

**Evil Twins and the Multiverse:  
Distinguishing the World of Difference Between Epistemic and Physical Possibility**

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**Abstract:** Physicists Brian Greene and Max Tegmark both make variants of the claim that if the universe is infinite and matter is roughly uniformly distributed that there are infinitely many “people with the same appearance, name and memories as you, who play out every possible permutation of your life choices.” In this paper I argue that, while our current best theories in astrophysics may allow one to conclude that we have infinitely many duplicates whose lives are identical to our own from start to finish, without either further advances in physics or advances in fields like biology, psychology, neuroscience, and philosophy, Greene’s and Tegmark’s claims about the ways in which our duplicates lives will differ from our own are not a consequence of our best current scientific theories. Rather, I argue that Greene and Tegmark’s conclusions rely on philosophically imprecise usages of the language of “possibility.”

I appreciate good works of popular science, and I deeply respect the individuals who take the time to write them. In a world of increasing specialization and of pervasive, deep-seated distrust of academics and intellectuals, effort to take specialized scientific knowledge and make it more accessible to a general audience is a laudable and important public service.

For non-scientists, like myself, what these scientist-authors have to say about science deserves deference. But it’s often hard to stay completely within one’s own area of expertise when writing engagingly for a general audience. And just as one’s peers have a responsibility to critically assess and respond to scholarship within a specialty area, so too does the larger academic community have a responsibility to critically assess and respond to scholarship—including popular science scholarship—that extends into other areas of expertise. This paper is an attempt to do just that.

In his 2011 book *Hidden Reality: Parallel Universes and the Deep Laws of the Cosmos*, physicist Brian Greene claims that,

“[I]f the universe is infinite there’s a breathtaking conclusion that has received relatively scant attention. In the far reaches of an infinite cosmos, there’s a galaxy that looks just like the Milky Way, with a solar system that’s the spitting image of ours, with a planet that’s a dead ringer for

earth, with a house that's indistinguishable from yours, inhabited by someone who looks just like you, who is right now reading this very book and imagining you, in a distant galaxy, just reaching the end of this sentence. And there's not just one such copy. In an infinite universe, there are infinitely many. In some, your doppelgänger is now reading this sentence, along with you. In others, he or she has skipped ahead, or feels in need of a snack and has put the book down. In others still, he or she has, well, a less than felicitous disposition and is someone you'd rather not meet in a dark alley."<sup>1</sup>

Similarly, in a 2003 piece for *Scientific American*, physicist Max Tegmark opens his article writing,

"Is there a copy of you reading this article? A person who is not you but who lives on a planet called Earth, with misty mountains, fertile fields and sprawling cities, in a solar system with eight other planets? The life of this person has been identical to yours in every respect. But perhaps he or she now decides to put down this article without finishing it, while you read on. The idea of such an alter ego seems strange and implausible, but it looks as if we will just have to live with it, because it is supported by astronomical observations. ... In infinite space, even the most unlikely events must take place somewhere. There are infinitely many other inhabited planets, including not just one but infinitely many that have people with the same appearance, name and memories as you, who play out every possible permutation of your life choices."<sup>2</sup>

There are three common components of Greene's and Tegmark's claims worth identifying. First Tegmark and Greene both predict that you have infinitely many "copies" or "doppelgängers". Let's call this the *Doppelgänger Prediction*. Second, they predict that the lives of these doppelgängers will "play out every possible permutation of your life choices" such that in some places "your doppelgänger is now reading this sentence, along with you. In others, he or she has skipped ahead, or feels in need of a snack and has put the book down. In others still, he or she has, well, a less than felicitous disposition and is someone you'd rather not meet in a dark alley." Let's call this thesis—to match the flare of Tegmark and Greene—the *Evil Twin Prediction*. Third, Tegmark and Greene both claim that these conclusions follow solely from current findings in astrophysics.

