Book Reviews

The Language of God: A Scientist Presents Evidence for Belief. By Francis Collins. New York: Free Press, 2006. 304 pp.

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A young woman checked into the oncology clinic at the University of Michigan seeking information about breast cancer, after her mother, her two sisters, her aunt, and two of her aunt's children had all been diagnosed with the disease. Given their family history, another of her cousins had elected to have a prophylactic double mastectomy rather than take her chances. Was there any new research that would give her hope and allow her to avoid such a drastic measure?

Luckily for her, a research project by two doctors at the same clinic had recently linked breast cancer with a dangerous mutation in a gene on chromosome 17. Genetic testing showed that she did not carry the mutation that her mother and other affected relatives carried, so there was no need for the surgery. Her tremendous relief was followed by genetic testing of other family members, who got their own surprises. The cousin who had had the double mastectomy years before did not carry the mutation after all. Genetic testing showed that their father did carry the dangerous mutation, and that he had in fact passed it on to five of his ten children. The mammogram of one of the daughters revealed a small tumor, which she was able to catch early through the genetic screening.

The researcher whose work led to this breakthrough is Francis Collins—physical chemist, medical geneticist and longtime director of the Human Genome Project. As a medical geneticist at the University of Michigan, Collins helped discover the genetic basis for cystic fibrosis, neurofibromatosis and Huntington's disease. He assumed leadership of the Human Genome Project after James Watson's departure, coordinating the work of thousands of geneticists in six countries. The Human Genome Project began in 1998 and produced a first-draft mapping of the three billion

base pairs of the human genome on June 26, 2000. Work continued toward finishing the sequence by 2003, the fiftieth anniversary of the discovery of the structure of the DNA molecule by Watson and Crick. The medical importance of this scientific achievement is enormous.

Collins is also the author of the bestselling book *The Language of God*, in which he describes the scientific and political challenges that the Human Genome Project had to overcome, and his key role in this gives this book a special interest. But his main purpose is to demonstrate that there is "a consistent and profoundly satisfying harmony" between science and religious faith. At the ceremony announcing the first draft of the human genome sequence, President Clinton said "Today we are learning the language in which God created life. We are gaining ever more awe for the complexity, the beauty, and the wonder of God's most divine and sacred gift." Taking his title from Clinton's remarks, Collins's purpose in *The Language of God* is to explore the possibility of finding harmony between scientific and spiritual worldviews:

> I will argue that these perspectives not only can coexist within one person, but can do so in a fashion that enriches and enlightens the human experience. Science is the only reliable way to understand the natural world, and its tools when properly utilized can generate profound insights into material existence. But science is powerless to answer questions such as "Why did the universe come into being?" "What is the meaning of human existence?" "What happens after we die?" One of the strongest motivations of humankind is to seek answers to profound questions, and we need to bring all the power of both the scientific and spiritual perspectives to bear on understanding what is both seen and unseen. The goal of this book is to explore a pathway toward a sober and intellectually honest integration of these views. (6)

Collins's own personal synthesis is a version of theistic evolution. He rejects creationism and intelligent design in favor of the view that God, as the Creator of the universe, sets the values of crucial physical constants in such a way that life and consciousness naturally evolve. To religious believers he addresses the following exhortation:

> If God is the Creator of all the universe, if God had a specific plan for the arrival of humankind on the scene, and if He had a desire for personal fellowship with humans, into whom He had instilled the Moral Law as a signpost toward Himself, then He can hardly be threatened by the efforts of our puny minds to understand the grandeur of His creation. . . . [S]cience can be a form of worship. Indeed, believers should seek to be in the forefront among those chasing after new knowledge. . . . [Otherwise we] bring ridicule on the church, driving sincere seekers away from God instead of into His arms. Proverbs 19:2 warns against this kind of well-intentioned but misinformed religious fervor: "It is not good to have zeal without knowledge." (230)

One of his goals, then, is to increase the basic science literacy of religious believers. The most charitable way to measure the book is with this goal in mind. Readers who come to the book from reading early books by Dennett and Dawkins and by other best-selling authors on the science vs. religion circuit are going to find it lacking in intellectual sophistication. But it is no small accomplishment to explain scientific achievements in a layperson's terms, and Collins is good at it. In section after section he describes scientific discoveries and hypotheses in terms that the lay reader can understand. Religious believers with little background in the sciences will find much that is fascinating and informative.

