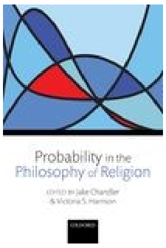


**Probability in the Philosophy of Religion**

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CHAPTER

# 6 6 Bayes, God, and the Multiverse

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## Abstract

The chapter begins by summarizing how the structure of an argument from the fine-tuning of a single universe to the existence of God can be expressed in terms of Bayes' theorem. There could however be scientific evidence in favour of the existence of a multiverse. Insofar as the theory of such a multiverse is simpler than that of a single universe, and that theory makes good predictions, it would make it more probable that there will be a fine-tuned universe, and so — it might seem — would diminish the force of an argument from fine-tuning to God. But it would not diminish it greatly, because God has reason to create such a multiverse, and the supposition that he has done so is a very simple explanation of the existence of such a multiverse, whereas the existence of an uncaused multiverse would be a very complex supposition.

**Keywords:** Bayes, fine-tuning, God, multiverse, simplicity, predication, universe

**Subject:** Philosophy of Science, Metaphysics, Philosophy of Religion

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## I. Introduction

A major probabilistic argument of natural theology claims that the 'fine-tuning' of the laws of nature and of the initial conditions of the universe (at the time of the Big Bang) which was necessary for the evolution of embodied beings of our level of intelligence (and made it physically very probable that they would evolve somewhere sometime[1]) makes it (inductively) probable that the universe was created by God.[2] This is because, the argument claims, it is most improbable that the universe could have such intelligent life-producing features by mere chance, whereas a God would seek to produce intelligent life. (The normal and in their general effect uncontroversial aspects of 'finetuning' to which scientists draw our attention are the facts that the density, velocity, and ratios of the different components of the Big Bang, and the constants of laws of nature all lie within the extremely narrow limits required in the above respect for the evolution of intelligent life.[3]) The objection to such arguments which has appealed most to p. 104 ↳ scientists of recent years is the 'multiverse' argument. Science gives reason to believe, it is claimed, that there are innumerable different universes (together constituting a 'multiverse'), each with different initial conditions and/or laws of nature; and so it is not improbable that one of these universes would be an intelligent-life-producing universe; and—as we are intelligent beings—it is inevitable that we will find ourselves in such a universe, and so there is no need to postulate a God to explain the characteristics of our universe. The purpose of this paper is to investigate this objection. In order to do so in a short paper, I need to summarize certain results which I claim to have established elsewhere.

I need to begin by articulating the structure of any probabilistic argument to a causal explanation, and then go on to outline the structure of any such argument to the existence of God from the general features of the universe (including fine-tuning). After that I shall note the various kinds of multiverse which have been postulated and the evidence for them; and go on to claim that, while there might well be a multiverse of a limited kind, that would not make a great difference to the strength of a probabilistic argument from fine-tuning to the existence of God.

## II. Five Criteria

A hypothesis *h* purporting to provide a causal explanation of evidence *e* is, I suggest, for background evidence *k*, probable in so far as:

1. If *h*, then given *k*, probably *e*;
2. If ~*h*, then given *k*, probably ~e;
3. *h* is a simple hypothesis;
4. *h* 'fits with' with *k*;
5. *h* has small scope.[4]

By 'background evidence' I mean evidence about how things behave in areas outside the range that *h* purports to explain. I claim that these criteria apply whether *h* is an explanation of an inanimate (or scientific) kind in terms of initial conditions and laws of nature, or one of a personal kind in terms of persons, their powers, beliefs, and p. 105 ↳ purposes. I assume that it is irrelevant to the evidential force of *e* whether *e* is known before or after the formulation of *h*; and so I shall use 'predict' in the sense that in so far as *h* makes *e* (for given *k*) probably true, *h* 'predicts' *e* with that degree of probability. So understood, (1) is simply the criterion that a hypothesis is more probable, the more probable it makes its observed predictions (the more probable, the more of them and the more accurate they are); (2) is simply the criterion that *h* is more probable if rival hypotheses of any significant probability (on criteria other than (2)) predict not-*e*. If *k* is itself a causal hypothesis about other fields, then *h* 'fits with' *k* in so far as (*h* & *k*) is simpler than any (*h** & *k*), where *h** is a rival to *h* in explaining *e*. In such a case, I shall say that *h* 'meshes with' *k*. If *k* are pieces of evidence of the same level of generality as *e*, then *h* 'fits with' *k* in so far as *k* makes a theory *t* more probable than any other theory of its field and (*h* & *t*) is simpler than any (*h** & *t*) where *h** is a rival of the above kind. So (4) claims that a hypothesis purporting to explain evidence in a named field (for example, about whether John committed a particular crime) is more probably true in so far as it fits (in either of these ways) with other things we know, for instance, whether John has committed other such crimes in the past. But the larger the field covered by the hypothesis, the less is the role for (4). A large-scale theory of physics purports to explain so much that there is little else for it to fit 'with'. The 'scope' of *h* is greater, as I shall understand this notion, the more and the more precise are its predictions (true or false, observed or unobserved). The more predictions a hypothesis makes and the more precise they are, the greater the probability that the hypothesis contains some error. I suggest that the practice of science shows that scientists give (5) less weight than the other criteria, since they regard large-scale theories which make predictions about a large field and which satisfy the other criteria well as very probably true.

There will always be an infinite number of theories (some of them making totally different predictions for the future from others) satisfying criteria (1), (2), and (5) for any value of the 'probably' in (1) and (2). In a situation where *h* covers such a large field that there is no significant contingent *k*, everything will depend on criterion (3), simplicity. And if the field covered by *h* is smaller and there is significant contingent *k*, all will depend on criteria (3) and (4); but as simplicity is crucial for assessing 'fit with background evidence', everything will again depend on simplicity. So simplicity is an all-important criterion without which we can make no inferences beyond our evidence. It follows that without an objective understanding of simplicity it will not be an objective matter whether evidence makes this or that hypothesis probable or improbable. I suggest that our ordinary practice, and that of scientists, historians and detectives, shows that we understand a hypothesis as simple to the extent to which it postulates few substances (entities), few kinds of substances, few properties, few kinds of properties, more readily observable properties, few relations between properties (in other words, few laws), and simpler kinds of relations between properties (that is, p. 106 ones involving simpler mathematics—a notion which can to a considerable extent be ↳ defined objectively).[5] If we think of scientific explanation as explanation by initial conditions (of substances and their properties) and laws, the principle of simplicity requires us to postulate the simplest combination of these. If we think of 'laws' as generalizations about the powers and liabilities of individual substances (liabilities to exercise powers in certain circumstances, that is) then the distinction between laws and initial conditions disappears, and the principle tells us just to postulate the fewest substances with the fewest and simplest properties (including powers and liabilities). For personal explanation, the principle of simplicity requires us to postulate the fewest persons with the fewest and simplest powers (for instance, to move limbs), beliefs and purposes. Since spatially extended substances consist of a number of smaller substances which stick together or act together (even if they cannot be separated into those small substances), the 'few substances' sub-criterion requires us to postulate substances no larger in spatial extent than are necessary for explanatory purposes. The various sub-criteria of simplicity often need to be weighed against each other, for example, postulating few laws against postulating more complicated laws. It is not always clear which postulation is overall the simplest, but in many paradigm cases it is clear.

