Philosophy Compass 4/1 (2009): 271–286, 10.1111/j.1747-9991.2008.00188.x

The Fine-Tuning Argument

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Abstract

The Fine-Tuning Argument (FTA) is a variant of the Design Argument for the existence of God. In this paper the evidence of fine-tuning is explained and the Fine-Tuning Design Argument for God is presented. Then two objections are covered. The first objection is that fine-tuning can be explained in terms of the existence of multiple universes (the 'multiverse') plus the operation of the anthropic principle. The second objection is the 'normalizability problem' – the objection that the Fine-Tuning Argument fails because fine-tuning is not actually improbable.

Introduction

The Fine-Tuning Argument (FTA) is a recent variant of the Design Argument (also known as the Teleological Argument) for the existence of God. The Fine-Tuning Argument grew out of discoveries prompted by the development of Big Bang cosmology in the twentieth century. Prior to this development, it was thought by almost all scientists and philosophers that the concept of the universe was too vague and amorphous to figure into any respectable scientific discussion. Indeed, drawing on the argument in Kant's First Antinomy, many claimed the term 'the universe' could not designate any genuine object, because reason dictated that such an object would have to be both finite and infinite. After the development of Big Bang cosmology, however, the universe was seen to be highly structured, with precisely defined parameters such as age (13.7 billion years), mass, curvature, temperature, density, and rate of expansion. Modern physics also revealed that specific kinds of particles compose the universe and specific kinds of forces govern these particles, and that the natures of these particles and forces determine large-scale processes such as cosmic expansion and star formation.

The results of these scientific inquiries can be represented using a table, with the fundamental physical parameters of the universe listed on the left and the actual values of those parameters on the right. The list would include lines such as the following.

Parameter	Actual value
M_p (mass of the proton)	938.28 MeV
M_n (mass of the neutron)	939.57 MeV
c (the speed of light)	2.99792458×10^8 m^1s^{-1}
G (the Newtonian gravitational constant)	6.6742×10^{-11} $m^3kg^{-1}s^{-2}$

Looking at the very precise numerical values of parameters such as these, some physicists asked what the universe would have been like if the values had been slightly different. More specifically, for many an individual parameter, they asked what the universe would be like if that parameter were varied while the remaining parameters were held fixed. The answer, to the surprise of many, was that the universe would not have been the sort of place in which life could emerge – not just the very form of life we observe here on Earth, but any conceivable form of life. In many cases, the cosmic parameters were like the just-right settings on an old-style radio dial: if the knob were turned just a bit, the clear signal would turn to static. As a result, some physicists started describing the values of the parameters as 'fine-tuned' for life. Let us henceforth use 'fine-tuning' as shorthand for the fact that our universe is fit for life when modern physics shows it so easily might not have been.

To give just one of many possible examples of fine-tuning, the cosmological constant (symbolized by the Greek letter 'Λ') is a crucial term in Einstein's equations for the General Theory of Relativity. When Λ is positive, it acts as a repulsive force, causing space to expand. When Λ is negative, it acts as an attractive force, causing space to contract. If Λ were not precisely what it is, either space would expand at such an enormous rate that all matter in the universe would fly apart, or the universe would collapse back in on itself immediately after the Big Bang. Either way, life could not possibly emerge anywhere in the universe. Some calculations put the odds that Λ took just the right value at well below one chance in a trillion trillion trillion trillion. Similar calculations have been made showing that the odds of the universe's having carbon-producing stars (carbon is essential to life), or of not being millions of degrees hotter than it is, or of not being shot through with deadly radiation, are likewise astronomically small. Given this extremely improbable fine-tuning, say proponents of FTA, we should think it much more likely that God exists than we did before we learned about fine-tuning. After all, if we believe in God, we will have an explanation of fine-tuning, whereas if we say the universe is fine-tuned by chance, we must believe something incredibly improbable happened.

This idea can be formalized. FTA involves three propositions that are common to any version of the Design Argument: (K) a statement of our background scientific *k*nowledge minus the alleged evidence of design; (E) a statement of the alleged *e*vidence of design; and (D) the hypothesis that there exists a supernatural *d*esigner. In the case of FTA the propositions are these.

