DESIGN INFERENCES IN AN INFINITE UNIVERSE

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Abstract

This paper addresses two main questions. First, how does one determine that something has the features it does as a result of design, as opposed to for example chance? Second, how are inferences to design affected when one makes the (plausible) assumption that the universe is spatially infinite? I will show that arguments for the existence of God based on the improbable development of life don't go through under the supposition that the universe is spatially infinite. I will also show that the model of design inferences promulgated by William Dembski is flawed, because it has the consequence that one can never infer design in a spatially infinite universe. My model for design inferences has the (desirable) consequence that there are circumstances where a seeming miracle can count as evidence for the existence of God, even if one would expect that type of event to naturalistically occur in a spatially infinite universe.

1. Three Types of Design Inferences

When people observe features of the universe, they sometimes infer that the feature occurred as a result of design, and they sometimes infer that the feature occurred some other way – by chance, necessity, coincidence, unguided natural processes, or what have you. (The term "design" has been used different ways in the literature; in this paper I use it in such a way that design always requires a designer. Thus, my usage differs from those atheist evolutionary biologists who are willing to say that a certain biological feature has a design.) Let's call any argument or line of reasoning where someone infers that a feature of the universe was designed, or shifts one's opinion in favor of the hypothesis that a feature was designed, an "inference to design", or "design inference". (While the term is sometimes used in the literature to refer to William Dembski's particular model for design inferences, I intend the term to be a general one; I will discuss Dembski's model below.)

It will be helpful to distinguish three types of design inferences:

(1) by appeal to certain features of the universe as a whole, inferring a designer somehow (at least in part) beyond the physical universe;
(2) by appeal to certain features of particular things or events in the universe, inferring a designer somehow (at least in part) beyond the physical universe;
(3) by appeal to certain features of particular things or events in the universe, inferring a designer that is a part of the physical universe.

An example of the first type of design inference is the fine-tuning argument. This line of reasoning points out that various fundamental physical constants are fine-tuned for life, in the sense that if the values of the constants were outside some narrow range, life couldn't exist, and then concludes that it is likely that God exists, because God would ensure that the constants are in that narrow range. An example of the second type of design inference is an appeal to miracles – people prayed for Fred, and his tumor disappeared; this series of events leads some people to conclude that God exists. An example of the third type of argument is when one finds a watch on the ground, and concludes that the watch was built by human agents.

Note that, for the first and second type of design inference, it is standard for people engaging in this line of reasoning to infer that the designer is God, but the designer need not be. For example, it may be that the whole universe we experience is really just a computer simulation being run by highly intelligent non-supernatural beings, as Nick Bostrom (2003) argues is plausible. Since the people who promulgate these design inferences are almost inevitably theists, I will set aside non-theistic hypotheses for the nature of the designer for the purposes of this discussion.

Inferences of the third type are often unproblematic – we do correctly infer that all sorts of artifacts are designed. Inferences of the first type are controversial, and have received a lot of discussion as of late in the literature. I will not be focussing on either of those types of inference here.

Instead, I will be focussing on the second type of inference. My main thesis is that the strength of some particular instances of the second type of inference depends in large part on whether the universe is spatially infinite. If the universe is spatially infinite (and various other conditions which would plausibly hold in a spatially infinite universe

actually do hold, conditions which I'll spell out below), then some design inferences of the second type are not very strong.

Specifically, I'll show that if the universe is spatially infinite, this gives us grounds to reject teleological arguments for the existence of God that focus on the origin of life, grounds to reject Michael Behe's appeals to irreducible complexity as evidence for design, and grounds to reject Dembski's model of design inferences. After showing all this, I will offer my own model for how to engage in design inferences, and this will enable me to show what it would take for a design inference of the second type to be successful. In particular, I will argue that design inferences of the second type could be successful, even if the universe is spatially infinite.

2. The Spatially Infinite Universe

While this isn't strictly speaking necessary for my argument, it's worth pointing out that the best current evidence from physics suggests that the universe is spatially infinite.

General relativity is our best current theory for the large-scale structure of the universe. General relativity allows for two types of models of space – models where space is finite in extent, and models where space is infinite in extent. The mainstream view of contemporary cosmologists is that the evidence suggests that space is infinite. Specifically, the evidence suggests that on a large scale space is not curved. For example, the Wilkinson Microwave Anisotropy Probe (WMAP) was recently used to measure the Cosmic Microwave Background radiation. The temperature fluctuations in the radiation suggest that space is flat, and hence infinite. Before the WMAP results the universe was predicted to be spatially infinite with a 15% margin of error; the WMAP results reduce that margin of error to 2%.[1]

So what is the rest of the universe like, beyond the limited region that we can observe? We can't be certain about this, but it is reasonable to think that matter elsewhere in the universe is similar to matter here – just as there are stars and planets here, there are stars and planets elsewhere. Moreover, it's reasonable to think that there is some variability in what exists here as opposed to what exists elsewhere. It *could* be that there is no variability – for example, it could be that the universe is divided into an infinite number of 500 trillion-light-year-cubed square-shaped regions, and what happens in the region we're living in is qualitatively duplicated in each of the other regions. A (more plausible) contrasting view is that there was at least some randomness in the initial

[1] For pre-WMAP evidence that the universe is spatially infinite, see Bahcall et al. 1999. For the WMAP evidence, see Spergel et al. 2003 and Bennett et al. 2003. General information on WMAP is at http://map.gsfc.nasa.gov/m_mm.html. To be precise, the WMAP evidence is that on a large scale, the universe is spatially flat. It is mathematically possible for the universe to be spatially flat and yet finite (as explained by for example Heckmann and Schücking (1962, 441-2)), but such non-standard topologies are usually rejected by physicists. In addition to the empirical evidence, there is theoretical support for the hypothesis that the universe is spatially infinite. Most versions of inflationary cosmology make this prediction, as explained by Linde (2000, 584-6).

conditions of the universe, such that different things can happen in different regions of the universe.[2]

Let's suppose that the universe is in fact spatially infinite, and that matter elsewhere in the universe is similar to matter here, and that there was randomness in the initial conditions for different regions of the universe. (Below, when I talk of the universe being spatially infinite, I will be implicitly assuming that these other conditions hold as well, unless I make clear otherwise.) What impact does the hypothesis that the universe is spatially infinite have on design inferences?