These criteria are captured by the probability calculus and in particular by Bayes' theorem:

$$\mathrm{P}\left(h|e\&k\right) = \frac{\mathrm{P}(e|h\&k)\mathrm{P}(h\&k)}{\mathrm{P}(e|k)}$$

I read this theorem as claiming that for any propositions *h* and *e*, in so far as the probabilities occurring in the theorem can be given a numerical value, it correctly states the numerical relationships that hold

between them. In so far as they cannot be given precise numerical values, Bayes' theorem simply claims that all propositions of comparative probability, that is about one probability being greater than (or much greater than) or equal to or less than (or much less than) another probability, which can be deduced from the theorem are true. For example it follows that if $P(e|h_1\&k) = P(e|h_2\&k)$, then $P(h_1|e\&k) \rangle P(h_2|e\&k)$ if and only if $P(h_1|k) \rangle P(h_2|k)$. In the special case where *h* is a causal hypothesis purporting to explain *e* with background evidence *k*, our five criteria tell us how to assess the probabilities on the right-hand side. $P(e|h\&k)$ measures the degree to which criterion (1) is satisfied. $P(h|k)$ is large to the extent to which *h* fits with *k* (criterion 4) and to the extent to which its intrinsic features (simplicity—criterion 3; and scope—criterion 5) make it probable. When there is no contingent background evidence, *k* is any tautology and $P(h|k)$ is then called the 'intrinsic probability' of *h*, and is a function solely of its simplicity and scope. By another theorem of the calculus $P(e|k) = P(e|h\&k)P(h|k) + P(e|h_1\&k)P(h_1|k) + P(e|h_2\&k)P(h_2|k)$... and so
p. 107 on for all hypotheses $h_n$ of the same field and of equal ↳ scope which are mutually exclusive and exhaustive. So $P(e|k)$ is large in so far as one or more rival simple hypotheses which fit with any contingent *k* make *e* probable (which spells out criterion 2).[6]

We have grounds to believe in states of affairs other than those which provide a probable causal explanation of our evidence if and only if our evidence makes it probable that they explain or are explained by (that is, cause or are caused by) those states which explain our evidence, or are connected by causal relations to the latter states. Thus I can predict rain tomorrow if I have a probable meteorological theory which provides a causal explanation of past weather patterns (or more general phenomena), and which predicts that whatever air currents caused the most recent weather patterns will also cause rain tomorrow. The probability calculus gives us a precise formula for prediction and retrodiction: the probability of a future event, such as rain tomorrow (*r*) on evidence (*e*) is the sum of probabilities of different theories ($h_n$) on that evidence, each multiplied by the probability of the event on that theory and the evidence.

$$P(r|e\&k) = \sum\nolimits_{\mathrm{n}} P(r|h_n\&e\&k)\,P(h_n|e\&k)$$

A similar formula governs retrodiction, for example, to the probability that it rained in Oxford on 1st January of the year 2 million bc. And we can use joint applications of retrodiction and prediction to infer further events. For example, we can retrodict from a crater that there was a large meteor impact in 60 million BC, and then predict that this would have led to much of the surrounding country being covered by a dense dust cloud which would have led to the extinction of the dinosaurs. But our recognized ways of acquiring knowledge of things past or future or unobserved give us no licence to ascribe probabilities to states of affairs different from their intrinsic probabilities unless our evidence suggests those states of affairs are causally connected to that evidence. The intrinsic probability of a state is the probability on mere tautological evidence that it would occur—which intuitively is a very small probability.

## III. Probabalistic Natural Theology

Natural theology claims that the most general features of the universe show that there is a God. I will construe a probabilistic natural theology as claiming that those general features make it probable that God causally explains the existence of the universe with these general features, by bringing it into existence (if it had a beginning) and by conserving it in existence as long as it has existed (whether for a finite time or
p. 108 forever).[7] ↳ Here I shall be concerned solely with the general feature of its fine-tuning and its contribution to a cumulative natural theology.

I understand by 'God' an essentially everlasting omnipotent, omniscient, perfectly free person. The natural theologian must claim that such a being is a very simple substance of such a kind as quite probably to bring about a universe with the general characteristics of our universe. I have argued elsewhere (Swinburne 2004: 93–109, and most recently and fully Swinburne 2010) that God so defined is a very simple substance, and that his other properties (including essential perfect goodness and not having a spatial extension) follow from this definition. For reasons of space I cannot repeat those arguments here. God's perfect goodness means that he will be as good as it is logically possible to be; and this, I suggest, is naturally construed as follows. In circumstances where there is a best possible action to do, he will do it, in circumstances where there are two or more equal best actions, he will do one of them; but in circumstances where there are available to God an infinite number of incompatible actions, each better than some other one, he cannot do a best action but he can and will do one of these actions. But if these latter actions can be divided into kinds, such that there is a best or equal best kind of action (but no best kind of the kind), he will do some action of that or those kinds.

Intelligent beings are as such a good thing, and so God has reason to bring them about. But humans are a special kind of intelligent being. We can choose between doing (limited) moral good or evil to ourselves and each other; we can discover by rational inquiry which actions are good and which are evil, and discover how to extend our power over the universe, and discover deep truths about the nature and origin of the universe; and by our choices to do good or evil, over time we can form our own characters—so that doing good or evil (as the case may be) comes naturally to us. We thus have a special kind of goodness, not possessed (as far as we know) by any other kind of conscious being including God himself (who can do no evil, and who is essentially omniscient and perfectly good). So God has substantial reason to bring about humans, even though he also has substantial reason not to bring them about in view of the evil they may well do (even if that evil serves some greater good). So I suggest that it would be an equal best kind of action for God to bring about humans as not to bring about humans, and so there would be a probability of half that God will bring about some humans (see Swinburne 2004: 110–32). From this it follows that there is at least that probability that God will bring about intelligent beings, and so the fine-tuning of the universe in the respects referred to, which, I am assuming, is necessary for the evolution of intelligent life and makes it probable. Now of
p. 109 course we cannot really ↳ give exact probabilities to God's actions, but the unique goodness of humans in the respects I have described does make it quite probable that God will create humans. (I shall understand in future by 'humans' any beings with the characteristics of humans described above.)