K = Many of the initial conditions and free parameters of a universe need to be finely tuned in order for the development of life in that universe to be possible.

E = The universe is indeed fine-tuned for life.

D = A supernatural designer of immense power and knowledge exists.

FTA then consists of three premises and a conclusion. (1) The probability of E, given K and assuming the denial of D, is extremely low; that is, fine-tuning is exceptionally improbable if there is no designer – if the universe is the way it is just by chance. (2) The probability of E, given K and assuming D, is quite high; that is, fine-tuning is quite probable if a supernatural designer exists. (3) The intrinsic probability of D – the probability of D just considered in light of K and not in light of E – is greater than the probability of E, given K and assuming the denial of D; that is, it is more probable that a supernatural designer exists than that, just by chance, the universe is fine-tuned. The conclusion derived is that the probability of D, given E and K, is quite high; that is, the existence of a supernatural designer is quite high given that the universe is fine-tuned.

Using the form $P(A \mid B)$ to stand for the probability of A conditional on B (the probability of A given that B), FTA can be expressed formally as follows.

The Fine-Tuning Argument (FTA)

(1) $P(E \mid K \,\&\, \sim D) \approx 0$

(2) $P(E \mid K \,\&\, D) >> 0$

(3) $P(D \mid K) >> P(E \mid K \,\&\, \sim D)$

$\therefore$ $P(D \mid E \,\&\, K) >> 0$

On this rendering, FTA is a Bayesian inference – a well-established form of scientific reasoning involving conditional probabilities as both inputs and outputs. Note that no specific numbers are mentioned in the inequalities above. The numbers one gets depend upon whatever calculations of the evidence of fine-tuning one considers relevant, as well as on one's estimates of the intrinsic probability of D and of the probability of E given K and D.

As is to be expected, there is considerable controversy surrounding the alleged 'cosmic coincidences' underlying FTA. There are scientific disagreements about the calculations involved, as well as disagreements about just what it takes for a universe to permit life. The fact that FTA concerns itself so intimately with these scientific details is what distinguishes FTA both from *a priori* arguments for the existence of God (e.g., the Ontological Argument) and *a posteriori* ones whose empirical premises are of an extremely general nature (e.g., the Cosmological Argument). Due to limitations of scope, the scientific details regarding FTA will not be addressed in this paper. Also not addressed here are generic problems confronting any Design Argument, whether that argument be from cosmic fine-tuning for life, from the 'irreducible complexity' that proponents of 'Intelligent Design Theory' say is rife in the biological realm, or from some other body of evidence. These generic objections tend to focus on premises (2) and (3) of FTA. References both to scientific sources on FTA and to general considerations regarding the Design Argument are provided in the 'For Further Reading' section at the end of this article. The rest of this paper is devoted to articulating two *philosophical* problems specific to FTA.

First Problem for FTA: The Multiverse Hypothesis

Many scientists and philosophers agree with the proponents of FTA that fine-tuning is special and stands in need of explanation. For example, cosmologist Lee Smolin, who says that '[t]he existence of stars is the key to the problem of why the cosmos is hospitable to life' (29), maintains that 'any philosophy according to which the existence of stars and galaxies appears to be very unlikely, or rests on unexplained coincidence, cannot be satisfactory' (35). Smolin does not think fine-tuning can be dismissed as the way things just happen to be. Yet he rejects FTA because he thinks fine-tuning can be explained in a purely natural way. More specifically, he thinks the fact that we *observe* a universe that is fine-tuned can be explained in a perfectly natural way, *if* there exists a vast multitude of universes. It is precisely such a 'multiple universe' theory that he develops in his *Life of the Cosmos*. His is but one of several multiple-universe theories available nowadays. Though there is considerable scientific dispute about the details of the various multiple-universe theories, many physicists (and many philosophers) support some such theory.