3. Life

Let's begin the answer to that question by looking at a particular design inference –one that appeals to the existence of life in the universe, and infers the existence of a God which created that life.

There are two prima facie promising reasons people will give nowadays to infer from the existence of life to the existence of God. The first is that the transition from non-life to life would not be expected in a naturalistic universe; the second is that some complex biological systems would not be expected to arise via Darwinian evolutionary means. I'll briefly explain each line of reasoning now.

Regarding the origin of life, intelligent design proponents like to quote the following summary by Francis Crick. He writes:

> An honest man, armed with all the knowledge available to us now, could only state that in some sense, the origin of life appears at the moment to be almost a miracle, so many are the conditions which would have had to have been satisfied to get it going. (Crick 1981, 88)

If Crick is right, it seems very improbable that life could have arisen from non-life via naturalistic means. Our knowledge is so limited that precise numerical estimates seem unreasonable, but they have been given. Robert Shapiro (1986, 127) cites Hoyle and Wickramasinghe's estimate of the chance of life naturalistically arising on a particular planet like ours as 1 in $10^{40,000}$, as well as Morowitz's estimate of 1 in $10^{100,000,000,000}$. (Actually, those odds are the odds for a particular trial – a particular physical process that could in principle form life from non-life. Shapiro estimates that on Earth there were 10^{51} trials available. But the difference between 1 in $10^{40,000}$ and 10^{51} in $10^{40,000}$ is well within the margin of error for these estimates.) Given these odds, this leads some to infer that the process of life arising from non-life happened via design.

In addition to a design inference based on the origin of life, another design inference is based on the particular type of life that exists. Specifically, Michael Behe (1996) argues that some biochemical systems are too complex to have plausibly arisen through naturalistic evolutionary processes. Behe argues that some systems are *irreducibly complex*: they have multiple parts and they need all their parts to do anything. Behe claims that we wouldn't expect such systems to arise via evolutionary means, since random chance would have to bring all the parts together at once for the system to be

[2] For a more technical discussion of these further conditions, see Ellis and Brundrit 1979, 37-8. For evidence that these conditions hold, see Tegmark 2003, 463.

functional; the existence of the system can't be accounted for via a step-wise evolutionary process.

Though there is some confusion about this in the literature, in fact Behe never claims that it's *impossible* for the complex systems he identifies to arise via evolutionary means, he just claims that (as far as we can tell) it's *unlikely*. For an irreducibly complex system to arise via evolutionary means, it would have to arise via an indirect scenario, where (for example) the individual parts first came into existence via evolutionary means because they each performed some other useful function, and then they got co-opted to use in the irreducibly complex system. Here is what Behe says about this possibility:

> "As the number of required parts increases, the difficulty of gradually putting the system together skyrockets, and the likelihood of indirect scenarios plummets. Darwin looks more and more forlorn." (1996, 73)

Thus, Behe's argument is probabilistic – it is highly improbable for an irreducibly complex system to arise via evolutionary means, so we should infer that the irreducibly complex system was designed.

I will argue that, if the universe is spatially infinite, we have the resources to reject both the origin-of-life design inference and Behe's design inference. My argument will be easier to follow if we first consider the following story.

Fred is not very good at darts. Sure, Fred can hit the dartboard every time, but other than that Fred's aim isn't very impressive; only about 1 in 1000 throws of his hit the bull's-eye. But Fred likes to throw darts a lot. For example, the other day Fred threw a dart 10,000 times. How many bull's-eyes would you guess that Fred got? Well, if he gets bull's-eyes on average of 1 in 1000 throws, and he throws 10,000 times, then you should guess that Fred got about 10 bull's-eyes. Similarly, if Fred throws 100,000 times, you should expect about 100 bull's-eyes, and so on.

What if Fred throws an infinite number of times? We should expect that he'll get infinitely many bull's-eyes. (If this isn't obvious, then tell me how many bull's-eyes you think Fred will get. I'll take that number, multiply by 1000, and tell you that that's about the number of throws it would take for Fred to probably get around the number of bull's-eyes you mentioned. But Fred's throwing many more times than that; Fred's throwing infinitely many times.)

Moreover, note that we should expect Fred to get infinitely many bull's-eyes regardless of how unlikely it is for Fred to hit bull's-eye on any particular throw – as long as that probability is not zero. Even if Fred will only hit bull's-eye 1 in 1,000,000,000,000 times, we should still expect Fred to hit bull's-eye infinitely many times if he throws infinitely many times. (I use this "expect" terminology because it is still *possible* for Fred to never hit bull's-eye, even if he is throwing randomly an infinite number of times, just as it is possible to flip a fair coin over and over and keep getting heads, no matter how many times one flips.)

So what does this have to do with life in the universe? Well, let's go back to the question we considered above: how probable is it that life would spontaneously arise from non-life on a particular planet? As long as the probability is not zero, then if the universe is spatially infinite we should expect life to arise *somewhere* in the infinite universe, just as, if Fred throws an infinite number of times, we should expect him to hit a bull's-eye. In fact, we can draw a much stronger conclusion. We should expect life to

arise *an infinite number of places* in the universe – just as we should expect Fred, when he throws infinitely many times, to get infinitely many bull's-eyes.

