STEVEN PINKER, How The Mind Works, 2009

GET SMART

The *Voyager* phonograph record, in any case, was a fine idea, if only because of the questions it raised. Are we alone? If not, do alien life forms have the intelligence and the desire to develop space travel? If so, would they interpret the sounds and images as we intended, or would they hear the voice as the whine of a modem and see the line drawings of people on the cover as showing a race of wire frames? If they understood it, how would they respond? By ignoring us? By coming over to enslave us or eat us? Or by starting an interplanetary dialogue? In a *Saturday Night Live* skit, the long-awaited reply from outer space was "Send more Chuck Berry."

These are not just questions for late-night dorm-room bull sessions. In the early 1990s NASA allocated a hundred million dollars to a ten-year Search for Extraterrestrial Intelligence (SETI). Scientists were to listen with radio antennas for signals that could have come only from intelligent extraterrestrials. Predictably, some congressmen objected. One said it was a waste of federal money "to look for little green men with mis-shapen heads." To minimize the "giggle factor," NASA renamed the project the High-Resolution Microwave Survey, but it was too late to save the project from the congressional ax. Currently it is funded by donations from private sources, including Steven Spielberg.

The opposition to SETI came not just from the know-nothings but from some of the world's most distinguished biologists. Why did they join the discussion? SETI depends on assumptions from evolutionary theory, not just astronomy—in particular, about the evolution of intelligence. Is intelligence inevitable, or was it a fluke? At a famous conference in 1961, the astronomer and SETI enthusiast Frank Drake noted that the number of extraterrestrial civilizations that might contact us can be estimated with the following formula:

(1) (The number of stars in the galaxy) ×
(2) (The fraction of stars with planets) ×
(3) (The number of planets per solar system with a life-supporting environment) ×
(4) (The fraction of these planets on which life actually appears) ×
(5) (The fraction of life-bearing planets on which intelligence emerges) ×

(6) (The fraction of intelligent societies willing and able to communicate with other worlds) ×
(7) (The longevity of each technology in the communicative state).

The astronomers, physicists, and engineers at the conference felt unable to estimate factor (6) without a sociologist or a historian. But they felt confident in estimating factor (5), the proportion of life-bearing planets on which intelligence emerges. They decided it was one hundred percent.

Finding intelligent life elsewhere in the cosmos would be the most exciting discovery in human history. So why are the biologists being such grinches? It is because they sense that the SETI enthusiasts are reasoning from a pre-scientific folk belief. Centuries-old religious dogma, the Victorian ideal of progress, and modern secular humanism all lead people to misunderstand evolution as an internal yearning or unfolding toward greater complexity, climaxing in the appearance of man. The pressure builds up, and intelligence emerges like popcorn in a pan.

The religious doctrine was called the Great Chain of Being—amoeba to monkey to man—and even today many scientists thoughtlessly use words like "higher" and "lower" life forms and the evolutionary "scale" and "ladder." The parade of primates, from gangly-armed gibbon through stoop-shouldered caveman to upright modern man, has become an icon of pop culture, and we all understand what someone means when she says she turned down a date because the guy is not very evolved. In science fiction like H. G. Wells' *The Time Machine*, episodes of *Star Trek*, and stories from *Boy's Life*, the momentum is extrapolated to our descendants, shown as bald, varicose-veined, bulbous-brained, spindly-bodied homunculi. In *The Planet of the Apes* and other stories, after we have blown ourselves to smithereens or choked in our pollutants, apes or dolphins rise to the occasion and take on our mantle.

Drake expressed these assumptions in a letter to *Science* defending SETI against the eminent biologist Ernst Mayr. Mayr had noted that only one of the fifty million species on earth had developed civilizations, so the probability that life on a given planet would include an intelligent species might very well be small. Drake replied:

> The first species to develop intelligent civilizations will discover that it is the only such species. Should it be surprised? Someone must be first, and being first says nothing about how many other species had or have the potential to evolve into intelligent civilizations, or may do so in the future. . . . Similarly, among many civilizations, one will be the first, and temporarily the only one, to develop electronic technology. How else

could it be? The evidence does suggest that planetary systems need to exist in sufficiently benign circumstances for a few billion years for a technology-using species to evolve.