How does such a theory explain fine-tuning? Call the hypothesis that there exists a vast multitude of universes 'Multiple Universes' (MU). According to MU there are very many (if not infinitely many) things like our universe. These huge physical systems share certain basic lawful structures; for example, they all follow quantum-mechanical laws. Their fundamental parameters are all the same; that is, in all of them there is a mass for the proton, a mass for the neutron, a speed at which light travels, a Newtonian gravitational constant, and so on. However, these parameters randomly take different values in the different universes. For example, whereas in our universe the mass of the proton is 938.28 MeV, in some other universe it is something else – say, 627.59 MeV. Given MU, it is unsurprising that at least one universe in the multitude is fit for the production of life. While the probability that any particular universe is fit for life is still very small, the probability that some universe or other is fit for life is now very high, just because MU affords so many chances for there to be a fit-for-life universe. In other words, say proponents of MU, the probability that should interest us is not P(E|K & ~D) but P(E|K & ~D & MU). That latter probability is very high.

Multiple Universes explains why some universe is fine-tuned. How does it explain why *this* universe is fine-tuned? Well, according to one version of what physicist Brandon Carter dubbed 'the anthropic principle', observers should expect the universe to meet whatever conditions are necessary for the existence of observers.[1] The anthropic principle calls to our attention an 'observational selection effect' at work in cosmology – a feature of our methods of observation that systematically selects from only a subset of the set of the logically possible observations. To take an example from the social sciences, conducting a telephone poll introduces an observational selection effect, because the method of telephone polling guarantees neglect of those without telephones. Likewise, according to Carter's version of the anthropic principle, the very fact that we are observing guarantees that we are not doing so from universes, places, or times that are incompatible with a living, embodied creature's doing any observing. Proponents of MU urge us to construe the question 'Why is our universe fine-tuned?' as the question 'Why do we *observe* our universe to be fine-tuned?' They then answer that latter question by saying (a) MU makes it highly probable that some universe is fine-tuned and (b) the anthropic principle reminds us that a universe that is fine-tuned is the only kind of universe we could observe. Thus MU, in tandem with the anthropic principle, seems to provide a plausible naturalistic alternative to design explanations of fine-tuning.

In response, FTA proponents typically complain that MU is *ad hoc*. The only motivation for believing it, they say, is to avoid the obvious religious implications of fine-tuning. Believing MU is the last resort of the desperate atheist, they think. Yet while perhaps some proponents of MU desire to avoid theism, it would be an *ad hominem* argument to reject MU on that basis. The relevant question is whether there is independent motivation within current physical theory for MU. If so, then proponents of MU cannot be accused of cooking up a theory just to block FTA. Many physicists say MU is, indeed, independently motivated within the theoretical models they employ. Furthermore, whatever the motivations for proposing MU, proponents of FTA cannot dismiss MU if it turns out to be empirically verifiable, as some cosmologists have recently proposed.

A different objection to MU is that it fails to explain why our universe in particular is fine-tuned. Philosopher Alan Olding articulates this complaint nicely.

> [T]he 'world-ensemble' theory provides no explanatory comfort whatsoever. The situation is this. We have our own universe with planets occasionally, if not always, producing life; and, to escape explaining this fact, we surround it with a host of other universes, most limp and halting efforts and some, perhaps, bursting at the seam with creatures. But where is the comfort in such numbers? The logical situation is unchanged – *our* universe, the one that begat and

> nourished us, is put together with as unlikely a set of fine-tuned physical values whether it exists in isolation or lost in a dense scatter of worlds. So, then, by itself or surrounded by others, the existence of our universe still cries out for explanation. (123)

This 'This Universe' objection is spelled out in a particularly detailed way by philosopher Roger White ('Fine-Tuning and Multiple Universes'). He argues that MU merely 'screens off' the probabilistic support that fine-tuning lends to D. That is, if there are many universes, then the probability that *this* one is fine-tuned will be no greater on the supposition that there is a designer than on the supposition that there is not. This is because there is no reason, White thinks, why a designer would single out *this* universe (as opposed to one of the others) to be the one that permits life. Compare the situation to surviving a firing squad. Suppose you are the only person lined up against the wall. The officer yells 'Fire!' and the bullets fly. They all miss. This is evidence that the shooters intended to miss. But if dozens of people are lined up against the wall, and all but you are dead after the bullets fly, you have much less evidence that the shooters intended to miss. After all, why would they have intended *you* to survive? So while the existence of a large number of victims of the firing squad is consistent with the hypothesis that the shooters intended to miss you, the large number of victims blocks – 'screens off' – the positive support that your surviving gave to the hypothesis that the shooters intended to miss you.

