FIRST THINGS

# Chance, by Design

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Christians who accept Darwinian evolution are, it is sometimes said, trying to have it both ways. If evolution is driven by random mutations, we cannot be part of a divine plan. How, the critics ask, can we possibly exist by chance and by design, by accident and by intention?

The question of how to reconcile chance with divine providence long predated Darwin. People didn't need science to tell them that chance had something to do with their being here. Each of us is the product of a long and tenuous chain of improbable events. We wouldn't have been born if our parents hadn't happened to meet or if some ancestor hadn't escaped disaster by a hair's breadth. Nor is the role of chance in the world news to theologians. "If the nose of Cleopatra had been shorter," wrote Pascal in the seventeenth century, "the whole face of the earth would have been changed." "No one in this life can escape being tossed about at the mercy of chance and accident," observed St. Augustine in the fourth. "Time and chance happeneth to them all," lamented Qoholeth much earlier than that.

But in the opinion of some contemporary anti-Darwinians, there cannot really be chance or randomness in the world if God is in charge, and for them that is reason enough to reject Darwinism out of hand. Such rejection, however, doesn't really dispose of the issue, for it arises even more dramatically in other branches of science.

It is now thought, for example, that not only this or that species of plant or animal arises as a result of random processes, but so did our entire galaxy, and thus our sun and earth as well. About 300,000 years after the Big Bang, matter was spread uniformly throughout the universe, but not perfectly so. Some regions were slightly denser than average, and these served as the seeds from which galaxies grew. These "density perturbations" were randomly distributed, as far as statistical analyses can tell, and there is reason to believe that they came from quantum

fluctuations that occurred moments after the Big Bang.

But for some reason it is Darwinism that provokes the greatest controversy and concern. This controversy flared up in July 2005, when Cardinal Christoph Schönborn (editor and chief author of the *Catechism of the Catholic Church*) wrote a memorable article in the *New York Times* suggesting that neo-Darwinism is not "compatible with Christian faith." He defined neo-Darwinism as the view that evolution is "an unguided, unplanned process of random variation and natural selection." The cardinal's concern was precisely whether the randomness posited by neo-Darwinian theory could be squared with a divine plan that guides all things.

I responded a few months later within an article in these pages titled "The Design of Evolution." My chief point was that the word "random" as used in science does not mean unguided and unplanned, but has a narrow technical meaning having to do with the statistical correlations among things. I gave examples showing that something could be guided and planned and yet exhibit such "statistical randomness," as it is often called. Words like "unguided" and "unplanned" when used in discussions of evolution are philosophical glosses, I said, not technical scientific terms.

Some anti-Darwinists claim that I was simply wrong about what "random" means in evolutionary biology. They assert that it does mean unguided and unplanned and that we have this on the authority of the scientific community itself.

In 1995, for example, the National Association of Biology Teachers stated that "the development of life on earth is the outcome of evolution, an unsupervised, impersonal, unpredictable, and natural process of temporal descent." In their textbook *Biology*, Kenneth Miller and Joseph Levine explain, "Of course, there has never been any kind of plan to evolution, because evolution works without either plan or purpose. . . . Evolution is random and undirected." Just two months after Cardinal Schönborn's piece appeared, an open letter to the Kansas State Board of Education signed by thirty-eight Nobel laureates in science affirmed that "evolution is understood to be the result of an unguided and unplanned process of random variation and natural selection." (That they used the cardinal's

very formulation was doubtless intended as a poke in the ecclesiastical eye.)

Recently, Jay W. Richards of the Discovery Institute averred, "The problem is that Barr is not using these words as they are almost universally used when scientists talk about biological evolution. He's committing what we might call the 'fallacy of private definition.'" The intelligent-design advocate Michael Behe, in a debate with me at Wheaton College last year, quipped, "Most scientists—with the exception of maybe one or two in Delaware—understand Darwinian evolution to mean" unguided and unplanned.

My answer is that one must distinguish between words used by scientists and words used scientifically—or, as I put it in "The Design of Evolution," "as used by [scientists] in their technical work." That is what counts philosophically and theologically, not the popular or polemical uses one finds in manifestos or even, at times, in textbooks.

When biologists start making statements about processes being unsupervised, undirected, unguided, and unplanned, they are not speaking scientifically. No measurement, observation, or mathematical analysis can test whether or not God planned a development like a genetic mutation. What apparatus would one employ? Being "unplanned by God" is simply not a concept that fits within empirical science. Being "statistically random," on the other hand, is, because it can be tested for.