The same sort of reasoning leads to the conclusion that we should expect complex life to arise an infinite number of places in the universe, even if complex life requires irreducibly complex systems. For any given individual planet with life, it's unlikely for complex life to arise. So if you could look at a very large but finite region of space, you would see various planets with life, but comparatively few of those planets would have intelligent life. Nevertheless, within the whole spatially infinite universe, we should expect there to be an infinite number of planets with complex life.

My conclusion is that one shouldn't use the development of life from non-life, or the existence of irreducibly complex biological systems, to argue for design. At least, this is the case if the universe is spatially infinite. As I mentioned above, my hypothesis that the universe is spatially infinite has built in to it two further assumptions – that there are stars and planets throughout the universe, and that the initial conditions vary appropriately across different regions of the universe. It could be that the rest of the universe beyond what we can observe is barren of matter, and hence there are only a relatively small finite number of planets on which life could potentially arise. If this is the case, and the odds of life naturalistically developing on any particular planet really are 1 in $10^{100,000,000,000}$, it would be very unlikely for life to arise in the universe via naturalistic means. Moreover, it could be that there are stars and planets throughout the universe, but the initial conditions for all regions of the universe other than here are such that it is guaranteed that the planets can't support life. I am not claiming that the universe is spatially infinite and that these other conditions hold – the most I am claiming is that it is reasonable to believe that our universe is that way. My main point is that if one believes that our universe is that way, then one has good reason to reject the design inferences discussed in this section.

In practice, even those who believe that the universe is spatially infinite wouldn't be certain about it – reasonable believers would hold that there is a non-zero probability that in fact the universe is not spatially infinite. For such people, origin-of-life considerations could lead to a small increase in the probability they assign to the designer hypothesis. Conditional on the universe being spatially finite, the probability for a designer goes up when presented with the origin-of-life argument, while conditional on the universe being spatially infinite, the probability for a designer stays the same. The people who hold that the universe is most likely spatially infinite will then obtain their probability for a designer as a weighted average of the two probabilities, one conditional on the universe being spatially finite and the other conditional on the universe being spatially infinite. Since the weight on the spatially finite case is small, the probabilistic increase in the designer hypothesis will similarly be small. (This all follows from standard probabilistic reasoning, which will be discussed in more detail in Section 7.)

There is an interesting side-note to make regarding my argument in this section. Antony Flew, an atheist for most of his life, recently (and famously) converted to theism. Flew discussed this conversion in a 2004 interview, saying:

> I think the most impressive arguments for God's existence are those that are supported by recent scientific discoveries. ... I think the argument to Intelligent Design is enormously stronger than when I first met it.

Elsewhere, Flew elaborates on this, citing the origin of life from non-life as an event that seemingly can't be accounted for via naturalistic means. He writes:

> the evidential situation of natural (as opposed to revealed) theology has been transformed in the more than fifty years since Watson and Crick won the Nobel Prize for their discovery of the double helix structure of DNA. It has become inordinately difficult even to begin to think about constructing a naturalistic theory of the evolution of that first reproducing organism.

He takes this problem of accounting for the existence of the first reproducing organism to provide evidence of the existence of God. He says that

> one place where, until a satisfactory naturalistic explanation has been developed, there would appear to be room for an Argument to Design is at the first emergence of living from non-living matter.[3]

Now, if what I've been saying is right, then one *can* give a satisfactory naturalistic explanation of the first emergence of living from non-living matter. Obviously, the specific biological details would need to be filled in, but such an event would be expected to occur, given the probabilistic resources one gets from a spatially infinite universe.

4. Robert Shapiro's Objections

I'll now consider some objections to the reasoning I've given in the previous section, due to origin-of-life scientist Robert Shapiro (1986, 125-31). Shapiro discusses the hypothesis that the universe is infinite in the context of the origin of life. At first, he dismisses out of hand the possibility that the universe being spatially infinite could help account for the origin of life, but later, he's slightly more charitable. He nevertheless would disagree with the line of reasoning I've offered above; I'll explain why he's mistaken.

His dismissal comes when he considers the suggestion that the odds of life forming on a particular planet are 1 in $10^{100,000,000,000}$. He writes:

> The improbability ... is so large that it reduces all considerations of time and space to nothingness. Given such odds, the time until black holes evaporate and the space to the ends of the universe would make no difference at all. (Shapiro 1986, 128)

But if the universe is spatially infinite, then the existence of that space would make *all the difference in the world* with respect to how often we would expect such an improbable event to occur. In fact, one doesn't even need space to be infinite – as long as space is large enough, we would expect such an improbable event to occur. For example, if space is large enough, it could contain many more than $10^{100,000,000,000}$ planets. So even though the origin of life would be unlikely to happen on any particular planet, with enough planets we would expect it to happen.

A couple pages later in his book, Shapiro takes the infinite universe hypothesis somewhat – but only somewhat – more seriously. He writes:

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[3] The first Flew quote is from http://www.biola.edu/antonyflew/flew-interview.pdf. The second is from http://www.philosophynow.org/issue47/47flew.htm.The third is from http://www.thewonderoftheworld.com/Sections1-article227-page1.html. For further developments of Flew's position, see Flew 2005, 11.

There is one way in which any event, however improbable, can be made probable. One need only select a model for the universe which postulates that it is infinite.