My claim is that, while the *Doppelgänger Prediction* (DP) may be a reasonable inference from our current findings in astrophysics, the *Evil Twin Prediction* (ETP) isn't a reasonable inference given current findings in astrophysics alone. Rather, ETP is the product of findings in astrophysics plus

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<sup>1</sup> Greene (2011), 10.

<sup>2</sup> Tegmark (2003), 41.

implied, controversial philosophical assumptions. I also contend that current observations in fields like biology, psychology, and neuroscience are evidence against ETP and currently give us reason to reject Tegmark and Greene's implied philosophical assumptions. ETP requires either advancements in physics that overcome this counterevidence or advancements in these other fields. My hope is that the critique I offer here can be used to help those like Greene and Tegmark, who are doing the important work of making science accessible, do so in a manner that more accurately reflects the general state of knowledge across fields.

In what follows I'll first put forward the arguments given by Tegmark and Greene for DP and ETP and then provide my critique of their arguments by suggesting that these scientists have made a philosophical slip.

Tegmark states the core of his argument as follows.

“The simplest and most popular cosmological model today predicts that you have a twin in a galaxy about  $10^{28}$  meters from here. This distance is so large that it is beyond astronomical, but that does not make your doppelgänger any less real. The estimate is derived from elementary probability and does not even assume speculative modern physics, merely that space is infinite (or at least sufficiently large) in size and almost uniformly filled with matter, as observations indicate. In infinite space, even the most unlikely events must take place somewhere. There are infinitely many other inhabited planets, including not just one but infinitely many that have people with the same appearance, name and memories as you, who play out every possible permutation of your life choices.”<sup>3</sup>

Tegmark's claim is that DP and ETP follow from two premises of astrophysics—namely, 1) that space is infinite, and 2) that matter is almost uniformly distributed. In Chapter 2 of *Hidden Reality*, Greene relies on the same two premises to reach DP and ETP.<sup>4</sup>

The rationale for how these two premises might lead to DP and ETP is intuitive if we add the following two items to our set of assumptions: 3) we can tell roughly how much matter is found in any region of space—regardless of whether or not we can observe that region—based on the fact

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<sup>3</sup> Tegmark (2003), 41.

<sup>4</sup> Greene (2011), 10-36.

that we know roughly how much matter is found in the region of space that we can observe, and 4) we know that it is possible for there to be someone whose life is indistinguishable from ours, on a planet, in a solar system and galaxy that is indistinguishable from ours because we know that we exist on our own planet, within our own solar system and galaxy. Thus, we know that the particular possibility constituting us and our solar system can be actualized, because we know that it is actualized. If space is infinite and matter is uniform—i.e. not all the matter in infinite space is clustered in a finite portion of infinite space—then each possible finite arrangement of matter will reoccur an infinite number of times throughout the infinite expanse of matter-filled space. And because a matter arrangement like the one that has given rise to us is clearly among the possible matter arrangements, it will reoccur an infinite number of times. Thus, DP and ETP (or so the argument goes).

There are various ways one could challenge both DP and ETP on philosophical grounds.<sup>5</sup> One could claim that one is committing a part/whole fallacy by assuming that just because an arrangement of matter is physically possible in one region of space that it is physically possible in other regions of space, or one could challenge the assumption that there are only a finite amount of possible ways a region of space could be. But I am not making any such argument here. Rather, I am content to accept that the astrophysical premises that Tegmark and Greene appeal to allow for at least a plausible, *prima facie* case that DP is true. What I wish to suggest is a philosophical slip is their move from DP to ETP.

Tegmark and Greene both appeal to undefined notions of possibility and epistemic terms. For example, Tegmark writes that our doppelgangers “play out every *possible* permutation of your life choices,”<sup>6</sup> and that “[e]very *conceivable* way that the world could be (within the scope of quantum

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<sup>5</sup> For a philosophical criticism of Tegmark’s version of DP, see Porpora (2013), and for a philosophical defense see Curtis (2015).