Despite this, White would say, the existence of lots of other potential victims on the wall does not increase the probability that the firing squad will miss you. Suppose you are blindfolded and set against the wall. You hear 'fire' followed by the sound of a hail of bullets. To your surprise, you find yourself still alive. Does that give you any reason to think that there were many other victims lined up against the wall – victims that *were* killed by the firing squad? Of course not. Philosopher Ian Hacking calls this mistaken kind of reasoning 'the Inverse Gambler's Fallacy'. It is the mistake of inferring a large number of trials (e.g., a lifetime's worth of poker hands) solely from observation of a single extreme outcome (e.g., a Royal Flush). Yes, a gambler is much more likely to have been dealt a Royal Flush at some point in her life if she has played a lot of poker. Yet suppose you walk into a casino and the first thing you observe is that some lucky gambler is getting paid an enormous amount of money for having been dealt a Royal Flush. Should you conclude that the gambler has probably played poker all her life? No. It could be her first time playing. [In fact, this is a frequent complaint of gamblers – that the jackpots go to new gamblers who have not 'paid their dues'.] Whether or not the gambler has played a lot of poker has nothing to do with whether she gets a Royal Flush in this particular instance.

More generally, although the existence of an extreme outcome is rendered more probable by a large number of trials, if all the trials are independent, the existence of many prior trials does not make the extreme outcome any more likely on the observed trial. Likewise, says White, MU fails to raise the probability that our universe is fine-tuned. MU tells us that there are lots of chances for a universe to turn out just right, but that does not explain why *this* universe turned out just right. Hence, says White, MU is not confirmed by the fact that our universe is fine-tuned. To further appreciate this point, suppose for the sake of argument that, according to MU, 1 percent of all the universes that are possible are such as to permit life and there are exactly 1,000 universes, all chosen at random from the set of possible universes. White would say that the probability that our universe permits life is still just 1 percent, because what goes on in the other 999 universes does not affect what goes on in ours. Of course, on this particular scenario, the probability that *some universe or other* permits life is much higher: 99.99%. [The probability that at least one of the 1,000 universes permits life is equal to 1 minus $(0.99)^{1000}$ – the probability that none of the 1,000 universes permits life.] But that is not relevant, White would say, because the question before us is why *this* universe permits life. Since MU does not explain that fact, MU fails to be a plausible alternative to D.

There are several problems with the 'This Universe' objection. Two will be mentioned here. First, the sort of question to which its proponents demand an answer – 'Why is *this* universe fit for life?' – is not properly asked with respect to comparable explanations. Suppose, for example, that we explain the fitness of the Earth for life by pointing to the recent discovery of a wealth of extra-solar planets. Given the vast number of galaxies in the universe, with each galaxy hosting a vast number of stars, we claim that it is likely that somewhere or other in the universe there exists a planet with conditions that are just right for life to develop on it. Should we be faulted for failing to explain why *this* planet is the fit one? Surely not. The reason why is that, when we set aside all of the features of the Earth that are essential to its ability to support life (including relational properties such as distance from the right sort of star), there is otherwise nothing special about Earth, and so no motivation for the demand to explain why Earth in particular is fit for life. Likewise, it seems the question for which the 'This Universe' objector demands an answer is simply a misguided question.[2]

Second, the 'This Universe' objection rests on the metaphysical assumption that, according to MU, the values taken by the free parameters of a universe are not among its essential properties. Yet MU theorists have simply not addressed the metaphysical issue of the essential and accidental properties of this new natural kind 'universes'. Let 'Uni' rigidly designate this universe – the universe we occupy. Granting MU, is there a possible world in which Uni exists and yet the cosmological constant Λ in Uni is a hundred times its actual value? Is the value of Λ no more essential to Uni than your hair color is to you? Or is the actual value of Λ somehow part of the very essence of Uni – part of what makes Uni the universe that it is? The actual values of the free parameters must be accidental, not essential, for the 'This Universe' objection to have any force. Unfortunately for philosophers, there are many MU theories, and on none of them is this metaphysical issue of the essential properties of universes addressed, or even raised. Insofar as the 'This Universe' objection presumes an answer to a question that MU theorists have never asked themselves, it is inconclusive.