He then draws a counterintuitive consequence from this hypothesis:

> Of course, this explanation can be used to legitimize any event. The earth may have been a jumbled heap of chemicals last night. Suddenly, by a random fluctuation, we, our memories, our possessions, and our civilization were created. This event also should occur once in an infinite universe. Perhaps this was the place. (1986, 130)

First of all, it's not at all clear to me that the event he describes is even physically possible. Perhaps we wouldn't expect it to happen anywhere in the universe. But let's grant Shapiro that the event he describes is possible. Shapiro is talking about our civilization, but let's set that aside for a moment; let's just look at the claim that an advanced civilization has a non-zero probability of arising overnight though random fluctuation. If that claim is right, then I would expect it to happen somewhere in the infinite universe. In fact, I would expect it to happen in an infinite number of places.

What about Shapiro's suggestion that our civilization could have arisen that way? My response is: yes, it could have, but it's *very* unlikely. Let's think about some large region of the universe, where there are lots and lots of civilizations. It's most likely the case that most all those civilizations arose via the ordinary way, via step-wise evolutionary processes. Only a very few, if any, would have arisen via Shapiro's extraordinary mechanism of random fluctuation. So given that one finds oneself in a civilization, should one expect to be in one of the ordinary ones, or one of the extraordinary ones? Since there are so many more ordinary ones, that's where one should expect to find oneself. In the absence of evidence to the contrary, we should not think that our civilization arose last night via random fluctuation.

Shapiro gives another reply to the argument that an infinite universe can account for the origin of life. He writes:

> The above argument will not hold if evidence indicates that the universe is definitely finite in extent. Even without such evidence, the argument is not a useful one. It cannot be refuted, and nothing can be done with it. (1986, 130)

Well, one way to refute the argument is to do what Shapiro suggests in the first sentence, and find evidence that the universe is spatially finite (evidence that in principle the WMAP observations could have provided, for example). Perhaps Shapiro is suggesting that the argument can't be refuted if we don't have evidence that the universe is spatially finite? But this is false: for example, we could obtain evidence that the universe is spatially infinite but only contains a finite amount of matter, or we could obtain evidence that the universe is spatially infinite but there are only a finite number of life-permitting planets and civilizations can't arise via random fluctuation.

Moreover, I just don't understand why Shapiro says that "nothing can be done" with the argument. If I'm right, the argument can be used to help account for the origin of life, despite the fact that the origin of life seems like an improbable event. Granted, my argument doesn't tell one how life actually arose – there is still important biological work to be done. But it should make one realize that, assuming the universe is spatially infinite (and the other conditions I've discussed hold), there is no need to appeal to design to account for the origin of life.

5. Michael Behe's Objections

In Behe's 1996 book *Darwin's Black Box*, where he originally gives the irreducible complexity argument, he does not discuss the possibility that the universe is spatially infinite. But in his 2007 book *The Edge of Evolution*, he takes up a related issue. Specifically, what he discusses is the possibility that there are many universes. Consideration of this possibility leads to the argument that there's no need to postulate a designer because, under the assumption that there is no designer, we would expect that most universes wouldn't have life, but given enough universes we would expect that some would. Behe takes issue with this argument.

The objections Behe gives to this argument prima facie carry over to my argument based on the spatially infinite universe, and so it's worth discussing Behe's objections. Before doing so, though, I want to point out that Behe seems unaware of my argument based on a single spatially infinite universe. He writes:

> Notice that the multiverse scenario doesn't rescue Darwinism. Random mutation in a single universe would still be terribly unlikely as a cause for life. (Behe 2007, 222)

On a particular planet, it would be very unlikely for random mutation to lead to the development of life. But in a single spatially infinite universe, we would expect there to be some planets where random mutation did act as a cause for life.

I'll now discuss the four objections Behe gives to the multiverse reply to his irreducible complexity argument. In doing so, I'll consider how these objections could be applied to my argument that appeals to a spatially infinite universe as a way of blocking the inference from the existence of life to the existence of a designer.

The first objection is that the multiverse scenario is "speculative" (p. 222). While this is true, I want to point out that the hypothesis that the universe is spatially infinite is less speculative – it's supported by standard scientific evidence, such as the WMAP observations.

The second objection is that "some multiverse models themselves require much fine-tuning to make sure that, if real, they would generate universes with the right possibilities" (p. 222). This is true, and thus I don't think an appeal to those sorts of multiverse models is successful as a reply to the fine-tuning argument. (For a reply to that argument, see for example Monton 2006.) I just want to point out that the hypothesis that the universe is spatially infinite also is not successful as a reply to the fine-tuning argument, since (arguably) there would have needed to be fine-tuning to get a life-permitting spatially infinite universe in the first place. This is a contentious issue though – one could hold that, within the spatially infinite universe, there are different regions with different laws and values of the fundamental constants, and that no fine-tuning was needed to create this diverse universe. That line of reasoning is more speculative than the line of reasoning I'm endorsing; I want to make clear that the line of reasoning I'm endorsing is not intended as a reply to the fine-tuning argument.

Behe's third objection is as follows. On the assumption that there are many universes where the properties of each universe are randomly established,

> we should very likely live in a bare-bones world, with little or nothing in life beyond what's absolutely required to produce intelligent observers. … Yet it certainly seems that life in our world is quite lush and contains much more than

> what's absolutely needed for intelligence. Just as one familiar example from this book, the bacterial flagellum seems to have little to do with human intelligence, but is tremendously unlikely. If I am correct that it isn't required to produce intelligent observers, the only one in a very large number of universes that had intelligent observers should be expected to also have bacteria with flagella. (Behe 2007, 223)

Behe is assuming that, out of the panoply of universes in the random multiverse scenario, there are more universes with bare-bones intelligent life than universes with lots of life that is not causally related to intelligent life. Let's not take issue with that, but instead let's consider an analogue of this argument in the spatially infinite universe case – an analogue that provides evidence against a designer.