<sup>6</sup> Tegmark (2003), 41.

mechanics) corresponds to a different universe.” Similarly, Greene writes that “every *possible* action, every choice you’ve made and every *option* you’ve discarded, will be played out in one patch or another. In some, your worst fears about yourself, your family, and life on earth have been realized. In others, your wildest dreams have come to pass.”<sup>7</sup>

Notice that the argument for DP doesn’t require that anything said in the above paragraph be true. DP doesn’t require every possible permutation. It is satisfied if there are infinitely many doppelgangers whose lives remain qualitatively identical to yours from start to finish. The claims in the above paragraph are the moves from DP to asserting ETP. My contention is that by appealing to an undefined concept of possibility, Greene and Tegmark have made a philosophical slip by assuming, without argument, that all the ways your life could unfold that are epistemically plausible are among those that are physically possible.

Because Tegmark and Greene do not define what they mean by ‘possible’, we need to cobble together an understanding based on other claims that they have made. Tegmark’s sense of possible seems to be all that is 1) conceivable and 2) compatible with quantum mechanics. Thus, on the Tegmarkian model, a) if it’s conceivable and doesn’t violate the (at least known) laws of quantum mechanics, it’s possible, and b) if it’s possible it’s realized an infinite amount of times throughout the multiverse.

The problem with this line of reasoning is that which conceivable states of affairs can be actualized is quite plausibly limited by things other than violations of the laws of quantum mechanics.<sup>8</sup> We can see this simply by appealing to findings in other sciences. For example, a tiger giving birth to a goat is certainly conceivable and it doesn’t clearly violate any known laws of

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<sup>7</sup> Greene (2011), 34-35.

<sup>8</sup> An alternative way to understand the scenarios that follow in a friendlier manner to a physical reductionist would be to claim that the observations that follow about what seem to be macro-level limiting factors at least indicate that there are additional laws of physics we’ve yet to discover that provide for additional physical limitations on what matter arrangements are physically possible. I will suppress this alternative way of framing the observations for the time being but will return to it later.

quantum mechanics, but it does violate our understanding of zoology and of evolutionary biology and as a result quite plausibly is not something ever encountered in the multiverse. Similarly, a tiger, which is indistinguishable from a tiger in the San Diego Zoo, living on a planet and in a solar system indistinguishable from ours, picking the lock on his cage, stealing money from a cash register, going into a home depot, purchasing a hammer and wood, and building a houseboat is at least conceivable and doesn't clearly violate the laws of quantum mechanics, but it does clearly violate sociobiology and animal psychology and very plausibly is not something found anywhere in the multiverse.

Analogously, the laws of quantum mechanics aren't clearly violated if someone who has had a life indistinguishable from yours suddenly decides to quit her day job and become a serial killer but the possibility that someone whose life has been identical to yours internally and externally up until this moment could take such a course of action while you don't may violate laws of physiology, psychology, sociology, or neuroscience. The point is that what is physically possible quite plausibly is limited by more than the laws of physics, and that if there are such additional restrictions on what's possible, some of these restrictions are much more likely to be discovered by those working in a wide variety of fields other than physics or astronomy.

I think it is highly likely that there are other such restrictions on what is physically possible. However, note that I don't need to show that there are such restriction or even that such restrictions are probable. Rather, the only conclusion I need is that findings in physics don't supply us with an answer as to whether or not there are such other restrictions. And without that answer, ETP cannot be derived solely from uncontroversial assumptions in physics.

In a subsection of *Hidden Reality* titled "Nothing But Physics" Greene anticipates pushback against ETP and states the following.