Second Problem for FTA: Fine-Tuning is not Improbable

A quite different objection to FTA is that the very concept of probability does not apply when it comes to the values of the fundamental cosmic parameters. To help see this problem, we must first realize that presentations of the fine-tuning data typically do not say anything at all about probability. Instead, claims of fine-tuning are usually presented in terms of counterfactual conditionals wherein expressions such as 'slight difference', 'small change', 'delicate balance', 'precise', 'different by n%', 'different by one part in 10^n', and 'tuned to the nth decimal place' appear in the antecedent. The following examples are typical.

> (A) The remarkable fact is that the values of these [fundamental] numbers seem to have been very finely adjusted to make possible the development of life. For example if the electric charge of the electron had been only slightly different, stars either would have been unable to burn hydrogen and helium, or else they would not have exploded. (Hawking 125)
> (B) [T]he existence of stars rests on several delicate balances between the different forces in nature. These require that the parameters that govern how strongly these forces act be tuned just so. In many cases, a small turn of the dial in one direction or another results in a world not only without stars, but with much less structure than our universe. (Smolin 37)
> (C) If the mass of neutrinos were 5×10^{-34} kg instead of 5×10^{-35} kg, because of their great abundance in the universe, the additional gravitational mass would result in a *contracting* rather than *expanding* universe. (Davis 140–1)

These claims about what the universe would have been like if the values of its fundamental parameters had been slightly different do not entail that it is improbable that the universe permits life. The following *non sequiturs* illustrate the point.

> (D) Tiger Woods swings at a golf ball, aiming for a pin that is two hundred yards away. The ball lands within six feet of the pin. If any aspect of Woods's swing had been more than the slightest bit different, the ball would not have landed within six feet of the pin. Therefore, the probability that Tiger Woods lands a golf ball within six feet of the pin from two hundred yards away is extremely low.

The problem with this inference, obviously, is that while the component parts of Woods's swing could have been different, his great skill makes the probability low that one of his actual swings deviates even slightly from the perfect swing. While his body *could* move in such a way that he completely misses the ball, say, that fact is quite irrelevant to the question of how probable it is that a shot of his from two hundred yards away lands within six feet of the pin. In other words, Woods's skill introduces a powerful bias in the set of his possible swings towards swings that lead to good golf results. If a bias in favor of life-permitting values likewise operates in connection with the free cosmic parameters, then a low probability for fine-tuning would not logically follow from the fact that life would not be possible if the parameters took slightly different values.

The next *non sequitur* brings out a different problem.

> (E) Michael Jordan is two meters tall. If he had been a meter shorter, he would be a dwarf. If he had been a meter taller, he would suffer from crippling gigantism. Hence Michael Jordan's height cannot differ by more than one meter if he is to play professional basketball. A light-year is approximately 10^{16} meters. Hence Michael Jordan's height cannot differ by more than one part in 10^{16} of a light-year if he is to play professional basketball. Therefore, the probability that Michael Jordan has a height that allows him to play professional basketball is 10^{-16}.

Non sequitur (E) shares a feature with (D). Although it is *possible* for a person to be one meter tall or three meters tall, it is vastly more probable that a person is two meters tall. The probability distribution for human heights is not flat, but instead is biased. Its graph takes the shape of a bell curve. In addition, (E) involves measuring heights in light-years. This illustrates a problem with many alleged cases of fine-tuning. As we see with (C), subatomic particle masses are being measured in kilograms, so of course changing the mass of a subatomic particle by the smallest bit *of a kilogram* will make a huge difference in the properties of that particle, just as changing the height of Michael Jordan by the smallest bit of a light-year will make a huge difference to the capacities of Michael Jordan. Obviously this case of fine-tuning is really only an artifact of the choice of a unit of measure. Consider that (C) is equivalent to the much less impressive fact that, if the mass of neutrinos were *ten times greater*, we would have a contracting rather than expanding universe. To avoid this problem of arbitrary units of measure, we must purge cases like (C) from the evidence base of FTA by restricting ourselves to 'dimensionless' parameters – parameters that do not involve any unit of measure. For example, while the particle masses M_n and M_p are given in kilograms, the ratio of the two masses M_n/M_p is a pure number – 1.00138. The mass ratio is the same number regardless of what units are used to measure mass, so focusing on dimensionless parameters alleviates the worry that the appearance of fine-tuning is being generated by arbitrary choices of units of measure.