To see why this thinking runs so afoul of the modern theory of evolution, consider an analogy. The human brain is an exquisitely complex organ that evolved only once. The elephant's trunk, which can stack logs, uproot trees, pick up a dime, remove thorns, powder the elephant with dust, siphon water, serve as a snorkel, and scribble with a pencil, is another complex organ that evolved only once. The brain and the trunk are products of the same evolutionary force, natural selection. Imagine an astronomer on the Planet of the Elephants defending SETT, the Search for Extraterrestrial Trunks:

> The first species to develop a trunk will discover that it is the only such species. Should it be surprised? Someone must be first, and being first says nothing about how many other species had or have the potential to evolve trunks, or may do so in the future. . . . Similarly, among many trunk-bearing species, one will be the first, and temporarily the only one, to powder itself with dust. The evidence does suggest that planetary systems need to exist in sufficiently benign circumstances for a few billion years for a trunk-using species to evolve. . . .

This reasoning strikes us as cockeyed because the elephant is assuming that evolution did not just *produce* the trunk in a species on this planet but was *striving* to produce it in some lucky species, each waiting and hoping. The elephant is merely "the first," and "temporarily" the only one; other species have "the potential," though a few billion years will have to pass for the potential to be realized. Of course, we are not chauvinistic about trunks, so we can see that trunks evolved, but not because a rising tide made it inevitable. Thanks to fortuitous preconditions in the elephants' ancestors (large size and certain kinds of nostrils and lips), certain selective forces (the problems posed by lifting and lowering a huge head), and luck, the trunk evolved as a workable solution for those organisms at that time. Other animals did not and will not evolve trunks because in their bodies and circumstances it is of no great help. Could it happen again, here or elsewhere? It could, but the proportion of planets on which the necessary hand has been dealt in a given period of time is presumably small. Certainly it is less than one hundred percent.

We *are* chauvinistic about our brains, thinking them to be the goal of

evolution. And that makes no sense, for reasons articulated over the years by Stephen Jay Gould. First, natural selection does nothing even close to striving for intelligence. The process is driven by differences in the survival and reproduction rates of replicating organisms in a particular environment. Over time the organisms acquire designs that adapt them for survival and reproduction in that environment, period; nothing pulls them in any direction other than success there and then. When an organism moves to a new environment, its lineage adapts accordingly, but the organisms who stayed behind in the original environment can prosper unchanged. Life is a densely branching bush, not a scale or a ladder, and living organisms are at the tips of the branches, not on lower rungs. Every organism alive today has had the same amount of time to evolve since the origin of life—the amoeba, the platypus, the rhesus macaque, and, yes, Larry on the answering machine asking for another date.

But, a SETI fan might ask, isn't it true that animals become more complex over time? And wouldn't intelligence be the culmination? In many lineages, of course, animals have become more complex. Life began simple, so the complexity of the *most* complex creature alive on earth at any time has to increase over the eons. But in many lineages they have not. The organisms reach an optimum and stay put, often for hundreds of millions of years. And those that do become more complex don't always become smarter. They become bigger, or faster, or more poisonous, or more fecund, or more sensitive to smells and sounds, or able to fly higher and farther, or better at building nests or dams—whatever works for them. Evolution is about ends, not means; becoming smart is just one option.

Still, isn't it inevitable that *many* organisms would take the route to intelligence? Often different lineages converge on a solution, like the forty different groups of animals that evolved complex designs for eyes. Presumably you can't be too rich, too thin, or too smart. Why wouldn't humanlike intelligence be a solution that many organisms, on this planet and elsewhere, might converge on?

Evolution could indeed have converged on humanlike intelligence several times, and perhaps that point could be developed to justify SETI. But in calculating the odds, it is not enough to think about how great it is to be smart. In evolutionary theory, that kind of reasoning merits the accusation that conservatives are always hurling at liberals: they specify a benefit but neglect to factor in the costs. Organisms don't evolve toward

every imaginable advantage. If they did, every creature would be faster than a speeding bullet, more powerful than a locomotive, and able to leap tall buildings in a single bound. An organism that devotes some of its matter and energy to one organ must take it away from another. It must have thinner bones or less muscle or fewer eggs. Organs evolve only when their benefits outweigh their costs.