And suppose we did define neo-Darwinism to include the belief that the world is "unguided and unplanned" by God. Then neo-Darwinism would be atheistic simply by definition. Only if neo-Darwinism is defined in terms of its *strictly scientific content* does how well it comports with a religious view of the world become an interesting and debatable question. This is the question I shall now examine, particularly how the kind of randomness posited by neo-Darwinian theory can be consistent with divine providence. But first we must understand what providence and randomness are.

Most traditional forms of biblical religion agree as to what providence is. They may dispute how providence relates to human freedom, but their

differences don't affect their understanding of merely physical processes such as evolution. The traditional doctrine is that God, the transcendent source of being, wills by one timeless act that all things exist, wherever in space and time they do exist. He is the creator of all finite beings in every aspect of their being, and hence he creates them with all their natural potentialities, powers, and relationships, including their causal relationships to each other.

A helpful analogy compares God to the author of a play. The playwright is the cause of the entire play in all its aspects—he pens its every character, event, and word. Call this "vertical causality." But it is also true that *within* the play, one thing causes another. Call this "horizontal causality." The two causalities are not in competition.

Consider this question: In *Hamlet*, did Polonius die because he was stabbed through a curtain or because Shakespeare wrote the play that way? The question is silly, of course, for the answer is *both*. The stabbing is the cause *within* the play, while Shakespeare is the cause *of* the play and all that happens in it. Similarly, there are causes *within* nature, which are studied by scientists and others, while God is the cause *of* nature. Theology traditionally refers to "primary" and "secondary" causality rather than vertical and horizontal causality. We see, then, how idle it is to ask whether some species of beetle exists because it evolved or because God created it. The species of beetle evolved because God wrote the script that way. And, indeed, each individual beetle only exists because God wrote it in as one of the *dramatis personae*.

The Book of Wisdom declares that God "reaches mightily from one end of the earth to the other and orders all things." His providence is not just some general oversight of the world, leaving the details to be worked out by someone else. Rather, he is the direct cause of every detail of the universe, just as Shakespeare wrote every syllable of *Hamlet*. God orders all things, whether the falling of a sparrow or the hairs of your head, which are numbered. This is the doctrine of "particular providence," taught by both Catholic and Calvinist.

Theologians distinguish between "mediate" and "immediate" providence. The former is exercised through natural secondary causes and the latter

directly. God does indeed "make the little green apples," as the song says, but he does so by making an entire process of natural growth and development occur, whereas no natural causes were at work when he turned water into wine at Cana of Galilee. Therefore, saying that something arose through natural processes in no way denies particular providence. Indeed, traditional teaching tells us that God's providence *ordinarily* works through natural causes. As the great scholastic theologian Francisco Suárez put it, "God does not intervene directly in the natural order where secondary causes suffice to produce the intended effect."

Now we come to the troublesome word "random." It is used throughout modern science. The word appears in the titles of over 70,000 research papers from every branch of science. Here are a few examples: "Domain growth in random magnets," "Non-stationary random vibration of bridges under vehicles with variable speed," and "Spatial coherence of random laser emission." The concept of "randomness" is useful in science because it allows us to calculate probabilities. If a deck of cards has been randomized by shuffling, one is able to compute the odds of getting dealt various hands. Similarly, assumptions about the randomness of molecular motions allow one to compute the relative probabilities of air molecules moving at different speeds.

Although widely used in science, the concepts of randomness and probability are notoriously slippery for philosophers and mathematicians. There exist, in fact, different and inequivalent definitions of them: "statistical randomness" versus "information-theoretic randomness" and "frequentist probability" versus "Bayesian probability." Fortunately, we need only consider these concepts as they are used in the everyday practice of natural science. It is best to consider a simple example rather than trying to lay down a definition.

Consider a series of coin tosses. The crucial fact is that the coin tosses are causally independent of each other. In other words, there is no mechanism by which one coin toss significantly affects the others. Because of this, there is no reason to expect their results to be correlated with each other in any particular way, that is, to exhibit any particular pattern. Therefore, the results of such tosses would form what mathematicians call

a “random sequence.” Strong correlations might occur—for example, a series of tosses alternating heads and tails—but they would be regarded as accidental. In a long random sequence, such striking patterns will be rare, and probability theory can tell us how rare. The odds of one hundred coin tosses giving alternating heads and tails is only about 1 in 500 billion billion billion. With a large sample, therefore, it is possible to test statistically for randomness.

But such tests can never be conclusive. Not only can a sequence exhibit an obvious pattern despite actually being produced by a random process, but the opposite can happen. The digits of the number *pi*, for instance, pass all statistical tests of randomness, but are not really independent of each other.