Even if we restrict ourselves to dimensionless parameters, however, proponents of FTA are left with a fundamental problem: how do the data regarding fine-tuning support premise (1) when that premise says something about probability and the data do not? What is needed is a 'normalizable' measure of the space of possible values for the cosmic parameters. That is, there must be a way that the space of possible values for the cosmic parameters can be construed mathematically as a unity. As noted by Timothy McGrew, Lydia McGrew, and Eric Vestrup,

> probabilities make sense only if the sum of the logically possible disjoint alternatives adds up to one – if there is, to put the point more colloquially, some sense that attaches to the idea that the various possibilities can be put together to make up one hundred percent of the probability space. (203)

For example, there are six, and only six, ways a standard die can turn up. Each, we think, has a 1/6 chance of turning up. The six possibilities must add up to be the same as the totality of the possibility space, which of course they do [$6 \times 1/6 = 1$].

A normalized measure of the space of possible values for the cosmic parameters can be generated in one of two ways. First, the space of possible values for the cosmic parameters can be limited somehow. For example, if M_n/M_p could be no greater than, say, 100, then we would have a basis for saying that the probability that M_n/M_p is within 50% of its actual value of 1.00138 is approximately 0.01. Second, there could be a bias factor favoring some possible values of the cosmic parameters over others. For example, if the function specifying the probability that M_n/M_p has any particular real-numbered value takes the form of a half-bell curve – with a bulge near zero and the curve tapering out to infinity – then it could be that, while there is no theoretical upper bound to the value of M_n/M_p, the area under the curve nonetheless adds up to one. But if the space of values for a given cosmic parameter has no upper bound, and if there are no bias factors at work, then there is no way to normalize the space. As McGrew, McGrew, and Vestrup note,

> if we carve an infinite space up into equal finite-sized regions, we have infinitely many of them; and if we try to assign them each some fixed positive probability, however small, the sum of these is infinite (203)

not finite, as is needed for it to make sense to talk about probability with regard to that space. In a case such as this, no probability can be defined.

It must be pointed out here that the preceding argument presupposes that probabilities are countably additive. As Robin Collins notes, 'The axiom of countable additivity says that the countable sum of [the probabilities of] mutually exclusive classes of events must be equal to the probability of an event occurring in the union of the classes' ('Fine-Tuning Arguments' 399). To use again the example of rolling a single die, the probability of rolling a 1 is 1/6. So is the probability of rolling a 2, a 3, a 4, a 5, and a 6. The sum of the probabilities of each of the outcomes of rolling a die is $1/6 + 1/6 + 1/6 + 1/6 + 1/6 + 1/6 = 1$. The event that is the 'union' of those events is simply the event of getting one of the numbers 1 through 6 when rolling a die. The probability of that event is also 1.

Hence the probabilities are countably additive in the case of rolling a single die. The objection of McGrew, McGrew, and Vestrup is just that, in the case of cosmic fine-tuning, the probabilities are *not* countably additive. They do not add up to 1, but rather either to 0 (if each region of the infinite space is assigned a probability of 0) or to an infinite number (if each region of the infinite space is assigned a probability greater than 0).

In the classic mathematical theory of probability, countable additivity is a precondition for probability; without it, it makes no sense to talk about the probability of the occurrence of a certain event from a range of possible events. In response to the argument of McGrew, McGrew, and Vestrup, some philosophers invoke esoteric mathematics to defend the idea that countable additivity is not a prerequisite for probability. This issue is taken up in detail in Collins ('Fine-Tuning Arguments'), Pruss, and McGrew and McGrew in a symposium on FTA. Readers interested in the mathematical basis of the normalizability problem for FTA are urged to read this symposium. I will confine myself here to saying that I side with the McGrews on the need for countable additivity.