Do you have a Personal Digital Assistant, like the Apple Newton? These are the hand-held devices that recognize handwriting, store phone numbers, edit text, send faxes, keep schedules, and many other feats. They are marvels of engineering and can organize a busy life. But I don't have one, though I am a gadget-lover. Whenever I am tempted to buy a PDA, four things dissuade me. First, they are bulky. Second, they need batteries. Third, they take time to learn to use. Fourth, their sophistication makes simple tasks, like looking up a phone number, slow and cumbersome. I get by with a notebook and a fountain pen.

The same disadvantages would face any creature pondering whether to evolve a humanlike brain. First, the brain is bulky. The female pelvis barely accommodates a baby's outsize head. That design compromise kills many women during childbirth and requires a pivoting gait that makes women biomechanically less efficient walkers than men. Also, a heavy head bobbing around on a neck makes us more vulnerable to fatal injuries in accidents such as falls. Second, the brain needs energy. Neural tissue is metabolically greedy; our brains take up only two percent of our body weight but consume twenty percent of our energy and nutrients. Third, brains take time to learn to use. We spend much of our lives either being children or caring for children. Fourth, simple tasks can be slow. My first graduate advisor was a mathematical psychologist who wanted to model the transmission of information in the brain by measuring reaction times to loud tones. Theoretically, the neuron-to-neuron transmission times should have added up to a few milliseconds. But there were seventy-five milliseconds unaccounted for between stimulus and response—"There's all this cogitation going on, and we just want him to push his finger down," my advisor grumbled. Lower-tech animals can be much quicker; some insects can bite in less than a millisecond. Perhaps this answers the rhetorical question in the sporting equipment ad: The average man's IQ is 107. The average brown trout's IQ is 4. So why can't a man catch a brown trout?

Intelligence isn't for everyone, any more than a trunk is, and this should give SETI enthusiasts pause. But I am not arguing against the search for extraterrestrial intelligence; my topic is terrestrial intelligence. The fallacy that intelligence is some exalted ambition of evolution is part of the same fallacy that treats it as a divine essence or wonder tissue or all-encompassing mathematical principle. The mind is an organ, a biological gadget. We have our minds because their design attains outcomes whose benefits outweighed the costs in the lives of Plio-Pleistocene African primates. To understand ourselves, we need to know the how, why, where, and when of this episode in history. They are the subject of this chapter.

LIFE'S DESIGNER

One evolutionary biologist *has* made a prediction about extraterrestrial life—not to help us look for life on other planets, but to help us understand life on this planet. Richard Dawkins has ventured that life, anywhere it is found in the universe, will be a product of Darwinian natural selection. That may seem like the most overreaching prognosis ever made from an armchair, but in fact it is a straightforward consequence of the argument for the theory of natural selection. Natural selection is the only explanation we have of how complex life *can* evolve, putting aside the question of how it *did* evolve. If Dawkins is right, as I think he is, natural selection is indispensable to understanding the human mind. If it is the only explanation of the evolution of little green men, it certainly is the only explanation of the evolution of big brown and beige ones.

The theory of natural selection—like the other foundation of this book, the computational theory of mind—has an odd status in modern intellectual life. Within its home discipline, it is indispensable, explaining thousands of discoveries in a coherent framework and constantly inspiring new ones. But outside its home, it is misunderstood and reviled. As in Chapter 2, I want to spell out the case for this foundational idea: how it explains a key mystery that its alternatives cannot explain, how it has been verified in the lab and the field, and why some famous arguments against it are wrong.

Natural selection has a special place in science because it alone explains what makes life special. Life fascinates us because of its *adaptive complexity* or *complex design*. Living things are not just pretty bits of bric-a-brac, but do amazing things. They fly, or swim, or see, or digest