If statistical tests can never be absolutely conclusive, how do we know that there really is randomness in nature? Ultimately, it is a *postulate* on the same footing as the assumption that nature obeys universal laws. No number of experimental tests could ever rigorously prove either of those postulates to be true. They are simply part of how we—not just scientists, but people generally—understand the natural order of the world. Just as something violating a universal law, such as water flowing uphill, would be regarded as contrary to nature, so would something that was wildly improbable given what one might call “natural randomness,” such as all the leaves in your windy tree-lined street landing in your neighbors’ yards and none in yours. Every day, in countless contexts, people take natural randomness for granted. Only superstitious people expect to find patterns in tea leaves.

The fact that one cannot rigorously prove randomness or non-randomness by statistical tests doesn’t make these concepts useless at the practical level. One can use such tests to look for suspicious correlations in cancer deaths, in election results, in poker hands, and in all sorts of other things. So it is in science. The key point is that randomness in empirical science boils down *in practice* to the absence of significant statistical correlations.

This brings us to our first question. Does “statistical randomness” in a process mean that it is “unguided and unplanned”? Let’s start with an analogy used in “The Design of Evolution.” Observing the license plates of

the cars that pass by on the highway, one will generally find that they are statistically random in the sense that knowing where one car is from provides no information about where another is from. This in no way implies that the cars' movements and locations are "undirected," "unguided," and "unplanned." In fact, the cars are directed by the wills of their drivers, who are guided by maps and pursuing plans. It is just that the lives of the various drivers, and thus their plans, are (generally speaking) causally independent of each other.

This example helps explain why statistical randomness and "chance" events occur in our world. It is not because events are uncaused or because we cannot trace their causes. It is because so many independent causal chains intersect and impinge on each other that sequences or juxtapositions arise that exhibit the lack of correlation we call "statistical randomness."

The intersection of independent chains of causality can give rise to chance events that disrupt the normal course of development in one of them. A dramatic example, which has directly to do with evolution, is the asteroid that struck the earth near the Yucatán Peninsula sixty-five million years ago and (in the view of most experts) was the primary cause of the extinction of the dinosaurs. Here were two systems, each going its own merry way, almost completely independently of each other: life on earth and the bodies orbiting the sun. When these two systems crossed paths, what occurred was, from the point of view of evolutionary history, a "chance" event.

St. Thomas Aquinas had a similar understanding of chance. It is found in Book 3, chapter 74 of his *Summa Contra Gentiles*, which is titled "Divine providence does not exclude fortune and chance." The fourth reason St. Thomas gives is that "the large number and variety of causes [in the world] stem from divine providence and control." But given the large variety of causes,

> one of them must at times run into another cause and be impeded, or assisted, by it in the production of its effect. Now from the concurrence of two causes it is possible for some chance

> event to occur, and thus some unintended event occurs because of this causal concurrence. For example, the discovery of a debtor, by a man who has gone to market to sell something, happens because the creditor also went to market.

The debtor and creditor happening to be at the market at the same time is like the cars in the license-plate example happening to be at the same place on the highway, or the asteroid happening to be at the same place as the Yucatán Peninsula.

One cause sometimes "run[ning] into another and be[ing] impeded or assisted in the production of its effect" is connected to the distinction St. Thomas makes between "necessary causes," which unfailingly produce their natural effects, and "contingent causes," which can be impeded by the action of other causes. Mass causing space-time to curve due to a universal law is an example of the first; the propagation of dinosaur species being impeded by asteroids is an example of the second. Contingent causes are subject to the vagaries of chance, while necessary causes are not. Aquinas thus sometimes says that things happen "by contingency," where we would say "by processes involving chance."

This is all very well, one might object, but perhaps evolutionary biologists mean something different and more radical when they speak of "random genetic mutations." Well, let's see.

In their college-level textbook *Modern Genetics*, F. J. Ayala and J. A. Kiger explain three senses in which mutations are said to be random: first, as "rare exceptions to the regularity of the process of DNA replication"; second, because "there is no way of knowing whether a given gene will mutate in a particular cell or in a particular generation"; and third, because "[these mutations] are unoriented with respect to adaptation." They note that this last meaning "is very important for evolution. . . . Mutations occur *independently* of whether or not they are adaptive in the environments where the organisms live" (emphasis mine). Mutations are produced by various causes, such as natural radiation or genetic copying errors. The adaptive needs of organisms arise from quite different—and independent—causes, such as changes in climate or food supply. This

produces a lack of systematic correlation between when mutations happen and when they are needed, so the former are "unoriented" with respect to the latter.