Collins as a Science Writer

The Evidence for Evolution

Collins is most in his element when he discusses scientific topics like the DNA evidence for evolution. In chapter 5, for example, he recounts some of the surprises from the first sequencing of the genomes of humans and other organisms. The first surprise is that so little of the genome (approximately 1.5 percent) is directly functional. It was thought that there were about one-hundred thousand protein-coding genes in the human genome, but the actual number turns out to be twenty thousand to twenty-five thousand. This is roughly the same as the number of genes in the genomes of simpler living things like plants and worms. A second surprise is that

the human genome has so little variation. Individual members of our species differ in only about one tenth of one percent of their DNA. Most other species have ten to fifty times more genetic diversity than we humans do.

More important for Collins's goal of helping religious believers get up to speed on evolution is the way patterns of variation between our DNA sequence and that of other organisms reflect the history of evolving species on our planet. We can pick a certain stretch of human DNA, Collins suggests, and ask whether there is a similar sequence in some other species.

A functional section of DNA, one that contains the instructions for producing a protein, will almost always be a highly significant match to the genomes of other mammals. Human genes are shared with all creatures. On the other hand, a stretch of DNA that lies between genes is still 98 percent for nonhuman primates, but drops to about 50 percent in other mammalian genomes.

> What does all this mean? At two different levels, it provides powerful support for Darwin's theory of evolution, i.e. for descent from a common ancestor with natural selection operating on randomly occurring variations. At the level of the genome as a whole, a computer can construct a tree of life based solely upon the similarities of the DNA sequences of multiple organisms. . . . Second, within the genome, Darwin's theory predicts that mutations that do not affect function . . . will accumulate steadily over time. . . . That is exactly what is observed. (129–30)

Evolutionary theory correctly predicts that such mutations will accumulate steadily over time, and that therefore the degree of overlap between two species will be a function of the time elapsed since those species diverged from their common ancestor. We share 98 percent of our nonfunctional DNA with chimps—we diverged from chimps recently, so not many new mutations in nonfunctional DNA have accumulated. On the other hand, during the long span since we diverged from fruit flies and roundworms, mutations have erased virtually all matches in the nonfunctional DNA of our genomes. Collins concludes, "The examples reported here from the study of genomes, plus others that could fill hundreds of books of this length, provide the kind of molecular support for the theory of evolution

that has convinced virtually all working biologists that Darwin's framework of variation and natural selection is unquestionably correct" (141).

The Evidence for Intelligent Design

Collins devotes chapter 9 to the intelligent design theory (ID). While he is sympathetic with the desire of Christians to respond in some way to the atheistic agenda that outspoken popularizers such as Dawkins and Dennett have tried to associate with acceptance of the theory of evolution, he urges believers to reject ID on both scientific and theological grounds. He reiterates the important but familiar theological arguments against conceiving God as a clumsy Creator, a deceiver, or a "God of the gaps." On the scientific side, he points out that ID did not arise in the normal way from scientific investigation: it fails to provide a mechanism by which the postulated supernatural interventions would give rise to complexity, it does not make testable predictions, and it has not been embraced by the mainstream scientific community, even though a significant number of biologists are also religious believers. "It remains a fringe activity with little credibility." (187)

The ID argument is that certain complex biological structures could not have come about by natural selection operating on random variations. The focus is usually on complex structures that involve the interaction of multiple proteins, where functioning is disrupted if any one of the proteins is inactivated. Each protein performs its function only if all the others are already up and running. How, then does any one of them evolve by natural selection? The claim is that they must function together or not at all, and the probability of an accidental coevolution of multiple, independently useless components is almost infinitely small. Therefore, the argument goes, such structures could not have evolved by natural selection. The flagellum of some bacteria is a favorite example.