The argument from fine-tuning can only make a positive contribution to natural theology if the evil (the suffering and wrongdoing) which accompanies humans (and animals) on earth, and is presumably a probable consequence of the particular tuning of the laws and initial conditions of the universe, does not totally annihilate the positive force of the argument as so far stated. It must be the case that, despite the evil, the existence of humans, and so the fine-tuning which produces them, increases the probability of the existence of God (from whatever is shown by other evidence). To show this requires a theodicy. The theodicy must show that there is a significant probability that any evil on earth is such that by allowing it to occur, a perfectly good God forwards some good purpose which could not be forwarded in any better way. Hence it will have to show that there is a significant probability that all such evil is caused by the free choice of an agent, or has an effect which provides an opportunity (not provideable in any better way) for some agent to do a good action or to acquire knowledge which will allow an agent to do a good action; and that God has the right to allow the amount and distribution of evil which occurs. If this cannot be shown, the argument will not have any force. But if an adequate theodicy can be provided, it will only justify kinds of evil for which it can be shown that they forward a good purpose which could not be forwarded in any better way; and which are of limited length and intensity (for example, any human suffering for no more than 80 years or so). I am going to assume what I have argued elsewhere, that this can be shown for the evil which we find on earth.[8]

Nevertheless God, like a good parent who gives so much to his children, has the right to impose only a limited amount of suffering on his children for their sake or the sake of others. It follows that there is a probability of 0 that God will bring about beings who suffer pointlessly (that is, their being allowed to suffer provides no benefit to themselves or anyone else), or endlessly; or do evil pointlessly (that is, their being allowed to do evil provides no benefit to anyone). It is also much more probable that God would bring about humans (who have a kind of goodness God lacks) than that he would bring about other finite intelligent beings who have a kind of goodness (for example, always to choose the good) already exemplified in God himself—for the reason that this kind of goodness is already exemplified (although of course, in view of the goodness of the latter beings, it is by no means very improbable that God would create more of them).

So, I claim, as must any probabilistic natural theologian, that—given an adequate theodicy for the evil on p. 110 earth—theism is a very simple hypothesis (criterion 3) which ↳ also satisfies criterion (1). Since it purports to explain almost everything else, criterion (4) is irrelevant; and given its great simplicity and the relative imprecision of its predictions, (5) will not detract very much from its probability. All turns on criterion (2) which in turn depends on whether there are rival hypotheses which satisfy criteria (1) or (3) better.

Rival hypotheses which postulate more or weaker godlike persons as the ultimate causes of the universe are clearly going to be less simple than theism (given that, for example, being omnipotent is a simpler property than having such-and-such a large but limited degree of power). A scientific (inanimate) hypothesis which satisfied criterion (1) well would postulate some first substance, or a backwardly infinite succession of substances, either ones which have normal physical properties or the property of a liability to produce good states. Given that laws of nature cannot affect the world unless there is some substance on which they operate, postulation of the existence of a substance with a liability to produce good states is the way we should construe the hypothesis put forward by John Leslie (1979) and Hugh Rice (2000), and considered by Derek Parfit (1992), that there is a propensity in nature to produce the good. I argue elsewhere (Swinburne 2010) that this hypothesis is not as simple a hypothesis as theism. What I want to consider in this paper is the possibility of a multiverse hypothesis which would be as probable as, or more probable than, theism.

I shall understand a 'universe' in the rather loose way in which physicists use this term as (in effect) a system of physical objects (for example, stars and planets) spatially related to (that is, at some distance in some direction from) each other, but either a long way away (relative to their distance from other members of the same system) from any other such system, or not spatially related to any other such system. It seems to me fairly evident that any ordinary non-theistic one-universe hypothesis (for example, the hypothesis that the Big Bang was the explosion of a first physical substance without itself having a cause) which predicts the fine-tuning of the universe which theism also purports to explain will not be nearly as simple as theism; and so the disjunction of all such hypotheses will not be as simple as theism.[9] A first physical substance, however small, would be an extended substance and so less simple than God; it needs to be governed by such general laws as the laws of Quantum Theory and of the four forces (or perhaps a unified 'theory of everything'); and the constants of its laws and the variables of its initial conditions would need to be very fine-tuned to cause the evolution of intelligent beings and so very un-simple in comparison to theism. So, in Bayesian terms, on the assumption of only one universe, with $h$ as theism, $h^*$ as the disjunction of all possible physical one-universe theories conjoined with the non-existence of God or gods, $e_1$ as the fine-tuning of the universe so as to produce intelligent life and $k$ as tautological background p. 111 evidence, ↳ $P(h|k)$ is so much greater than $P(h^*|k)$, that even though $P(e_1|h\&k) = 1/2$ and even if $P(e_1|h^*\&k) = 1$, $P(h|e_1\&k) \gg P(h^*|e_1\&k)$.

## IV. Interpretations of 'Multiverse'

Hence the suggestion of a universe-generating mechanism which produces many universes (a multiverse) each differing from the others in its laws and/or initial (or boundary) conditions, in such a way that it is probable that there will be at least one universe with the most general characteristics of our universe, including producing intelligent beings in which, inevitably, if we exist, we will find ourselves. To have reason to believe that there is such a multiverse, by my earlier argument we would need reason to postulate a substance, either our universe at some early stage or another universe or some other physical state such as a vacuum field, which would have caused the existence of our universe fine-tuned to produce intelligent life, and which would have caused or been caused by other universes. By my earlier argument that reason would have to consist in the fact that the postulated universe or other physical state satisfies criteria (1) or (3) better than does the one-universe hypothesis. And if we are to have reason to postulate it as the uncaused cause of the fine-tuning of the universe, it would have to satisfy these criteria better than does theism. In the light of these considerations let us assess the various multiverses on offer.

Max Tegmark has distinguished four 'levels' of multiverse. A first-level multiverse is one consisting of many universes, all governed by the same laws as operate in our universe but with different initial conditions (see Tegmark 2007). There are (or could be) two types of physical theory which predict a level-1 multiverse. One is a theory according to which universes are generated by something else physical (for example, 'the vacuum field'). The other type of theory is one according to which universes are generated by other universes. The obvious example of the first type is an inflation theory, according to which the fluctuating 'vacuum field' is continually expanding due to its internal energy; however inflation comes to an end in a particular region when fluctuations lead to a potential minimum, and that provides initial conditions for a universe. If the vacuum field is everlasting in time and infinite in space, 'inflation… generates all possible initial conditions with non-zero probability' (Tegmark 2007: 104).