Or consider the definition given by Ernst Mayr, one of the twentieth century's leading evolutionary biologists: "When it is said that mutation or variation is random, the statement *simply* means that there is no *correlation* between the production of new genotypes and the adaptational need of an organism in a given environment" (emphasis mine).

We now come to the critical issue. While the example of the license plates showed that a process may exhibit statistical randomness despite being guided and planned, the randomness occurred in an aspect of the process that was irrelevant to the purposes of those directing it. The motorists were not trying to arrange their license plates in an interesting sequence. This suggests that if certain effects arise through chance—if, for example, a series of cars passed by from states in alphabetical order—the effects were not intended in themselves but were at most accidental byproducts of something else that was intended.

To put it another way, in St. Thomas' example, we call the discovery of the debtor a chance event precisely because the debtor and the creditor independently decided to go to the market. But what if they had the same master, who sent them separately to the market so that they should meet, only seemingly by accident? If God has written the cosmic play so that the human race and each specific human being would come to exist, it would seem that there is no causal independence. Everything in the universe would be rigged and not random. This is the very heart of the problem, and why many people, both religious and non-religious, do not believe that randomness in evolutionary processes and God's having intended man to exist can both be true.

The problem arises, as do so many other false problems, from a confusion of horizontal and vertical causality. When people speak of randomness, whether in science, in other professions, or in everyday life, they are not speaking of how things in this world relate to God, but how they are related to each other; that is, they are referring to the horizontal level of

causality. What is involved is the independence of various *natural* causes from each other, which leads to what I called "natural randomness" earlier.

If you toss a coin ten times, there is no *natural mechanism* by which any toss significantly affects the others. And if you need nine of them to come up heads to win a game, there is no natural mechanism by which your need can cause them to come up heads. The outcomes of the tosses are uncorrelated with your competitive needs, just as genetic mutations are uncorrelated with organisms' adaptive needs. Someone might object that if you get nine heads in ten tosses and actually win the game, that proves that the tosses *were* in fact correlated with your needs. But that's an empty statement that misses the point. Obviously, the tosses will turn out to have been correlated with the winner's needs. The point, however, is that no mechanism in the process of tossing a coin takes account of any particular player's needs. And so, in a sense that is objectively meaningful and everyone understands, the coin tosses are random and the game is fair.

In evolutionary biology, too, it is only natural causes and mechanisms that are being talked about. In the words of Elliott Sober, a leading philosopher of science, the "randomness" of genetic mutations in evolutionary theory means that "there is no *physical mechanism* (either inside organisms or outside of them) that detects which mutations would be beneficial and causes those mutations to occur" (emphasis mine). Whenever anyone —whether an actuary, an investor, a weather forecaster, or a physicist —computes probabilities, the assumptions being made have solely to do with *natural* causes being independent of each other.

A comparison of "natural randomness" and "natural laws" may be helpful here. The fundamental laws of nature also have to do with horizontal causal relationships. Ordinarily, God causes things to happen in accordance with those laws, as when water runs downhill, and on much rarer occasions he causes things to happen that contravene those laws, as when water once turned into wine. In all cases, however, whether the kinds of horizontal relationships we call natural laws hold or fail to hold, it is God who, in the vertical sense, is causing things to happen, and to happen just as they do.

Similarly, most things happen in accordance with natural randomness and therefore with natural probabilities, such as coin tosses coming out heads 50 percent of the time, or a certain kind of subatomic particle called the K-short decaying 69.3 percent of the time into electrically charged particles and 30.7 percent of the time into neutral ones. On some occasions, however, things may happen that are so grossly contrary to natural probabilities as to be clearly miraculous. (As in the legend of the seventy-two translators of the Septuagint, who, working independently, arrived at exactly the same Greek translation of the Hebrew Bible.)

In either case, whether or not things unfold in accordance with natural randomness and natural probabilities, it is God who in the vertical sense is causing them to happen that way. As St. Thomas put it, "The effect of divine providence is not only that things should happen somehow; but that they should happen either by necessity or by contingency. Therefore, whatsoever divine providence ordains to happen infallibly and of necessity, happens infallibly and of necessity; [whereas those things that divine providence conceives should happen from contingency], happen by contingency."

By itself, the doctrine of divine providence only tells us that everything unfolds in accordance with God's plan. It does not tell us what that plan is, either in its general features or in its particular details. It does not tell us the mix of law and chance, or of necessity and contingency, that God chose to use in his plan. Evolutionary history may have unfolded entirely in accordance with natural laws, natural randomness, and natural probabilities, as the great majority of biologists believe, or there may have been some extraordinary events along the way that contravened those laws and probabilities. In either case, evolution unfolded exactly as known and willed by God from all eternity.

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