> The structure of the flagellum, which consists of about thirty different proteins, is really quite elegant. It includes miniature versions of a base anchor, a drive shaft, and a universal joint. All of this drives a filament propeller. The whole arrangement is a nanotechnology engineering marvel. If any one of these thirty proteins is inactivated by genetic

> mutation, the whole apparatus will fail to work properly. [The ID] argument is that such a complex device could never have come into being on the basis of Darwinian processes alone. (185)

Plausible evolutionary explanations of ID's parade cases of "irreducible complexity" have not been long in coming. Progress is being made toward explaining the evolution of the flagellum, for example. Comparison of protein sequences from multiple bacteria has shown that components of the flagellum mechanism are related to an entirely different mechanism, an offensive weapon used by bacteria to inject toxins into other bacteria. This "type III secretory apparatus" has obvious survival value. The new evidence is consistent with the hypothesis that elements of this weapon structure were duplicated hundreds of millions of years ago and combined with other proteins that had evolved to carry out simpler functions to form the flagellum mechanism (192).

Collins does a good job of sharing the excitement of scientific discovery. Thanks to attention-grabbing detail and the sincerity of his writing—along with the powerful example set by his personal scientific accomplishments and his relaxed, self-confident faith—the book will perhaps spur other believers to continue their scientific development.

Collins as a Christian Apologist

The Moral Law

The centerpiece of Collins's defense of religious belief is his "Moral Law" argument. In chapter 1 he tells the story of his religious conversion from atheism to belief in God. The key event was reading C. S. Lewis's discussion of "the Moral Law" in the book *Mere Christianity*, in which Lewis argues that our sense of right and wrong is an essential human trait, that cultural differences lead to differences in its expression but not its essential nature, and that God is the source of this peculiarly human experience.

People who find themselves aware of yearnings for properties such as beauty, goodness, significance, and love that transcend the physical universe often experience their sense of right and wrong as having transcen-

dent significance. But people who do not believe in God typically find an argument like Collins's unconvincing. Logically, they are right. Even if a sense of right and wrong is universal among humans and it cannot be explained by the natural sciences, it does not automatically follow that God exists.

C. S. Lewis's original argument had a different tone. If we are already wondering whether God exists or not, and if we recognize that if there *were* a transcendent Creator of the universe Who wants to communicate with us, and if He could not show Himself to us as one of the ordinary facts inside the universe, then it might make sense to us that God would show Himself to us as some force, influence, or desire within ourselves. We might come to recognize such a force, influence, or desire—our conscience—as the voice of God.

Collins takes the argument in a slightly different direction. He focuses on altruism, an important aspect of the Moral Law, and argues for a supernatural origin of Moral Law from the premise that true altruism will never be explained by Darwinian science. This is a "God of the gaps" argument, and it is surprising to find Collins resorting to it. A divine origin of Moral Law (and thus the existence of God) does not follow from the inability of Darwinism to explain altruistic behavior. Collins dismisses sociobiological explanations of altruism in a short paragraph. Sociobiology, if understood as the study of the epigenetic rules that form the biological basis of some human behaviors, is a legitimate endeavor. It should not be prematurely and summarily dismissed. More importantly, any "God of the gaps" argument, as Collins himself has argued, is fundamentally misconceived.

And yet there is no doubt that the voice in the human heart—that fragile impulse that leads us to do what is right *because it is right*, that soul the loss of which Jesus said would outweigh the gain of the whole world—is sacred. As Lao-tzu, Buddha, Jesus, Bahá'u'lláh, and the Old Testament prophets urged, it is the reality itself and not our words about it that count. Even if our sciences can one day offer a complete scientific description of every aspect of the human person, including the pull of our moral conscience, the reality itself (as opposed to the description) of the self-transcending search for what is good, beautiful, and true will remain as sacred as before.