"...I should declare my bias. I believe that a physical system is completely determined by the arrangement of its particles. Tell me how the particles making up the earth, the sun, the galaxy, and everything else are arranged, and you've fully articulated reality. This reductionist view is common among physicists, but there are certainly people who think otherwise. Especially

when it comes to life, some believe that an essential nonphysical aspect (spirit, soul, life force, chi, and so on) is required to animate the physical. Although I remain open to this possibility, I've never encountered any evidence to support it. The position that makes the most sense to me is that one's physical and mental characteristics are nothing but a manifestation of how the particles in one's body are arranged. Specify the particle arrangement and you've specified everything."<sup>9</sup>

Here are two points in response, both of which involve appeals to ambiguous language in Greene's argument.

First, as Greene has set up this dialectic, the anticipated disagreement is between the physicalist and the non-physicalist (with Greene siding with the physicalist). However, there is an ambiguity in his presentation as to what counts as the non-physical. There is a broad interpretation of non-physical such that it synonymous with the non-material. On this interpretation, the quintessential kinds of things that are non-physical are things like spirit, soul, and the other presumably non-extended entities that Greene lists. Large portions of the population believe in such entities and there are non-physical assumptions of this sort one could use to generate counterarguments to Greene's position—e.g. perhaps spiritual entities are not uniformly distributed throughout the cosmos the way matter is—so this is a sensible kind of view for Greene to respond to. I am going to treat what Greene says in response to this kind of non-physicalism as sufficient for purposes of his argument.

However, there is a second, narrower interpretation of what one could mean by the non-physical—i.e. anything that cannot be explained in terms of the law of physics (or under a less epistemological guise, anything that is not ontologically part of physics). On such a reading some of the observations I provided earlier about serial killers versions of you or tigers who build houseboats may not count as discussions of the physical. If this is what Greene has in mind, his claim that he's "never encountered any evidence" to support the existence of such things will not do. He clearly has

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<sup>9</sup> Green (2011), 33.

encountered things like people and tigers and if he rejects the ability of macro-level states of affairs containing objects like people and tigers to provide us with evidence as to the kinds of states of affairs that might exist in the universe, the burden of proof is on him to show that this is so, given the claim that ETP follows from findings in physics alone. The fact that this may be a common presumption among physicists isn't enough, because the view is a philosophical one, and the deference we should give to physicists within their area of expertise doesn't extend this far.

But what exactly this "reductionist" view is leads us to a second possible equivocation in language—in this case over the word 'determined.' Greene claims that he believes "that a physical system is completely *determined* by the arrangement of its particles." He explains what he means by claiming that a description of the particle arrangement "fully articulate[s] reality." This claim is controversial, but for the sake of argument I won't challenge it. Rather, what I want to point out is the compatibility of holding both that 1) macro-level states of affairs about people and tigers provide us with plausible reasons to think there are limitations on which state of affairs are possible that we cannot yet give a quantum explanation for, and that 2) particle arrangements "fully articulate reality."

Once this is recognized, we can see that the gap in Tegmark and Greene's argument that they have failed to show how physics (or any other branch of science) provides us with evidence that all the epistemically possible permutations of how our lives could unfold are sequences of particle arrangements that could be actualized. To accommodate a reductionist view, one can simply recast the evidence about tigers and people as indicating that there are more laws of physics still to be found that explain the appearance of these limitations. Why think that if an organism whose life, down to a particle level, has been completely identical to yours from the start of life up until this moment could suddenly become hungry while you do not? This is certainly epistemically possible, but the current state of affairs in biology, physiology, etc. doesn't indicate that this is likely. We simply don't know currently whether quantum indeterminacy is such that it allows for such

alterations on a macro-level, but our study of things like evolution, instinct, and personality provide us with good reason to be skeptical that all such permutations are possible. It's quite plausible that no matter how many copies of us there are, that we always choose option A when considering between A and B because that is simply what an organism or person like us is bound to do.