A second-level multiverse is a multiverse of universes which differ not merely in their initial conditions but in the constants of the fundamental laws, leading to different lower-level laws in different universes. The mechanism of production will lead to 'breaking the underlying symmetries of particle physics' which 'will change the line-up of elementary particles and the effective equations that describe them' (Tegmark 2007: 107). Many theories of the inflation type also have this feature. An example of a theory of the universes-generated-by-universes type which has this feature is Lee Smolin's CNS (Cosmological Natural Selection) theory that new universes with different initial p. 112 ↳ conditions and lower-level laws are generated from black holes in an old universe (see Smolin 2007).

Now both level-1 and level-2 multiverses seem to me to constitute serious physical theories which should each be assessed by the criteria described earlier. Two obvious questions arise: are they in any way simpler than the one-universe theory, and do they lead to predictions which differ from those of the one-universe theory? A level-1 inflation theory postulates a far larger initial substance (a vacuum field) than our universe at its beginning, and for that reason is less simple than the one-universe theory. The advocates of such a theory claim as its great merit that it does not require the kind of 'fine-tuned' initial conditions needed by a one-universe theory in order to bring about somewhere at some time a universe of our kind. But if we suppose that the vacuum field has been inflating for only a finite time, it would require special initial conditions to get the inflation started.[10] Yet to suppose that it has been inflating forever and so has always been of infinite extension does seem to involve postulating a very unsimple first substance. These considerations put in doubt whether a level-1 inflation theory is any simpler than a one-universe Big Bang theory. Perhaps the simplest kind of level-2 inflation theory is one based on 'a Grand Unified' theory of physics which derives three of the four forces from one more general law and allows different sets of values for the fundamental constants in the different universes produced when the vacuum field reaches a potential minimum. In this respect its laws might well seem simpler than those of a one-universe theory,

but it has been questioned whether it allows enough variations in the constants to make probable the occurrence of a universe with the laws of our universe. If it is to generate enough different systems of lower-level laws (to make it probable that our universe would be produced), it may need to be backed up by string theory which has a very large number of unstable states (see Collins 2009: 264); this instability 'allows the Universe [i.e., multiverse] to sample all of a large part of the landscape' (Susskind 2007: 262). String theory, in its now generalized form of 'M-theory', however, might seem very complex, and is certainly not an
p. 113 established part of physics.[11] A Smolin-type level-2 multiverse needs ↳ only a universe of our size to generate the multiverse, and that first-universe also does not need to have any very special features; but CNS postulates some 'very speculative physics' (Carr 2007: 84), additional to normal physics governing the formation of black holes and their 'bouncing back' into new universes. Any level-2 universe needs general laws with far fewer constants than ours; but it still needs the laws of Quantum Theory, the Pauli exclusion principle, forces both of attraction and repulsion, and the laws of Relativity Theory. Overall, while it is immensely difficult to assess the comparative simplicity of multiverse theories, I am going to assume (in order to give the multiverse objector as much as possible) that on the whole one or more multiverse theories are simpler than our one-universe theory, and that in consequence their disjunction is in this respect significantly more likely to be true than the disjunction of one-universe theories.

What about predictions (in my wide sense)? Since other universes cannot be observed (being too far distant for any light from them to reach us), these must be of phenomena in our universe which are consequences of a particular multiverse theory, and which would otherwise be arbitrary features of initial conditions or other inexplicable features of our universe. The great merit of inflation theory was its ability to predict the 'smoothness' of the universe—that it has (to a high degree of approximation) the same density and rate of expansion in all regions—which is an arbitrary feature of the initial conditions in a one-universe theory. Inflation evens out the bumps in the vacuum field. A further merit of inflation theory was its ability to explain the approximations, in the form of the exact values of the tiny temperature fluctuations in the cosmic background radiation. There is much discussion about whether there are any other obvious known features of our universe predicted by a particular multiverse theory but otherwise inexplicable, and what other tests might reveal new such features; and what observations would count against any particular multiverse theory. One obvious relevant type of observation concerns whether the actual values of the human-life-producing features lie in the middle of the range predicted by a multiverse theory, or whether they are on the edge of those allowed by the theory—which would be improbable if the theory is true.[12]

It has however been argued that inflation theory (even in its level-1 variety) makes one prediction about our universe whose evident falsity makes the theory itself very improbable:

> Boltzmann argued that our entire universe was an immensely rare 'fluctuation' within an infinite and eternal time-symmetric domain... If Boltzmann were right, we would be in the smallest fluctuation compatible with our awareness—indeed, the overwhelmingly most likely configuration would be a universe containing nothing but a single brain with external sensations fed into it.
> (Rees 2007: 67)

p. 114 These 'external sensations' would most likely give the brain a totally false picture of the universe in which it lived, and the brain would continue to exist only for a very short time. Modern inflation theory differs from Boltzmann's theory mainly in holding that the vacuum field is continually inflating, but Collins has argued plausibly that inflationary cosmology gives rise to the same problem (Collins 2009: 265–71). The proportion of minimum potential states which give rise to Boltzmann-brain universes (as they are called) is far greater than those which give rise to a vast universe like ours containing a planet on which there are many intelligent beings who, we suppose, have a roughly correct picture of what that universe is like. (If we assume that the apparent universe is a delusion produced by our brains, we could have no reason to believe in other universes, or much else beside our own existence over a very short period of time.) So, if this argument is correct, the evidence that we do live in a vast universe with other intelligent beings on earth and have a roughly correct picture of the world counts massively against inflationary theory, which is generally recognized as by far the most probable kind of level-1 or level-2 theory.

Tegmark sees the Many-Worlds-Interpretation (MWI) of Quantum Theory as constituting a separate level of multiverse: level-3. But it is really, as he acknowledges, a peculiar variant of either level-1 or level-2. The 'peculiarity' consists in the peculiar interpretation given to the ψ-wave function of Quantum Theory. This function is the basic underlying process (of the Universe, or parts of it); it develops in a deterministic way until an observation is made. An observation 'collapses the wave packet' by yielding a particular result (for example, the value of some variable such as the position of a particle within a narrow range). The ψ-function however only allows us to predict in advance different results of an observation with different degrees of probability. The various 'interpretations' of Quantum Theory try to explain what makes it the case that an observation yields one particular result rather than another—for example, on one interpretation the observation creates the result, whereas on a different interpretation the observation reveals the result which the ψ-function has already produced. Most of the interpretations have the problem that Quantum Theory cannot be complete because, whether the 'collapse' creates or reveals the result, it cannot explain why observation collapses the deterministic wave packet at all, so as to yield one result rather than another. MWI claims to solve this problem by claiming that observation produces all possible results. An observation with *n* possible outcomes divides the world into *n* branches (*n* universes), all of which are actual universes.