Miracles

The only part of the religious writing in the book that I found fresh and interesting is Collins's approach to belief in miracles. How, he asks, can a believer who is rational and scientifically literate accept religious claims about miracles? Events like Muhammad's reception of the Qur'án, Jesus' healing miracles and resurrection, the events surrounding the exodus of the Jews from slavery in Egypt, and the divine revelation of the Báb and Baha'u'llah are held by their respective believers to be supernatural in origin. How can a believer accept seemingly supernatural events without falling into credulity and superstition? And once the believer achieves a balanced, noncredulous, mature view, how does he defend its rationality to nonbelievers?

Clearly, the direct evidence for a particular miracle is always something presented to the senses, and we know that the senses are fallible. If something extraordinary seems to have happened, it is always possible that we are the victim of an illusion. If an event is *very* extraordinary, the illusion hypothesis will always be more probable. So we cannot be certain that it really happened, even about something we have seen or heard ourselves or have been told about by credible people who saw and heard it themselves. On the other hand, the way we interpret seemingly extraordinary events depends almost entirely on our background assumptions. If our background assumptions exclude the supernatural, for example, nothing we see or hear will make us believe a miracle has happened.

The interesting point that Collins makes is that this interplay between prior beliefs and new evidence is not unique to religious faith. Our everyday rational belief revision has this same structure. Bayes' Theorem is very widely used to model the process of updating our beliefs on the basis of experience. The basic insight expressed in Bayes' Theorem is this: if a theory's being true would raise the probability of a certain event occurring, then the occurrence of the event increases the probability that the theory is true.[1]

Think of it this way: we do not know if *T* is true or not, but we have some evidence, perhaps some otherwise inexplicable occurrence, that would make more sense if *T were* true. If we do have that kind of evidence, we should revise our probability that *T* is true upwards. We still may not

believe that *T* is true, particularly if our prior probability for *T* was very low. But the occurrence of the otherwise inexplicable event that *T* would explain makes the probability of *T* higher. A hypothesis or theory is confirmed by any occurrence that its truth renders more probable. This may seem complicated, but it is in fact the reasoning we use all the time. If we are wondering whether something is true or not, we might say "Maybe so. That would explain why [such and such happened]."

Bayes' Theorem can be used very generally to describe both the inductive methodology of science and the way that rational people spontaneously update their common-sense beliefs in the face of new evidence. We can give mathematical expression to the notion of open-mindedness, for example. To be open-minded is to avoid assigning a probability of one or zero to any of one's beliefs. The open-minded person recognizes that she cannot be completely certain about any of her beliefs and is prepared to update those beliefs if given new evidence. She might feel certain that God does not exist, for example. For her, the prior probability of *T*, the theory that God supernaturally intervened to produce the event *E* making *E* a miracle, is very low. If God does not exist, then God cannot intervene. Still, if she is rational, she recognizes that she does not know for certain that God does not exist and did not intervene to produce the event. So, even for her, the probability of *T* is not zero. Evidence that some event occurred which God's intervention would explain better than an alternative hypothesis will nudge her in the direction of believing that God exists.

Two people who assign different prior probabilities to the theory that God produced the event miraculously will also, other things being equal, assign different posterior probabilities to the theory after seeing the extraordinary event *E*. One's prior assumptions have a significant effect on how one interprets new evidence. But both people, if rational according to this Bayesian model of rationality, can at least agree that *if* God exists and God produced the extraordinary event, that would explain its occurrence. And so both can agree that the theory *T* has a higher probability of being true than it would have had given the occurrence of the event *E*. And perhaps most importantly, they can both recognize that the other is acting in a manner that is rational, given their prior assumptions. Collin's explains it as follows:

> You have been taken captive by a madman. He gives you a chance to be set free—he will allow you to draw a card from a deck, replace it, shuffle, and draw again. If you draw the ace of spades both times, you will be released.
>
> Skeptical of whether this is even worth attempting, you proceed—and to your amazement you draw the ace of spades twice in a row. . . .
> Being mathematically inclined, you calculate the chances of this good fortune as 1/52 x 1/52 = 1/2704. A very unlikely event, but it happened. A few weeks later, however, you find out that a benevolent employee of the company that manufactured the playing cards . . . had arranged to have one of every hundred decks of cards be made up of fifty-two aces of spades. So perhaps . . . a knowledgeable and loving being (the employee), unknown to you at the time of your capture, intervened to improve the chances of your release. The likelihood that the deck you drew from was a regular deck of fifty-two different cards was 99/100; the likelihood of a special deck of only aces of spades was 1/100. For those two possible starting points, the "conditional" probabilities of drawing two aces of spades in a row would be 1/2704 and 1, respectively. By Bayes' Theorem it is now possible to calculate the "posterior" probabilities, and conclude that there is a 96 percent likelihood that the deck of cards you drew from was one of the "miraculous" ones. (49–50)

Even though the prior probability of a miraculous intervention is only 1/100, the probability that there was a miraculous intervention *given that you drew two aces of spades* is 96/100. The occurrence of an otherwise improbable event raises the probability of any hypothesis that, if true, would explain it.

Collins uses a Bayesian analysis to good effect in two sections of the book. In the section on miracles, he suggests that religious believers, like their nonbelieving friends, should set the prior probability of miraculous interventions to be very low. There are good reasons to think that miracles, even if they do occur, will be very infrequent, some of which are theological. Intellectual and religious maturity requires a delicate balance between openness to miracles in general, and avoidance of credulity and superstition. If a believer, for whom the prior probability of a miracle is very small

but not zero, observes a spontaneous cure of a typically fatal cancer in its final stages, and there is no known natural explanation, he is rational to revise his probability of a miracle upward. When he does this, he is updating his beliefs in the same way as other rational people do, in both science and common sense. As Collins writes, "Miracles do not pose an irreconcilable conflict for the believer who trusts in science as a means to investigate the natural world, and who sees that the natural world is ruled by laws. If, like me, you admit that there might exist something or someone outside of nature, then there is no logical reason why that force could not on rare occasions stage an invasion" (53). On the other hand, even for believers, the prior probability of miracles should be very low. Since the laws of nature themselves are expressions of God's will, we should not expect them to be interfered with except at great turning points in the spiritual history of humankind, where they underline some profound truth about the character of the divine relationship to creation. "To be credible, miracles must convey a deeper understanding than could have been obtained without them" (Polkinghorne 93, qtd in Collins 53).

The Origin of the Universe

The discussion of miracles and Bayes' Theorem in chapter 2 is a preparation for Collins's discussion of the origin of the universe in chapter 3. Theoretical physicists tell us that many features of our universe have to be precisely as they are for life to be as we know it and for consciousness to have evolved. Stephen Hawking, for example, writes that if the rate of expansion one second after the Big Bang had been smaller by one part in one hundred thousand million million, the universe would have collapsed in on itself before reaching its present state. If the rate of expansion had been greater by even one part in a million, stars and planets and life as we know it would never have evolved. Similarly, if the strong nuclear force that binds protons and neutrons in the nucleus of atoms had been weaker, the only element that would have formed in the universe is hydrogen. If it had been even slightly stronger, all hydrogen would have been converted to helium and none of the heavier elements necessary for life would have been formed in the centers of stars. As Collins writes,

> Altogether, there are fifteen physical constants whose values current theory is unable to predict. They are givens: they simply have the value that they have. This list includes the speed of light, the strength of the weak and strong nuclear forces, various parameters associated with electromagnetism, and the force of gravity. The chance that all of these constants would take on the values necessary to result in a stable universe capable of sustaining complex life forms is almost infinitesimal. And yet those are exactly the parameters that we observe. In sum, our universe is wildly improbable. (74)

On the face of it this looks a lot like an intelligent design argument, i.e. an argument that the wildly improbable combination of physical features of our universe cannot have come about naturally and thus points to a divine cause. The difference is that, unlike explanations of altruism or the flagellum of bacteria, the values of the physical constants are bare facts—givens—that escape the net of scientific explanation altogether. Someone might argue that there is a nonzero probability that one or more of them will become dependent variables in some as-yet-undreamed-of "theory of everything," but it seems more reasonable to acknowledge the distinction.