On the assumption that life in the universe arose randomly, one would expect a bare-bones universe, with most of the universe barrenly devoid of life. On the assumption that life in the universe arose as a result of a designer, one would expect a lush, non-barren universe. In fact though, the universe, as far as we can tell, is mostly a barren place. We don't find life abundant throughout the universe; so far we've only found life here. Thus, the observed distribution of life in the universe provides evidence against a designer.

Behe clearly wouldn't be happy with this line of reasoning; in reply he might give a pro-designer argument that appeals to the type of life we have here. As Behe points out in the above quote, we have bacterial flagella, and yet bacterial flagella aren't needed for intelligent life. Behe takes this as evidence for a designer; he would presumably say (in the context of the spatially infinite universe hypothesis) that, under the assumption that there's no designer, it would be much more likely to find intelligent life on a bare-bones planet than on a planet with lush life.

In contrast, I believe that the existence of bacterial flagella that have nothing to do with intelligent life provides evidence *against* a designer. Random undesigned evolutionary pathways would be expected to lead to all sorts of life, including life that was not especially intelligent. But I would expect a designer not to desire the existence of bacterial flagella. (I recognize that this argument is speculative, because it depends on the intentions of the hypothesized designer. But it shares this speculative feature with all the design arguments of which I'm aware.)

Another reply to Behe's argument is that unlikely events would be expected to happen on any planet during the long evolutionary process that led to intelligent life. It is plausible to hold that the vast majority of planets with intelligent life wouldn't have bacterial flagella, but they would have other types of life with unlikely features. What Behe would have to argue is that our planet has a much greater number of unlikely types of life than one would expect for a planet where intelligent life evolves via unguided evolution, or that our planet has forms of life that are much more unlikely than one would expect for a planet where intelligent life evolves via unguided evolution. But he has not given such an argument.

Here is the fourth and final objection from Behe. Behe argues that, if there are an infinite number of universes, there are an infinite number of "freak observers", where matter spontaneously arranges itself so as to form a conscious brain for some interval of time. This would be very unlikely to happen in any particular finite region of spacetime, but

> In an infinite multiverse, probabilities don't matter. Any event that isn't strictly impossible will occur an infinite number of times. (Behe 2007, 225)

If you are one of the infinite number of freak observers, then you would have no reason to trust your senses. Behe argues that this is problematic:

> Infinite multiverse scenarios are no different from brain-in-a-vat scenarios. If they were true, you would have no reason to trust your reasoning. So anyone who wants to do any kind of productive thinking must summarily reject the infinite multiverse scenario for intelligent life and assume that what we sense generally reflects the reality we know exists. (Behe 2007, 227)

I have two replies to Behe's reasoning here. First, even if you thought that you might be a brain-in-a-vat, or a freak observer, you could still do productive reasoning. For example, you could make judgements about how things appeared to you; you could evaluate your phenomenal experience for signs that you are a brain-in-a-vat or a freak observer; you could engage in a priori reasoning.

Second, contrary to Behe's claim that "probabilities don't matter", one is able to make reasoned probabilistic judgements in a spatially infinite universe or an infinite multiverse. Even if events occur an infinite number of times, we can still make probabilistic judgements about them, or judgements that are functionally equivalent to probabilistic judgements. For example, imagine a spatially infinite universe divided up into an infinite number of equally big cube-sized regions, and suppose that in each region there are many regular observers and one freak observer. If I were to learn that I was a part of this universe, I would assume that I was probably a regular observer, since in each of the equal cube-sized regions there are more regular observers than freak observers.

Now, it is true that one could divide this universe up into gerrymandered regions where each region contained one regular observer and many freak observers. But this gerrymandering wouldn't respect the spatial metric of the universe, and (in the absence of any motivation to the contrary) it makes sense to use the spatial metric to make probabilistic judgements in the infinite space.

I conclude that Behe's four objections to the multiverse reply to his irreducible complexity argument aren't successful against my appeal to the spatially infinite universe to block design inferences based on the existence of life.

6. William Dembski's Design Inference

Dembski is one of the most famous contemporary proponents of intelligent design. In his book *The Design Inference*, he lays out his particular version of how inferences to design should take place, and in various other works he suggests that his design inference allows one to infer that various features in the universe are designed by God. Some have hailed Dembski as finally laying out the foundations for inferences to design. As Michael Behe (1999, 9) puts it, "until Dembski, thinking about how we detect design was like writing before the alphabet or calculating before Arabic numerals." In the future, "we will make our judgments about design and complexity on the theoretical foundation of Dembski's work" (p. 12).

In contrast, I will argue that Dembski's model for design inferences is flawed. This can be seen by considering what results Dembski's model would yield in a universe

that's spatially infinite. There have been other arguments against Dembski in the literature, but this argument based on the size of the universe has not been given before.[4] While I don't have the space to go into it here, I believe that the extant arguments against Dembski are either flawed, or don't get to the core of what is wrong with his model for design inferences. My argument in this section, coupled with my replacement model for design inferences in the next, do get to the core of what is wrong with Dembski's model.

To determine that some events occur due to design, Dembski uses what he calls "the explanatory filter".[5] Here is the basic idea. First, one asks whether the event happened due to necessity. If it did, one stops. If not, one asks whether the event happened due to chance. Here Dembski utilizes what he calls "the Law of Small Probability" (which I will explain in more detail below): "specified events of small probability do not occur by chance" (1998, 48). Dembski concludes that specified events of small probability occur by design. I will argue that the Law of Small Probability is false, thus calling into question the validity of Dembski's inferences to design.

Dembski's precise criterion of what it is to for an event to be specified is complicated, but the basic idea is easy to grasp. If you flip a coin a bunch of times, you'll get a certain sequence of heads and tails. For a fair coin, each particular sequence is as probable as any other sequence. But nevertheless, some sequences we would find surprising. For example, if you flipped a coin a million times, and you got heads, then tails, then heads, then tails, and so on, we would be surprised. Similarly, if you flipped a coin a million times, and got all heads, we would be surprised. The reason we would be surprised is that these sequences match a particular pattern. In Dembski's terminology, these sequences are *specified*.