There are very considerable problems in giving an intelligible and logically coherent account of MWI. The first major problem is: what happens to the observer? MWI cannot say that he will be found only in one branch, since then Quantum Theory would be incomplete in not being able to explain why he is found in this branch rather than that branch. The answer usually given is that the universe-division splits the observer (as well as the rest of the universe) into a number of successor-persons (each of whom is partly identical to the original observer), one in each branch. There are to my mind insuperable philosophical difficulties in supposing that persons, unlike inanimate things, can be split. If I were to be split into two persons and one p. 115 of them ↳ loses $1m and the other gains $1m, then presumably I neither gain money nor lose money; but no subsequent person in either world neither gains nor loses. Yet even if sense could be given to the notion of a person being split, this account then seems to provide no answer to what it means to say that one result has a probability (or 'weight' as MWI theorists sometimes call it) (say, 2/3) greater than that of another result (say, 1/3), since both results inevitably occur. An alternative for MWI to the split-observer answer is to say that what we call 'one observer' before the observation really consists of a collection of innumerable persons (presumably an infinite number of such), each with a predetermined but unknown future history; and what the probability of an observation measures is the probability that a given already existing observer is one of the innumerable observers predestined to observe that result. But of course it seems immensely implausible to suppose that what we normally take to be one observer really consists of an infinite number of distinct persons. And even if all these philosophical difficulties could be overcome, and a logically coherent account of MWI be produced, there would still be a need to show why it should be believed in preference to an alternative interpretation of Quantum Theory.[13] The reason that MWI alone allows Quantum Theory to be a complete deterministic theory of the universe doesn't seem much of a reason unless it could be supplemented by MWI making predictions not made by other interpretations. Yet even if MWI were shown to be probably true, it would not raise any new problems for theism beyond those produced by a level-2 multiverse. For a level-3 multiverse would contain no worlds of a kind other than would occur in a level-2 multiverse; the most general laws of Quantum Theory and the four forces would be the same, and so the kinds of universe produced from any particular initial state (or over infinite time) would be the same.

Finally there is the level-4 multiverse, which Tegmark states as the claim that 'all mathematical structures exist'; every possible system of laws of nature and initial conditions is instantiated in one and only one universe, not because of any causal process which brings about these universes—but because that is just how things are (Tegmark 2007: 118). But why stop there? Why not suppose that every possible law-like and chaotic universe exists, as David Lewis (1986) has suggested? And finally, even beyond Lewis, why suppose that each universe described in full detail in terms of the pattern of substances and their properties (and relations) is unique; maybe there are innumerable qualitatively identical universes differing in the physical matter of which they are made? But, as seen above, we have grounds to postulate a universe only if doing so provides a probable explanation of phenomena, or is a consequence of such an explanation (that is, the postulated universe is postulated to be causally connected to our universe). We could have such grounds only for universes of level-1 or level-2 (and perhaps level-3) multiverses. Universes of level-4 multiverses, which do not belong to level-1, level-2, or level-3 multiverses, are not caused to exist by our universe, or by any universe which causes our universe, or by any universe which is caused by any such p. 116 ↳ universe, and so on. The criterion of simplicity insists that we should not postulate many entities of a kind, when few entities of that kind will explain our evidence. We can have no good reason to believe in level-4 (or higher level) universes. So there could only be good reason (of a normal scientific kind) to believe in a level-1 or level-2 multiverse (or perhaps also level-3, though, as we have seen, that would make no difference to the kinds of universes produced).

## V. Multiverse and Intelligent Life

But what if there is a God? Does God who, as we have seen, has substantial reason to bring about humans and so one universe productive of humans, have reason for bringing about any more universes? However many civilizations of humans God makes (that is, intelligent beings similar to humans in their general characteristics, as described above), and so planets containing them, it would be better if he made more of them since they are a good thing. So, although God cannot make the best number of such planets, it is not very improbable that he would make quite a few. The initial conditions and laws of our universe may well be such as to lead to more than one planet containing a human civilization. Or maybe not, because we do not know how big that universe is and—even given the normally discussed initial conditions necessary for intelligent life—how rare are the initial conditions (among the conditions necessary for intelligent life) sufficient to produce human life. Most universes in a multiverse will not be conducive to the emergence of intelligent life, let alone human life. So does God have any reason for making universes not so conducive? I suggest that many universes are beautiful things in themselves, great works of art, even if bereft of any life. So certainly God has some reason to produce all those other universes. Does he have any reason to bring about another universe containing planets productive of intelligent life, if there are anyway other such planets in our universe? I suggest that he does, because variety is a good thing, but only so long as the other intelligent life is a good form of life, whether human or non-human. It follows that any multiverse God makes will have such laws and initial conditions as necessary to bring about only good intelligent life (human or of some other kind, for example, intelligent beings with no propensity to do evil); or laws and initial conditions such that this will be (physically) very probable and, if necessary, God will intervene to stop the improbable occurring, that is to stop the evolution of bad intelligent life.

The argument from fine-tuning as analysed so far has ignored the fact that the universe is such that—either through an initial fine-tuning, or as a result of the indeterministic laws of Quantum Theory—not merely does it produce intelligent life, but that it produces human life.[14] I gave reason to suppose that it was quite probable that God would bring about not just intelligent life, but human life. And in presenting p. 117 ↳ the argument to God I made the assumption that there is a theodicy adequate to show that the amount of evil in the world does not cancel out the positive force of the argument. I pointed out that such a theodicy could explain only certain limited kinds of evil, for example, any humans suffering for no more than 80 or so years, which I assumed were the only kinds of evil on earth.