Collins takes a Bayesian approach. He personally agrees with those physicists and cosmologists for whom "the Big Bang cries out for a divine explanation" (67), but he recognizes that it is a question on which rational people can disagree. He describes three possible explanations for the origin of our universe, and uses an informal Bayesian calculation to evaluate their relative merits. In each case, the probability of the hypothesis being true is the product of its prior probability (i.e., is the hypothesis plausible in general?) and the degree to which it being true would raise the probability of the observed facts, in this case the fact that the values of the fifteen physical constants are precisely what they need to be for conscious life as we know it to have evolved. It comes down to a contest between two options:

1. The first possible explanation is that all possible universes (with all possible combinations of physical constants and physical laws) exist. We naturally observe this particular universe because this is the one in which creatures like us can evolve. *All* possible universes exist, so of course our universe exists.

2. This universe is the only universe that exists, and the fact that its physical constants and physical laws are finely tuned to support the evolution of intelligent life is explained by the fact that it was created this way by God. (74–75)

Both options would, if true, explain the existence of our finely tuned universe. Assuming they each make our universe equally likely, they compete on the basis of their prior probability. Collins asks which is more reasonable: to believe that infinitely many universes exist, even though we can have no causal contact with them and therefore no direct physical evidence of them, or to believe that a supernatural Creator exists, even though we can have no direct physical evidence of Him? Collins suggests that option 2 is at least as plausible as option 1, and concludes that for those willing to even consider the possibility that God exists, the fine-tuning of our universe toward the production of intelligent life "provides an interesting argument in favor of a Creator" (78).

Conclusion

The purpose of *The Language of God* is to argue for the harmony of science and religion. Collins puts forward a theistic view of evolution, carrying on the tradition of other theistic evolutionists like Asa Gray (Darwin's famous nineteenth century defender in the U.S.), Theodosius Dobzhansky (a leading twentieth century evolutionary biologist), Arthur Peacocke, Francisco Ayala, and a significant number of practicing biologists. He summarizes his theistic view of evolution thus:

1. The universe came into being out of nothingness, approximately 14 billion years ago.
2. Despite massive improbabilities, the properties of the universe appear to have been precisely tuned for life.
3. While the precise mechanism of the origin of life on earth remains unknown, once life arose, the process of evolution and natural selection permitted the development of biological diversity and complexity over very long periods of time.

4. Once evolution got under way, no special supernatural intervention was required.
5. Humans are part of this process, sharing a common ancestor with the great apes.
6. But humans are also unique in ways that defy evolutionary explanation and point to our spiritual nature. This includes the existence of the Moral Law (the knowledge of right and wrong) and the search for God that characterizes all human cultures throughout history. (200)

Collins's view might best be described as dualistic. There is the world of matter, about which science is said to be the only reliable guide (6) and there is the spiritual world, to which the Moral Law is a pointer and religion is the guide. Science should be taken at face value, but it cannot explain the origin of the universe or the uniquely human capacities enshrined in the Moral Law.

For some believers this might appear to be a stable solution. But rapidly continuing progress in the sciences is opening up new and deep questions about, for example, the fundamental role of consciousness in the universe and the constructed, species-specific character of the human perceptual experience on which empirical science is based. The religion-evolution debates, for all the heat they still generate publicly, are passé. There is no conflict between creation and evolution. But deep shake-ups in deterministic, reductionistic physicalism are underway. It is too early yet for a profound synthesis. Bahá'ís and other people of faith should avoid premature closure, deepen their religious practice, and, as Collins suggests, contribute as much as they can to the generation of new knowledge.

The science sections alone make this a wonderful book for nonspecialists. And while the religion sections will almost certainly fail to satisfy militant atheists or literalist Christians, the two groups of readers that Collins explicitly addresses, they do suggest ways to keep the door open between scientific investigation and religious experience, an effort that should be welcomed by moderates everywhere.

Notes

1. For a simplified description of Bayes' Theorem, see <http://www.trinity.edu/cbrown/bayesWeb/index.html>.