Now, Dembski knows that events of small probability occur by chance. John's winning the lottery is a small probability event, and yet it can happen by random draw that John wins. Dembski would say that John's winning the lottery is not a specified event; it doesn't fit a pattern. However, Dembski would say that the existence of complex life is a specified event, and it's a low-probability event; hence the existence of complex life is due to design.

Dembski fills in the details of this characterization of specificity, but let's not bother; let's take for granted that this concept is legitimate. What I want to focus on is the notion of low probability. Is it really right to say that specified events of low probability *do not* occur by chance? Note that this is a *much* stronger claim than, for example, the claim that specified events of low probability *are unlikely* to occur by chance. How small

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[4] [Note for referee: without violating blind review, I'd like to point out that I have given this argument in a paper posted on the internet, and at a conference, and as a result there has been some discussion of my argument.]

[5] The explanatory filter originally used in *The Design Inference* talks of "regularity", "chance", and "design" (p. 37), where an event that happens by regularity is an event that "(almost) always happens". This is confusing, because it's not clear what the difference is between a high probability event that happens by regularity and a probabilistic event that happens by chance. In subsequent work, Dembski has improved on his filter by substituting "necessity" for "regularity" (see for example Dembski 1999, 133), thus limiting the first node of the filter to non-contingent events.

does a probability have to be in order for a specified event with that probability to *never* occur by chance?

Dembski gives a number: the probability has to be less than 1 in 10^{150}. Specified events with higher than that probability may be able to occur by chance; specified events with lower than that probability do not occur by chance. By looking at the reasoning that goes into generating this cutoff, we'll be able to see what's wrong with Dembski's design inference.

Dembski says that physical constraints restrict how many possible events can occur. Here is how he explains the constraints:

> within the known physical universe there are estimated to be no more than 10^{80} elementary particles. Moreover, the properties of matter are such that transitions from one physical state to another cannot occur at a rate faster than 10^{45} times per second. Finally, the age of the universe is about a billion times younger than 10^{25} seconds. (Dembski 1998, 209)

Dembski multiplies these three numbers together, and gets the result that "the total number of specified events throughout cosmic history cannot exceed ... 10^{150}." (p. 209)

The problem here is that Dembski's restriction to the "known" physical universe is parochial; he's only taking into account the part of the universe that we can directly observe. Interestingly, he quickly ignores this restriction. On the very next page after the quoted passage, he writes:

> "Technically, 10^{150} is the total number of state changes that all the elementary particles in the universe can undergo throughout the duration of the universe."

What happened to the restriction "*known* universe"? Dembski is assuming that there are only 10^{80} particles in the universe. In fact, the evidence actually suggests that there are an infinite number of particles in the universe.

Once one takes into account the probabilistic resources one gets from an infinite universe, one can see that specified events of small probability *would* occur by chance. For example, let's focus on the origin of life issues discussed above. The origin of life from non-life on any particular planet is a specified event of small probability, and I'm willing to grant that the probability is smaller than 1 in 10^{150}. But as I argued above, it doesn't matter how small the probability is: as long as the probability is non-zero, the event would be expected to occur somewhere in the universe. It follows that Dembski's Law of Small Probability is simply false. Thus, it follows that we can't use Dembski's design inference to conclude that the origin of life is due to design, not chance.

Dembski has given a response that's related to my line of argument above. He says that "it is illegitimate to rescue chance by invoking probabilistic resources from outside the known universe" (2003a, 255). His rationale here is that we can't get evidence that such probabilistic resources exist: of the various proposals that there are probabilistic resources outside the known universe, "none of them possesses independent evidence for its existence" (p. 260). But Dembski does not mention the WMAP data – physicists take this to be evidence that the universe is spatially infinite. (Presumably, Dembski wrote his paper before the WMAP data came out. But even then, there was other data that suggested that the universe is spatially infinite, as explained by Bahcall et al. 1999.)

I do agree with Dembski to the extent that I recognize that the evidence for probabilistic resources outside the known universe isn't conclusive. But that's how science works; evidence in science is never conclusive. Dembski is being unreasonable

when he says that the proposition that the universe is infinite "is not an empirical proposition" (2003b, 3). We can get evidence for aspects of the universe that we cannot directly observe. If Dembski disagrees, then I worry that his position is coming close to a van Fraassen-style scientific anti-realism (van Fraassen 1980). This would be a radial move for Dembski to make to save his model of design inferences.

In *The Design Inference*, Dembski was embracing science. He asked the question "Are there more than 10^{80} elementary particles in the universe?" and he replied "Our current best science answers a firm No" (p. 217). But now, Dembski seems to be rejecting science: our current best science suggests that the universe is spatially infinite, with an infinite number of elementary particles, but Dembski doesn't like that answer. So instead he makes the questionable claim that we can't get evidence for the hypothesis that the universe is spatially infinite.

In fact, we can show that Dembski's model for design inferences is flawed without getting into arguments about whether the universe is spatially infinite, or whether we can get empirical evidence for that claim. Just consider an agent who *believes* that the universe is spatially infinite. Imagine such an agent applying the explanatory filter, and focus on all those events which do not occur due to necessity. For each of those events, the agent will not be able to say that the event occurs due to design. Since the agent believes there are an infinite number of probabilistic resources (not just 10^{150}) the agent will never be able to conclude that (on the chance hypothesis) the probability of such an event is small enough that the chance hypothesis should be rejected and design should be inferred. In other words, for such an agent to infer design, the probability of the event would not have to be simply less than 1 in 10^{150}, but instead less than $1/n$, in the limit as n goes to infinity. Such an agent would never be able to make this inference, and hence would never be able to infer design. But this is clearly unreasonable – in fact, believing that the universe is spatially infinite does not preclude one from legitimately inferring that some things are designed.