But there could be universes which contained bad intelligent life. There could be intelligent beings who suffer much more intensely or for much longer than they do on earth (and not by their own choice). There could be a race of intelligent beings who (not as a result of their own choice or the influences of the choices of others) love to cause suffering to those of other races, having no natural compassion for them and no moral sense.[15] There could be a race of intelligent beings (for example, conscious computers or Boltzmann brains) with hard exterior skeletons making them unable to do any harm or provide any help to each other or to themselves (or to be helped by other beings); and yet there could be just as much total suffering as there is in our world with none of it resulting from free choice or providing information for the sufferers or others which they could use to avoid future suffering. And so on. I see no reason to suppose that natural selection would soon weed out such beings. And anyway natural selection can only select from variants thrown up by genetic recombinations and mutations, and there could be universes in which genes for the above characteristics were linked to ones which gave their possessors selective advantages, or ones in which most combinations and most mutations still produced genes of the same evil kind, or universes in which there was such abundance of food and space that natural selection did not operate. But, as far as we know (and given my assumption about there being a theodicy adequate to explain the limited evil on earth), our universe produces only good intelligent life; and in particular it produces humans, the kind of good intelligent life which God is most likely to produce. I have suggested that there is a probability of 0 that God would create bad intelligent life, but a considerable probability that he would create humans. Just how probable it is that (if there is no God) the initial conditions and laws which would very probably produce intelligent life would produce humans and no bad intelligent life, it is not easy to say until physicists, biologists, etc., have worked out the consequences of different laws and initial conditions in immensely more detail than they have been able to do so far. But it does look not too improbable that circumstances fairly similar to those produced by the Big Bang which produced the human genotype would have produced one in which there was bad intelligent life. (Scientists have recently drawn attention to the risks involved in making contact with any alien beings discovered by SETI.) And plausibly there could be universes of some
p. 118 ↳ level-2 multiverse which produced bad intelligent beings by a mechanism other than the genetic mechanism which operates on earth. The fact that, as far as we know, our universe contains no bad intelligent life (and in particular that we are not bad beings of this kind) but that it contains humans, is evidence that if there is a multiverse, it is a God-produced multiverse. And of course it is also evidence that if there is only one universe, it is God-produced. Even those who doubt my theodicy (that is, doubt whether all suffering and evil-doing on earth is such that there is a point in it being allowed to occur) must admit that there could be universes a great deal worse than ours, universes which much more obviously contained bad intelligent life, or ones which contained less good than ours (for example, ones in which the good intelligent beings were not humans). The fact that the situation is not like this, but could well be if there were a Godless multiverse, increases the probability of the existence of God.

## VI. A Bayesian Context

Now let's put all this in Bayesian terms. As before, let *h* be theism. In order to simplify the formalization I omit *k* and read expressions such as P(*h*) as the probability of *h* on tautological background evidence (that is, the intrinsic probability of *h*). Let $e_1$ be the currently available evidence of the fine-tuning of a universe (ours), in the kind of respects to which physics has drawn our attention, to produce intelligent life, previously denoted by *e*. Assume that we have no further evidence relevant to the existence or non-existence of a multiverse; but suspect that our assessment of the probability of *h* on *e* is mistaken through not taking into account this possibility. So we may rephrase Bayes' theorem so as to take this into account. Let *m* be the hypothesis of the existence of a multiverse of some kind (that is, the disjunction of possible multiverses) which will produce at some time a fine-tuned universe; and let *u* be the hypothesis that there is only one universe and it is fine-tuned. All actual one-universe or multiverse theories merely give a high value less than 1 to $P(e_1|u)$ and $P(e_1|m)$; but to make the argument less cumbersome without making any crucial difference to it, I shall assume $P(e_1|u) = P(e_1|m) = 1$; and then of course $e_1 = (u \vee m)$. Then:

$$P(h|e_1) = \frac{P(h\&m)+P(h\&u)}{P(h\&m)+P(h\&u)+P(\sim h\&m)+P(\sim h\&u).}$$

Humans are such good things that I have attributed the value of ½ to $P(e_1|h)$. So P(*h*&*m*) + P(*h*&*u*) = ½P(*h*). I have suggested that God has some reason to produce a multiverse rather than just one universe, because of the goodness of the variety of different kinds of universes which would result—although not of course a multiverse which would bring about the existence of bad intelligent life. So I suggest that $P(h\&m) \geq P(h\&u)$. I have already suggested that P(~*h*&*u*) is very small. So all turns on whether P(~*h*&*m*) is much bigger than P(~*h*&*u*); and that turns on whether the initial conditions and laws of possible multiverses are much simpler and so *a priori* more probable than those of a single universe. I said earlier that (in order to give the
p. 119 multiverse objector as much as possible) I was going to assume that P(~*h*&*m*) is quite ↳ a bit greater than P(~*h*&*u*). However P(~*h*&*m*) is still going to be vastly smaller than P(*h*&*m*) = P(*m*|*h*)P(*h*) 〉1/ 4P(*h*). This is because only a multiverse (of level-1 or level-2; or, if it is coherent, level-3) with a moderately small range of initial conditions (an extended state of matter-energy such as a vacuum field of a certain size with a certain range of fluctuations) and some complicated laws (for example, laws of Quantum Theory) can lead to a universe having $e_1$. This is a vastly complicated hypothesis in comparison with the hypothesis of one unextended essentially omnipotent, omniscient and perfectly free substance. So, given no new evidence, my conclusion is $P(h|e_1)$ is smaller than it would be if we ignored the possibility of a multiverse but still much greater than $P(\sim h|e_1)$.

Now suppose that there is evidence $e_2$ of the kind considered by physicists confirming or disconfirming *m*. This may be evidence already known (for example, the smoothness of the universe, or the fact that we are not Boltzmann brains) or something newly discovered. I see every reason to suppose that a perfectly good God will not give us deliberately misleading evidence on this matter. So $P(e_2|m\&h) = P(e_2|m) = P(e_2|m\&\sim h)$; $P(e_2|u\&h) = P(e_2|u) = P(e_2|u\&\sim h)$.

Then $P(h|e_1\&e_2) = \frac{P(e_1\&e_2|h)P(h)}{P(e_1\&e_2|h)P(h)+P(e_1\&e_2|\sim h)P(\sim h)}$

$$= \frac{P(e_1\&e_2\&h)}{P(e_1\&e_2\&h)+P(e_1\&e_2\&{\sim}h)}$$
$$= \frac{P((mvu)\&e_2\&h)}{P((mvu)\&e_2\&h)+P((mvu)\&e_2\&{\sim}h)}$$
$$= \frac{P(m\&e_2\&h)+P(u\&e_2\&h)}{P(m\&e_2\&h)+P(u\&e_2\&h)+P(m\&e_2\&{\sim}h)+P(u\&e_2\&{\sim}h)}$$
$$= \frac{P(e_2|h\&m)P(h\&m)+P(e_2|u\&h)P(u\&h)}{P(e_2|h\&m)P(h\&m)+P(e_2|u\&h)P(u\&h)+P(e_2|m\&{\sim}h)P(m\&{\sim}h)+P(e_2|u\&{\sim}h)P(u\&{\sim}h)}$$
$$= \frac{P(e_2|m)P(h\&m)+P(e_2|u)P(h\&u)}{P(e_2|m)P(h\&m)+P(e_2|u)P(h\&u)+P(e_2|m)P(m\&{\sim}h)+P(e_2|u)P(u\&{\sim}h)}$$

The effect of $e_2$ has been that extra terms $P(e_2|m)$ and $P(e_2|u)$ have been inserted so as to increase or decrease the relative value of conjunctions involving *m* as against those involving *u*.