Here's another way to put the point. It seems highly plausible that certain arrangements of particles (perhaps especially those that form complex organic beings like us) are such that they greatly restrain the set of possible particle arrangements that can follow from certain other particle arrangements. On the macroscopic scale, such hypotheses are currently examined as questions about things like instinct and evolutionarily encoded behavioral preferences in organisms, personality and its relationship to behavior, and the presence of libertarian free will, but of course that doesn't mean we can't someday examine all these questions on the level of physics as well. It seems plausible that such additional limitations don't require a violation of the law of quantum mechanics, but that they are additional physical limitations on sequences of particle arrangements nonetheless. However, even if it turned out to be the case that, contrary to what we currently know in fields like biology, psychology, neuroscience, etc., all such limitations would violate the laws of quantum mechanics, this is not part of what our current findings in astrophysics or quantum mechanics have proven. Thus, either way, ETP does not follow from our currently best supported theories in astrophysics alone.

It is worth emphasizing the scope of my claim, both by clarifying what I'm claiming as well as what I'm not. I'm *not* claiming that the macro-regularities we observe and can describe in terms familiar to fields like biology, psychology, etc. show that there are additional natural laws that can't ultimately be reduced to or explained as laws of physics. Perhaps there are no such laws. Perhaps the

reductionists or proponents of the causal closure of physics are correct.<sup>10</sup> Weighing in on that debate is not my concern here. Rather, what I am claiming is that our macro-level observations provide us with *prima facie* reason to think that what's physically possible may be a much smaller set than that which is conceivable and that going from the claims that 1) space is infinite and that 2) matter is roughly uniformly distributed to conclude that ETP is to smuggle in substantive claims in philosophy of science and to fail to address the macro-level observations we all have which plausibly cut against ETP.

Nothing that I say here is intended to discourage a philosopher inclined to accept causal closure of physics or a physical reductionism from taking up the cause of defending ETP. Rather, what I aim to have shown is that it is a cause that still needs to be taken up—whether by physicists, philosophers, or others—because the arguments we've been given by Tegmark and Greene rely on implicit assumptions which ought to be questioned and assessed. Physicists have made truly amazing breakthroughs, and they have the right to claim that they've shown all kinds of thrilling and unintuitive things to be the case. But ETP is not yet one of those things. As of now, getting to ETP requires physics plus substantive (and not uncontroversial) philosophical arguments plus yet-to-be-provided evidence (whether from philosophy or physics or some other field) to overcome plausible counter-evidence to ETP coming from other scientific disciplines.

The key point I've sought to make in this paper is a simple one. When physicists like Tegmark and Greene claim that ETP is a consequence of our best supported theories in physics they are conflating physical possibility with epistemic possibility and are failing to respond to *prima facie* indications of additional limits on what's possible gleaned from our current macro-level

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<sup>10</sup> For a taste of the debate surrounding the causal closure of physics and whether the special sciences can ultimately be reduced to physics or not, see Papineau (2009) in favor of reduction and Fodor (1997) against. I currently favor the anti-reductionist view, which perhaps explains why I have been drawn to organizing my argument the way that I have. But one who embraces the causal closure of physics and a physical reductionist view can just as easily raise qualms with Tegmark and Greene's arguments for ETP by showing how they've helped themselves to saying all sort of states of affairs are possible without providing physical explanations for how these states of affairs could arise.

observations. None of this is meant to be a criticism of Tegmark's and Greene's expertise in physics or of their laudable efforts and great successes in making science accessible and interesting. But it does serve as a critique of the rapidity with which they are inclined to accept a physical reductionism on which important questions about whether or not someone who heretofore has lived a life identical to your own could turn down a variety of different paths, including paths that are repugnant to you, your values, or predilections. Learning that space is infinite and that matter is roughly uniformly distributed throughout the universe isn't enough information on its own to determine what possibilities a being like us could actualize. Perhaps someday physics alone can answer that question for us. But for the time being, in addition to physics, we must pull from other fields like biology, psychology, neuroscience, and philosophy to learn about who we are and what it's possible that we could be.<sup>11</sup>

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