Unfortunately, the physicists who provide the fine-tuning data do not give the proponents of FTA what they need to solve the normalizability problem. They do not give theoretical upper bounds on the values of the parameters in question, nor do they give theoretical reasons why some of those values are more likely to be actual than others. The following *a priori* argument suggests why they cannot give these things. Consider any fundamental dimensionless parameter. If it is truly *fundamental* – if the value of it does not depend on or derive from the values of any other parameters – then any upper bound to its possible values would be completely arbitrary. It would simply be a brute fact that the parameter could not have been greater than, say, 739. There being an upper bound would not stand to reason. The same problem confronts bias factors. It would simply be a brute fact that, say, it is much more probable that the parameter takes a value close to zero than a value far from zero. While the human mind finds it easier and more natural to think of numbers closer to zero, we have no reason to expect fundamental reality to be biased in conformity with our limitations. Thus there being bias factors also would not stand to reason – if we are talking about truly *fundamental* parameters.

Some defenders of FTA respond that the normalizability problem does not show that FTA involves a mistaken inference – only that FTA should not be understood formally as a Bayesian inference. Philosopher Timothy O'Connor offers precisely this defense of FTA.

> As is well known, similar objections can be made to forms of reasoning structurally analogous to the argument from fine-tuning that it would be folly to dismiss. For example, suppose there were a fair lottery (it would need to be administered by God!) in which there were an infinite number of entries. You would reasonably conclude that it is effectively certain that your entry will not be picked. We may not be able to capture the sense of likelihood here in terms

> of classical probability theory (and no one has an idea of how to extend classical theory in a way that would capture such infinite scenarios), but the soundness of the inference seems beyond challenge. (103)

Yet this response begs the question. To call a lottery fair is just to say that each ticket in it has an equal mathematical probability p_i of being selected. By the definition of probability, $0 \leq p_i \leq 1$, so either $p_i = 0$ or $p_i > 0$. Now let us suppose, *per impossibile*, that there is a fair lottery with an infinite number of tickets. If each $p_i = 0$, then the sum of them is zero. If each $p_i > 0$, then the sum of them is infinite. In neither case is the sum equal to one, as is required for talk of probability to be meaningful. This is precisely the point we already saw McGrew, McGrew, and Vestrup make. Positing a fair lottery with an infinite number of entries, then, is just to assume what the normalizability objector denies. Bringing in God to administer the lottery does not solve the problem. If the normalizability objector is right, the phrase 'administering a fair lottery with an infinite number of tickets' describes an impossible task – something that is beyond even God's power to perform.

In premise (1) of FTA, the proponent of FTA asks us to conceive of the fundamental cosmic parameters as taking 'winning' values by chance rather than by design. For the reasons just given, however, if this taking of winning values by chance is thought of as analogous to holding the winning ticket in a fair lottery with an infinite number of tickets, the universe's being fit for life cannot properly be classified as improbable. If FTA proponents insist on describing this scenario as one in which there is a maximally low probability of the universe's permitting life – even though the formal conditions for speaking of probability are not met – then they confront the problem of 'coarse-tuning' articulated by McGrew, McGrew, and Vestrup (204). Suppose, they say, that the universe would permit life even if the cosmic parameters 'could take any values within a few billion orders of magnitude of our values'. In that case, we would have just as much reason to describe the universe as fine-tuned for life as we do now! Suppose, for example, that physicists discovered that the universe would permit life even if M_p was as great as the mass of Jupiter. If we can argue from coarse-tuning as well as from fine-tuning, then even in this extreme case the actual value of M_p counts as 'just right' for life. If this is the logic of FTA, one begins to wonder whether it even deserves to be called *a posteriori*, since all of the evidential work of the argument is being done by the *a priori* assumptions that there is no upper bound to the values the cosmic parameters could take and that there are no bias factors in the selection of those values.

The problem with calling fine-tuning 'improbable' is nicely summed up by theoretical physicist Paul Davies.

> The problem is that there is no natural way to quantify the intrinsic improbability of the known 'coincidences'. From what range might the value of, say,

> the strength of the nuclear force . . . be selected? If the range is infinite, then any finite range of values might be considered to have zero probability of being selected. But then we should be equally surprised however weakly the requirements for life constrain those values. This is surely a *reductio ad absurdum* of the whole argument. What is needed is a sort of metatheory – a theory of theories – that supplies a well-defined probability for any given range of parameter values. No such metatheory is available, or has to my knowledge ever been proposed. (*The Mind of God* 204–5)

For this reason, it seems premise (1) of FTA must be rejected. Perhaps some argument for the existence of God can be constructed on the basis of fine-tuning, but it cannot be a Bayesian argument from small probabilities.