Thus, Dembski's model for design inferences is fallacious. This leads to the natural question: how should design inferences take place?

7. How to Infer Design

It is my view that design inferences, like many inferences in science, are not all-or-nothing matters. One doesn't get evidence that establishes with certainty that something was or was not designed; instead one makes judgments of probability – that it is more or less likely that something was or was not designed. To take William Paley's (1802, 5) example of finding a watch on a heath, I wouldn't want to conclude with certainty that the watch was designed, but I would certainly judge it incredibly likely that the watch was designed. It could be that the watch came into existence as a result of some highly unusual quantum fluctuation, and if such a fluctuation has a non-zero probability of occurring, we would expect it to occur somewhere in a spatially infinite universe. So, it is reasonable to think that, in a spatially infinite universe, there are some watches on heaths that are undesigned. Nevertheless, it's very unlikely that the watch Paley found is such a watch; it is legitimate for Paley to infer that the watch was designed – and it is legitimate for Paley to infer this regardless of whether he believes that the universe is spatially infinite. How do such design inferences take place?

My answer is: via standard probabilistic reasoning. An agent has a probability function that represents her opinion, and she updates that probability function in light of new evidence. Or, on a less subjectivist account: based on the evidence an epistemic community has, there is an objectively correct probability function that represents how much each proposition is supported by the evidence, and that probability function is updated in light of new evidence. I don't want to take a stand on whether a subjectivist or objectivist account of probability is preferable. I also don't want to endorse Bayesianism in all its glory: Bayesianism faces the problem of old evidence, problems with logical omniscience, problems handling information loss, and problems with indexical propositions, among other problems. Nevertheless, the axioms of probability theory are plausible, and there is something right about modeling opinion via a probability function that gets updated in light of new evidence. Those are all the resources I will need for the following discussion.

Suppose that we witness a seeming miracle: a man walks on water. Did this event happen due to design or due to chance? Let *M* be the evidence in question, the proposition that the particular event of this man walking on water occurred. Let *G* be the proposition that there is a designer (God) who has the power to make miracles happen. Let *C* be the proposition that there is no designer with this power, and thus that any seeming miracle has to be due to chancy naturalistic processes. (For the walking on water case, it could be the case that the water molecules, which normally have randomly distributed velocities, happen to line up their velocities at the appropriate place and time to counteract the force of the man's foot on the water surface. Of course, there are other options too, but I will set those aside to keep things simple.)

One probability we're interested in is $P(G|M)$ – the probability that God exists, given that this man walked on water. But the value of this is dependent on the value of the prior probability $P(G)$, before the evidence *M* is taken into account, and this value will differ significantly depending on what agent or epistemic community we have in mind. To factor out the prior probabilities, we can look at the ratio $P(G|M)/P(C|M)$, and compare that to the ratio $P(G)/P(C)$. If the first ratio is larger than the second, then the seeming miracle has provided evidence for the existence of God. From the axioms of probability theory and the definition of conditional probability (that the probability of *G* conditional on *M*, $P(G|M)$, is equal to $P(G\&M)/P(M)$), this follows:

$$P(G|M)/P(C|M) = P(M|G)/P(M|C)\ (P(G)/P(C)).$$

Thus, the crucial factor is $P(M|G)/P(M|C)$. If this number is greater than 1, *M* provides evidence for *G*; if this number is less than 1, *M* provides evidence for *C*.

The values for $P(M|G)$ and $P(M|C)$ will depend on the details of what opinions the agent or epistemic community holds. But it would be reasonable to have opinions such that $P(M|G) > P(M|C)$, and thus that the seeming miracle provides evidence for a designer. The reason this is the case is that $P(M|C)$ is astronomically small – the water molecules lining up in just the right way is an incredibly improbable event. While we know that God, supposing he exists, doesn't regularly let people we observe walk on water, it would be reasonable to take such an event to be more likely than the water-molecule-lining-up event. Thus, it would be reasonable to take a seeming miracle of a man walking on water to provide evidence for the existence of God.

A key aspect of this reasoning is that it does not depend on whether the universe is spatially infinite. Thus, we can infer design, even when we observe an event that would be expected to happen somewhere by chance in a spatially infinite universe.

Note that the reasoning would be different if we focussed instead on a more generic proposition *M**: someone, somewhere in the universe, walks on water. If the universe is spatially infinite, then somewhere in the universe, this sort of event is expected to happen via chance – $P(M^*|C)$ is approximately equal to 1, as is $P(M^*|G)$.[6] So we can't infer design on the basis of the truth of the generic *M**. But if *M* is true – if this particular person that we observed walked on water – this is more likely to happen via design than via chance, and hence this does provide evidence for design. Thus, we can in principle get this evidence for design, even under the supposition that the universe is spatially infinite. If all we knew was that *M** is true, we couldn't infer design, but if we knew that *M* is true, we could.[7]

As a final topic, it's worth making explicit why we can infer design in the seeming miracle case, but not in the origin of life case or the irreducible complexity case. After all, one might think that the cases are analogous – in each case, there's the possibility that God did it, and the (highly improbable) possibility that it happened due to chancy naturalistic processes. So since we could infer design if a seeming miracle were to occur, why not already infer design based on the existence of irreducibly complex life?