Consider the two extreme cases. The first is that $e_2$ is incompatible with *u*. Then the equation reduces to:

$$P(h|e_1\&e_2) = \frac{P(h\&m)}{P(h\&m)+P({\sim}h\&m)}$$

Given that $P(h\&m)$ is not very different from $P(h\&u)$, the effect of $e_2$ on *h* will depend once again on whether *m* is much simpler than *u*. On the assumption that it is quite a bit simpler but not too much simpler, $e_2$ will diminish the probability of *h* but not by very much: $P(h|e_1\&e_2) \langle P(h|e_1)$, but still $P(h|e_1\&e_2) \gg P({\sim}h|e_1\&e_2)$.

p. 120 The other extreme case is that $e_2$ is incompatible with *m*. Then the equation reduces to: ↳

$$P(h|e_1\&e_2) = \frac{P(h\&u)}{P(h\&u)+P({\sim}h\&u)}$$

Given that *m* is simpler than *u*, and that $P(h\&u)$ is not very different from $P(h\&m)$, this has the consequence that $e_2$ increases the probability of *h*.

If $e_2$ only raises or lowers the probability of *m* or *u* as the case may be without being incompatible with one of them, then the resulting value of $P(h|e_1\&e_2)$ will lie between the two extreme values. (There is a near-extreme case if *m* makes it very probable that humans would be Boltzmann brains, and $e_2$ includes the evidence that we are not Boltzmann brains.)

However, we must now bring in $e_3$: that the universe is fine-tuned in the further respect that it produces not merely any intelligent life, but humans, and no bad intelligent life on earth or on any other planet which we have been able to study. To repeat the earlier formula:

$$P(h|e_1\&e_2) = \frac{P(e_1\&e_2|h)P(h)}{P(e_1\&e_2|h)P(h)+P(e_1\&e_2|{\sim}h)P({\sim}h)}$$

Now $\frac{P(e_1\&e_2\&e_3|h)}{P(e_1\&e_2|h)} \rangle \frac{P(e_1\&e_2\&e_3|{\sim}h)}{P(e_2\&e_2|{\sim}h)}$

since $e_3$ is more to be expected (given $e_1\&e_2$) if *h* then if ~*h*. The multiverse hypothesis makes no contribution towards explaining why intelligent life ($e_1$) takes a human form ($e_3$). So the effect of adding $e_3$ to the evidence will be to raise the probability of *h* significantly (whether combined with *m* or *u*), even if $e_2$ lowered it significantly by constituting conclusive evidence for a multiverse hypothesis. All told, the result of this complicated argument is that recognizing the possible existence of a multiverse does not make a great difference to the strength of probabilistic arguments from the fine-tuning of the universe to the existence of God. Of course, this result could be overturned if someone produces an argument from physics to show that some of the values which I have allocated to probabilities on the strength of my limited physical intuition are badly mistaken; but in the absence of that I conclude that the possible existence of a multiverse does not greatly diminish the powerful force of the argument from fine-tuning to the existence of God.[16]

## Appendix A

Inductive probability is a measure of the probability of a hypothesis on some body of evidence; whereas physical probability is a measure of the degree to which an event is predetermined by its causes. I assume
p. 121 that (very roughly) there is a correct measure of inductive probability, ↳ which I call 'logical probability' (see Appendix B). The argument is normally presented merely as an argument from the existence of 'fine-tuned' necessary conditions for the evolution of intelligent life. But the argument would not have so much force if despite the initial conditions (at the time of the Big Bang) and laws providing such necessary conditions, it was still physically very improbable (because of the indeterministic character of the laws) that intelligent life would evolve. For the argument depends on the supposition that God would seek to bring about intelligent life, and would have some reason to do so by an evolutionary process. In that case he would have to have made the initial conditions such that it was (physically) very probable that intelligent life would evolve. Otherwise it is (logically) very probable that he would have needed to intervene at a later stage in the natural order to produce the desired effect; and the argument from fine-tuning would need to be backed up by a further argument to show that it was very probable that he had done this, if it was to be as strong as an argument from the initial conditions being such that intelligent life would very probably evolve. Some biologists do of course offer arguments to show divine intervention at a later stage. (See the discussion of such arguments in Swinburne 2004: 346–9.) Such arguments would need to suggest a reason why God would have made a universe which needed such intervention at a later stage instead of being wound up at the beginning so as very probably to produce intelligent life. But I read the evidence of fine-tuning as showing that the initial conditions of the universe at the time of the Big Bang were such that, given the vast size of the universe and despite the indeterministic character of the laws of Quantum Theory, it is physically very probable that intelligent life would evolve at some time somewhere. So I am going to understand the argument in this stronger sense, even if many of its exponents do not so read it. (For a discussion of the relation to each other of the two different kinds of argument, see Dougherty and Poston (2008).)

Why would an argument for God having created the universe to be such as to produce intelligent life not need to show that at its beginning necessarily (not merely 'very probably') intelligent life would evolve? A major reason why God would create intelligent beings would be for them to exercise free will in a sense which involves their actions not being predetermined by physical causes (see the discussion in the body of this paper), and for this reason a small degree of indeterminism in the physical laws is necessary. Unless God was to intervene to change the laws of nature, that indeterminism would need to be there from the beginning. Only if (very improbably) the universe began to evolve in such a way that it would not produce
p. 122 human life anywhere, would God need to intervene to redirect its development. ↳

## Appendix B

As I am using Bayes' theorem, it concerns 'logical probability' in the sense of the objectively correct probability on evidence determinable *a priori*. Since, however, intrinsic probability is crucial for determining any prior probability, the theorem can only be applied to determine the logical probability of some explanatory theory *h* on evidence *e*($P(h|e\&k)$, if we know the intrinsic probability of *h* (in order to calculate $P(h|k)$) and the intrinsic probabilities of all possible rival theories and can calculate all their consequences (in order to calculate $P(e|k)$). So if we have no idea of the range of possible theories in some field and so of the range of their intrinsic probabilities, we cannot have any idea of the logical probability of any particular explanatory theory on any evidence, and so we will have to make do with a kind of inductive probability which I call 'epistemic probability'. This is probability relative to our knowledge of possibilities and our abilities to calculate consequences. For this distinction between 'logical' and 'epistemic' probability see Swinburne (2001: 56–73). If, still more sceptically, we do not think that there are any intrinsic probabilities, we cannot apply Bayes' theorem to determine $P(h|e\&k)$. For this reason many theorists try to measure the probability of a theory only by its relative 'likelihood', that is the extent to which the observed evidence is (logically) more probable given that theory than given other theories. Collins has a concept which he calls 'epistemic probability', which depends on relative likelihood, which leads him to hold that we can only reach judgements of the probability of some theory within a certain comparison range, which he calls the 'epistemically illuminated range', that is within the range of theories which are taken seriously by scientists and the consequences of which we can calculate (Collins 2009: 244). Those theories which yield the most probable conclusions are the epistemically most probable ones. Hence, according to Collins, we can only argue from fine-tuning to God on the (provisional) assumption that the only relevant scientific theories are the ones currently discussed whose consequences we can calculate and judge their epistemic probability on the basis of their relative likelihood. By contrast I hold that their simplicity and scope are crucial criteria for assessing the probability of scientific theories, and they enable us to judge the relative intrinsic probabilities of theories; and so that Collins' attempt to assess the force of the argument from fine-tuning without taking account of intrinsic probabilities must fail. I also argue (in Swinburne 2004) that we can make a very imprecise judgement of the range of intrinsic probabilities which would be possessed by all possible scientific theories of universes (not yet articulated) and that we can compare the total intrinsic probability of theories of that range with the intrinsic probability of the existence of God. This is because the postulation of the existence of God is a very simple postulation, far simpler than any scientific theory could be. Hence we can make judgements of the logical probability of the existence of God on the evidence of fine-tuning.