For Further Reading

For a general survey of Design Arguments and their problems, including the FTA, see the essays in Manson (*God and Design*). Notable books on the FTA in particular include Leslie (*Universes*) and Holder (*God, the Multiverse, and Everything*). The most comprehensive presentation of the various cases of fine-tuning in physics can be found in Barrow and Tipler (*Anthropic Cosmological Principle*); see also Carter ('Large Number Coincidences'). Barrow and Tipler (ch. 8) also discuss how to define 'life' and 'intelligent life'. The most recent scientific data on fine-tuning are presented in Collins ('Evidence for Fine-Tuning'), Holder (ch. 3), and Ellis (§9.1). For a general discussion of Bayesian reasoning, see Howson and Urbach; for how it applies in the case of FTA, see Manson (*God and Design* 5–8) and Holder (ch. 5). For a well-developed but controversial multiple-universe theory, see Smolin. Other multiple-universe models, as well as the testable implications of them, are discussed in Rees (ch. 11) and reported on in Steele. Observational selection effects in cosmology are discussed throughout Leslie and are the sole subject in Bostrom. For a presentation of the 'This Universe' objection, see White ('Fine-Tuning and Multiple Universes'); for a critique of that objection, see Manson and Thrush. The normalizability problem is touched upon in Manson ('There is no Adequate Definition') and is presented vigorously in McGrew, McGrew, and Vestrup. A symposium on the normalizability problem consisting of papers by Collins ('Fine-Tuning Arguments'), Pruss, and the McGrews advances the debate considerably, with Collins and Pruss claiming they have solved the normalizability problem, over the vigorous objections of the McGrews. See also Koperski for a proposed solution to the normalizability problem. The normalizability problem is also raised in the specific context of inflationary cosmology by Earman and Mosterin (31–4).

As a version of the Design Argument, FTA is susceptible to a host of generic objections. For a vigorous statement of the objection that the design hypothesis cannot explain anything, see Narveson. For an argument that multiple-universe theorists presuppose an objective theory of value, see Manson ('Cosmic Fine-Tuning'); interestingly, the same point is made against origin-of-life researchers by White ('Does Origins of Life Research Rest on a Mistake?'). The question of why God would want to create a universe at all is explored in Kretzmann ('General Problem of Creation'; *Metaphysics of Creation*), and Manson ('The "Why Design?" Question'). Finally, anyone interested in the Design Argument should read Hume.

Short Biography

Neil A. Manson is an assistant professor of philosophy at the University of Mississippi. His central research interests concern the intersection of philosophy of science, philosophy of religion, and metaphysics. His specific research focus is on contemporary design arguments for the existence of God. In addition to editing the anthology *God and Design: The Teleological Argument and Modern Science* (Routledge, 2003), he has authored numerous articles on the topic. He also writes on issues in applied ethics, including environmental philosophy and medical ethics. His article 'Formulating the Precautionary Principle' (*Environmental Ethics* 24.3) is widely cited in the literature, and he was interviewed for the BBC Radio 4 program 'Analysis: Risky Business'. He holds B.A. degrees in both English and Philosophy from the University of Maryland, College Park, and a Ph.D. in Philosophy from Syracuse University.

Notes

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[1] The term 'anthropic' misleadingly suggests the principle refers to humans only, as opposed to observers more generally (e.g., Martians, Arcturans, or very smart dolphins). Since the term 'anthropic principle' is so entrenched, however, most people who write about FTA continue to use it.

[2] On hearing news reports that a lone family in a remote Armenian village survived a devastating earthquake in December 1988 (nearly 50,000 Armenians were killed by that earthquake), a friend of mine said at the time 'It's a miracle'. When I noted that, given the size of the area, it was not unlikely that some family occupied a protected position in a fortified cellar at the time of the quake, she replied 'Well, it's a miracle that *they* survived'. I retorted that this was (from her point of view) equivalent to saying 'Well, it's a miracle that *the survivors* survived' and that there was nothing the least surprising about *that*. If there was nothing special about the survivors aside from the fact that they survived, I said, then their survival was no cause for surprise. She made a few choice comments about how I liked to ruin everything.

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