Here is one key difference. In explaining why one can infer design on the basis of the seeming miracle, I pointed out that the seeming miracle would be more likely to occur under the supposition that God exists than it would under the supposition that there is no designer. This is what leads to the probability shift in favor of the designer hypothesis. In the existence of life case, though, it would be reasonable to think that there would be no more life in the universe under the supposition that God exists than under the supposition that there is no God. After all, even under the supposition that there is no God, we would expect there to be life in an infinite number of places in the universe. I see nothing in Christian theology, for example, which suggests that the density of life in the spatially infinite universe would be greater than it would be if there were no God.[8]

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[6] The only way $P(M^*|G)$ would not be close to 1 is if we thought there was a reasonable chance the designer would intervene to prevent the occasional improbable walking-on-water events from occurring.

[7] What I've said should make clear how I'd respond to Dembski's line of reasoning here:

> Was Arthur Rubinstein a great pianist or was it just that whenever he sat at the piano, he happened by chance to put his fingers on the right keys to produce beautiful music? … Unlimited probabilistic resources ensure not only that we will never know, but also that we have no rational basis for preferring one to the other. (Dembski 2003a, 263)

[8] There is still the question of why life exists on *this* planet. Before taking into account our knowledge that we're here, that event is highly implausible under the chance hypothesis. But it is also highly implausible under the design hypothesis – we have no antecedent reason to think that God would create life on this planet, out of the infinite pool of planets in existence.

Now, contrast that with the seeming miracle case. If there were no God, only a tiny proportion of intelligent beings would experience a seeming miracle.[9] But under the supposition that God exists, it is reasonable to expect seeming miracles to be more frequent. (For example, according to many versions of Christian theology, there have been multiple miracles even on this planet.) This is why a seeming miracle can provide evidence for the existence of God, while the existence of life does not.[10]

7. Conclusion

We legitimately engage in design inferences – we infer that some things and events in the universe are due to design. Moreover, we legitimately do this even if we believe that the universe is spatially infinite. Believing that the universe is spatially infinite allows us to reject some inferences to design, such as the inferences to design based on the origin of life and the existence of irreducibly complex biological systems. However, contrary to the result one gets from Dembski's model for design inferences, believing that the universe is spatially infinite does not prevent one from making any inference to design. Dembski's model for design inferences should be rejected, in favor of design inferences based on standard probabilistic reasoning. Such design inferences could in principle provide strong evidence for the existence of God, but given our current evidence they fail to do so.[11]

References

Bahcall, Neta; Ostriker, Jeremiah; Perlmutter, Saul; and Steinhardt, Paul (1999), "The Cosmic Triangle: Revealing the State of the Universe", *Science* 284: 1481-8.

[9] To see that this proportionality talk makes sense even in an infinite universe, imagine evenly dividing the universe into large finite regions, and looking at the proportion in each region. More would need to be said for me to be perfectly precise, but the people who are familiar with the technical problem here will also be familiar with the proffered solution.

[10] What if one's preferred theology is such that God would be expected to create much more life than would exist in a naturalistic universe – would our existence provide evidence for the existence of God? Or what if one's preferred theology is such that God would be expected to create life only on one planet – would our existence provide evidence against the existence of God? To address these questions would get us into controversial issues related to the fine-tuning argument (White 2000), the problem of old evidence (Monton 2006), and the doomsday argument (Bostrom 2001). In this paper I have been careful to restrict my discussion in such a way that it does not depend on these controversial issues.

[11] [Acknowledgements removed for blind review.]

Behe, Michael (1996), *Darwin's Black Box: The Biochemical Challenge to Evolution*, The Free Press.

Behe, Michael (1999), "Foreword", in Dembski 1999, pp. 9-12.

Behe, Michael (2007), *The Edge of Evolution: The Search for the Limits of Darwinism*, The Free Press.

Bennett, C.L. et al. (2003), "First-year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Preliminary Maps and Basic Results", *Astrophysical Journal Supplement Series* 148: 1-27.

Bostrom, Nick (2001), "The Doomsday Argument Adam & Eve, UN++, and Quantum Joe", *Synthese* 127: 359-87.

Bostrom, Nick (2003), "Are You Living in a Computer Simulation?", *Philosophical Quarterly* 53: 243-55.

Crick, Francis (1981), *Life Itself: Its Origin and Nature*, Simon and Schuster.

Dembski, William (1998), *The Design Inference: Eliminating Chance Through Small Probabilities*, Cambridge.

Dembski, William (1999), *Intelligent Design: The Bridge Between Science & Theology*, InterVarsity Press.

Dembski, William (2003a), "The Chance of the Gaps", in Neil Manson (ed.), *God and Design*, Routledge, pp. 251-74.

Dembski, William (2003b), "Infinite Universe or Intelligent Design?", available at http://www.designinference.com.

Ellis, G.F.R, and Brundrit, G.B. (1979), "Life in the Infinite Universe", *Quarterly Journal of the Royal Astronomical Society* 20: 37-41.

Flew, Antony (2005), *God and Philosophy*, Prometheus Books.

Linde, Andrei (2000) "Inflationary Cosmology", *Physics Reports* 333-334: 575-91.

Monton, Bradley (2006), "God, Fine-Tuning, and the Problem of Old Evidence", *British Journal for the Philosophy of Science* 57 405-24.

Paley, William (1802), *Natural Theology*, Glazier & Co.

Shapiro, Robert (1986), *Origins: A Skeptic's Guide to the Creation of Life on Earth*, Bantam.

Spergel, D.N. et al. (2003), “First-year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters”, *Astrophysical Journal Supplement Series* 148: 175-94.

Tegmark, Max (2003), “Parallel Universes”, in Barrow, Davies, and Harper (eds.), *Science and Ultimate Reality*, Cambridge, pp. 459-91.

van Fraassen, Bas (1980), *The Scientific Image*, Oxford.

White, Roger (2000), “Fine-Tuning and Multiple Universes”, *Nous* 34: 260-76.