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**RESERVE**

Chapter 1

THE  
 MOST  
 PRECIOUS  
 THING

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Carl Sagan 1966.  
 The Demon-  
 Haunted World.

All our science, measured against reality,  
is primitive and childlike—and yet it is  
the most precious thing we have.

ALBERT EINSTEIN  
(1879–1955)

As I got off the plane, he was waiting for me, holding up a scrap of cardboard with my name scribbled on it. I was on my way to a conference of scientists and TV broadcasters devoted to the seemingly hopeless prospect of improving the presentation of science on commercial television. The organizers had kindly sent a driver.

“Do you mind if I ask you a question?” he said as we waited for my bag.

No, I didn’t mind.

“Isn’t it confusing to have the same name as that scientist guy?”

It took me a moment to understand. Was he pulling my leg? Finally, it dawned on me.

“I *am* that scientist guy,” I answered.

He paused and then smiled. “Sorry. That’s my problem. I thought it was yours too.”

He put out his hand. “My name is William F. Buckley.” (Well, he wasn’t *exactly* William F. Buckley, but he did bear the name of a contentious and well-known TV interviewer, for which he doubtless took a lot of good-natured ribbing.)

As we settled into the car for the long drive, the windshield wipers rhythmically thwacking, he told me he was glad I was “that scientist guy”—he had so many questions to ask about science. Would I mind?

No, I didn’t mind.

And so we got to talking. But not, as it turned out, about science. He wanted to talk about frozen extraterrestrials languishing in an Air Force base near San Antonio, “channeling” (a way to hear what’s on the minds of dead people—not much, it turns out), crystals, the prophecies of Nostradamus, astrology, the shroud of Turin . . . He introduced each portentous subject with buoyant enthusiasm. Each time I had to disappoint him:

“The evidence is crummy,” I kept saying. “There’s a much simpler explanation.”

He was, in a way, widely read. He knew the various speculative nuances on, let's say, the "sunken continents" of Atlantis and Lemuria. He had at his fingertips what underwater expeditions were supposedly just setting out to find the tumbled columns and broken minarets of a once-great civilization whose remains were now visited only by deep sea luminescent fish and giant kraken. Except . . . while the ocean keeps many secrets, I knew that there isn't a trace of oceanographic or geophysical support for Atlantis and Lemuria. As far as science can tell, they never existed. By now a little reluctantly, I told him so.

As we drove through the rain, I could see him getting glummer and glummer. I was dismissing not just some errant doctrine, but a precious facet of his inner life.

And yet there's so much in real science that's equally exciting, more mysterious, a greater intellectual challenge—as well as being a lot closer to the truth. Did he know about the molecular building blocks of life sitting out there in the cold, tenuous gas between the stars? Had he heard of the footprints of our ancestors found in 4-million-year-old volcanic ash? What about the raising of the Himalayas when India went crashing into Asia? Or how viruses, built like hypodermic syringes, slip their DNA past the host organism's defenses and subvert the reproductive machinery of cells; or the radio search for extraterrestrial intelligence; or the newly discovered ancient civilization of Ebla that advertised the virtues of Ebla beer? No, he hadn't heard. Nor did he know, even vaguely, about quantum indeterminacy, and he recognized DNA only as three frequently linked capital letters.

Mr. "Buckley"—well-spoken, intelligent, curious—had heard virtually nothing of modern science. He had a natural appetite for the wonders of the Universe. He *wanted* to know about science. It's just that all the science had gotten filtered out before it reached him. Our cultural motifs, our educational system, our communications media had failed this man. What the society permitted to trickle through was mainly pretense and confusion. It had never taught him how to distinguish real science from the cheap imitation. He knew nothing about how science works.

There are hundreds of books about Atlantis—the mythical continent that is said to have existed something like 10,000 years ago in the Atlantic Ocean. (Or somewhere. A recent book locates it in Antarctica.) The story goes back to Plato, who reported it as hearsay coming

down to *him* from remote ages. Recent books authoritatively describe the high level of Atlantean technology, morals, and spirituality, and the great tragedy of an entire populated continent sinking beneath the waves. There is a "New Age" Atlantis, "the legendary civilization of advanced sciences," chiefly devoted to the "science" of crystals. In a trilogy called *Crystal Enlightenment*, by Katrina Raphaell—the books mainly responsible for the crystal craze in America—Atlantean crystals read minds, transmit thoughts, are the repositories of ancient history and the model and source of the pyramids of Egypt. Nothing approximating evidence is offered to support these assertions. (A resurgence of crystal mania may follow the recent finding by the real science of seismology that the inner core of the Earth may be composed of a single, huge, nearly perfect crystal—of iron.)

A few books—Dorothy Vitaliano's *Legends of the Earth*, for example—sympathetically interpret the original Atlantis legends in terms of a small island in the Mediterranean that was destroyed by a volcanic eruption, or an ancient city that slid into the Gulf of Corinth after an earthquake. This, for all we know, may be the source of the legend, but it is a far cry from the destruction of a continent on which had sprung forth a preternaturally advanced technical and mystical civilization.

What we almost never find—in public libraries or newsstand magazines or prime time television programs—is the evidence from sea floor spreading and plate tectonics, and from mapping the ocean floor which shows quite unmistakably that there could have been no continent between Europe and the Americas on anything like the timescale proposed.

Spurious accounts that snare the gullible are readily available. Skeptical treatments are much harder to find. Skepticism does not sell well. A bright and curious person who relies entirely on popular culture to be informed about something like Atlantis is hundreds or thousands of times more likely to come upon a fable treated uncritically than a sober and balanced assessment.