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## Notes

1 I shall assume, in order not to complicate my exposition, that a physical theory which explained the evolution of the bodies of intelligent beings would thereby explain the evolution of embodied intelligent beings, understood—as I understand it here—in the sense of conscious intelligent beings. In fact in my view no physical theory is in the least likely to be able to explain the evolution of consciousness, and so for example why human bodies are the bodies of conscious beings. The argument from fine-tuning is really an argument from the universe being fine-tuned so as to produce bodies of intelligent beings. The occurrence of consciousness connected to these bodies provides a further argument for the existence of God. See Swinburne (2004: 192–212).

2 See Appendix A.

3 Most expositions of the 'fine-tuning' assume the standard model of particle physics (including the 'four forces') and then show that only for one narrow range (or a few narrow ranges) of the constants involved in this model (and of values of the variables of the properties with which this model deals) would intelligent embodied beings evolve. Some expositions assume a somewhat wider class of possible models, for example, those of seriously considered scientific theories (some of which do not include the standard model) 'and/or the ones we can perform calculations for' (Collins 2009: 240). This latter phrase is that of Robin Collins who gives by far the fullest and most up-to-date detailed account of the extent of the fine-tuning, that is of just how much different constants and variables could vary if the universe was still to be productive of intelligent life. (See his very long article Collins 2009.) I have argued that in order to show the improbability of fine-tuning if there is no God, one needs to show more than is shown in these expositions. One needs to show that it is (if there is no God) improbable that any scientific theory would have the consequence that intelligent embodied beings would evolve, and that involves showing that it is improbable that any scientific theories other than those currently seriously considered would have this consequence, for example, because they would need to be very complicated. For my attempt to argue for this improbability see Swinburne (2004: 181–8).

4 I have expounded these criteria in many other places, normally—by combining what I am listing as criteria (1) and (2) as one criterion—as 'four criteria'. See for example Swinburne (2001: 80–3); I did however there mistakenly confuse the 'scope' of a hypothesis with the size of the field which it purports to explain. The latter is only one of the two factors which determine the scope of a hypothesis, the other being the precision of its predictions within the field. What limits the need

for a fit with background evidence (criterion 4) is the size of the field; the precision of predictions is irrelevant. I am grateful to a referee for drawing my attention to the confusion.

5 For analysis and justification of this understanding of simplicity, see Swinburne (2001: 83–102).

6 See Appendix B.

7 If our universe or (see later) the multiverse of which it is a member were to prove everlasting, then the argument from its being fine-tuned so as to produce intelligent life at some time or place would be an argument, as well as from its laws of nature, not now from its initial conditions, but from its boundary conditions in the sense of those general features which it has at every moment of past time. The argument would be an argument from the boundary conditions being such and every physical object having the powers and liabilities codified in the 'laws' being such as to make it probable that God would have been sustaining these conditions at every moment of past time. An analogy would be if we were to find a hall where a very large number of puppets are dancing in unison. If we learn that this has been going on forever, that would not remove the need for an explanation in terms of a common cause; but the common cause would have to have been a cause operating throughout all past time, for example some puppet master who had been controlling the puppets everlastingly by invisible strings.

8 For my theodicy see Swinburne (2004: 219–72), and—more fully—Swinburne (1998).

9 Although a disjunction of hypotheses will always have smaller scope than any one of its disjuncts (and for that reason be more probably true), the single disjunct will always be simpler. We saw earlier that great simplicity (together with some satisfaction of the other criteria) suffices to make a hypothesis probably true.

10 'The onset of inflation seems to require very special initial conditions' (Stoeger 2007: 454). See Stoeger's references to Penrose, Ellis and others. See also Smolin: 'On several plausible hypotheses about the initial state, the conditions required for a region to begin inflating are improbable' (Smolin 2007: 334).

11 In his recent 'popular' book Stephen Hawking claims that M-theory 'is the *only* candidate for a complete theory of the universe. There is no other consistent model' (Hawking and Mlodinow 2010: 181). Presumably what he means is that it is the simplest theory consistent with the data (where 'consistent with the data' is understood in terms of having the relation to the data set out in my first two criteria in Section II). But, given that 'nobody has yet written down the equations that govern the full M-theory, let alone solved them' (Davies 2007: 129), that seems an ill-justified claim. My response to the much-publicized claim of Hawking's book that because the multiple universes 'arise naturally from physical law', 'their creation does not require the intervention of some supernatural being or god' (Hawking and Mlodinow 2010: 8–9) is that certainly it would not require the 'intervention' of such a being, but the all-important question remains whether the operation of the relevant physical laws themselves would be best explained by the agency of God. I claim that my arguments here, together with other arguments contained in Swinburne (2004), show that it would, and that these arguments make the existence of God significantly more probable than not.

12 See for example Aguirre (2007). A number of the articles in Carr (2007) discuss possible observations which might confirm or disconfirm various multiverse theories.

13 For these problems with MWI, see the various papers in Saunders et al. (2010).

14 I discuss the good features of humans at greater length in Swinburne (2004: 219–35).

15 While some natural altruism for those of one's own group may well give a selective advantage, altruism which extends to care for the old and sick and even to competing groups is surely disadvantageous. And so too is a 'moral sense', leading one to believe that one ought to help the old and sick, and so on, even where one does not have any natural altruism. As T. H. Huxley put it, 'the practice of that which is ethically best… involves a course of conduct which in all respects, is opposed to that which leads to success in the cosmic struggle for existence' (Huxley 1894: 81–2).

16 I am most grateful to Robin Collins who commented on an earlier version of this paper, and provided me with much help in understanding the consequences of an inflationary multiverse for the prevalence of Boltzmann brains. Many thanks also to two referees who provided very helpful detailed comments on the penultimate version of the paper.