed in terms of epistemic probabilities, but in different ways.

Collins argues that when it is epistemic probability at work, one should reject countable additivity (for the aforementioned reasons). Monton, however, argues that when it's epistemic probability at work, it is the Principle of Indifference that should go.[35] Monton makes clear that a defender of the FTA working with epistemic probability could assign probabilities in accordance with the Principle of Indifference (as Collins does), but they are free not to. In such a case, "it is open for an agent to assign zero probability to other possible values. It follows that the probabilities assigned to the various disjoint possibilities can sum to one."[36]

Conclusion

I have attempted in this paper not to refute the normalizability objection to FTAs, but to simply sketch some possible replies. The technical skill required to evaluate these probability claims on their own is not needed to appreciate the replies as testimonial evidence undercutting undue confidence in the normalizability objection to FTAs. Although the failure of the normalizability objection does not mean the fine-tuning argument for the existence of God is sound, that the FTA can overcome its strongest objections doesn't hurt its plausibility. It is doubtful, though, that even if the FTA continues to succeed in overcoming its strongest objections, most philosophers and scientists will see it as revealing the Holy Grail of existence.

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[35] Monton, "God, Fine-Tuning, and the Problem of Old Evidence," p. 410.

[36] Ibid.