Maybe Mr. "Buckley" should know to be more skeptical about what's dished out to him by popular culture. But apart from that, it's hard to see how it's his fault. He simply accepted what the most widely available and accessible sources of information claimed was true. For his naïveté, he was systematically misled and bamboozled:

Science arouses a soaring sense of wonder. But so does pseudoscience. Sparse and poor popularizations of science abandon ecological niches that pseudoscience promptly fills. If it were widely understood that claims to knowledge require adequate evidence before they can be accepted, there would be no room for pseudoscience. But a kind of Gresham's Law prevails in popular culture by which bad science drives out good.

All over the world there are enormous numbers of smart, even gifted, people who harbor a passion for science. But that passion is unrequited. Surveys suggest that some 95 percent of Americans are "scientifically illiterate." That's just the same fraction as those African Americans, almost all of them slaves, who were illiterate just before the Civil War—when severe penalties were in force for anyone who taught a slave to read. Of course there's a degree of arbitrariness about any determination of illiteracy, whether it applies to language or to science. But anything like 95 percent illiteracy is extremely serious.

Every generation worries that educational standards are decaying. One of the oldest short essays in human history, dating from Sumer some 4,000 years ago, laments that the young are disastrously more ignorant than the generation immediately preceding. Twenty-four hundred years ago, the aging and grumpy Plato, in Book VII of the *Laws*, gave his definition of scientific illiteracy:

Who is unable to count one, two, three, or to distinguish odd from even numbers, or is unable to count at all, or reckon night and day, and who is totally unacquainted with the revolution of the Sun and Moon, and the other stars . . . All freemen, I conceive, should learn as much of these branches of knowledge as every child in Egypt is taught when he learns the alphabet. In that country arithmetical games have been invented for the use of mere children, which they learn as pleasure and amusement . . . I . . . have late in life heard with amazement of our ignorance in these matters; to me we appear to be more like pigs than men, and I am quite ashamed, not only of myself, but of all Greeks.

I don't know to what extent ignorance of science and mathematics contributed to the decline of ancient Athens, but I know that the consequences of scientific illiteracy are far more dangerous in our time

than in any that has come before. It's perilous and foolhardy for the average citizen to remain ignorant about global warming, say, or ozone depletion, air pollution, toxic and radioactive wastes, acid rain, topsoil erosion, tropical deforestation, exponential population growth. Jobs and wages depend on science and technology. If our nation can't manufacture, at high quality and low price, products people want to buy, then industries will continue to drift away and transfer a little more prosperity to other parts of the world. Consider the social ramifications of fission and fusion power, supercomputers, data "highways," abortion, radon, massive reductions in strategic weapons, addiction, government eavesdropping on the lives of its citizens, high-resolution TV, airline and airport safety, fetal tissue transplants, health costs, food additives, drugs to ameliorate mania or depression or schizophrenia, animal rights, superconductivity, morning-after pills, alleged hereditary antisocial predispositions, space stations, going to Mars, finding cures for AIDS and cancer.

How can we affect national policy—or even make intelligent decisions in our own lives—if we don't grasp the underlying issues? As I write, Congress is dissolving its own Office of Technology Assessment—the only organization specifically tasked to provide advice to the House and Senate on science and technology. Its competence and integrity over the years have been exemplary. Of the 535 members of the U.S. Congress, rarely in the twentieth century have as many as one percent had any significant background in science. The last scientifically literate President may have been Thomas Jefferson.\*

So how do Americans decide these matters? How do they instruct their representatives? Who in fact makes these decisions, and on what basis?

Hippocrates of Cos is the father of medicine. He is still remembered 2,500 years later for the Hippocratic Oath (a modified form of which is

\* Although claims can be made for Theodore Roosevelt, Herbert Hoover and Jimmy Carter. Britain had such a Prime Minister in Margaret Thatcher. Her early studies in chemistry, in part under the tutelage of Nobel Laureate Dorothy Hodgkins, were key to the U.K.'s strong and successful advocacy that ozone-depleting CFCs be banned worldwide.

still here and there taken by medical students upon their graduation). But he is chiefly celebrated because of his efforts to bring medicine out of the pall of superstition and into the light of science. In a typical passage Hippocrates wrote: "Men think epilepsy divine, merely because they do not understand it. But if they called everything divine which they do not understand, why, there would be no end of divine things." Instead of acknowledging that in many areas we are ignorant, we have tended to say things like the Universe is permeated with the ineffable. A God of the Gaps is assigned responsibility for what we do not yet understand. As knowledge of medicine improved since the fourth century B.C., there was more and more that we understood and less and less that had to be attributed to divine intervention—either in the causes or in the treatment of disease. Deaths in childbirth and infant mortality have decreased, lifetimes have lengthened, and medicine has improved the quality of life for billions of us all over the planet.

In the diagnosis of disease, Hippocrates introduced elements of the scientific method. He urged careful and meticulous observation: "Leave nothing to chance. Overlook nothing. Combine contradictory observations. Allow yourself enough time." Before the invention of the thermometer, he charted the temperature curves of many diseases. He recommended that physicians be able to tell, from present symptoms alone, the probable past and future course of each illness. He stressed honesty. He was willing to admit the limitations of the physician's knowledge. He betrayed no embarrassment in confiding to posterity that more than half his patients were killed by the diseases he was treating. His options of course were limited; the drugs available to him were chiefly laxatives, emetics, and narcotics. Surgery was performed, and cauterization. Considerable further advances were made in classical times through the fall of Rome.

While medicine in the Islamic world flourished, what followed in Europe was truly a dark age. Much knowledge of anatomy and surgery was lost. Reliance on prayer and miraculous healing abounded. Secular physicians became extinct. Chants, potions, horoscopes, and amulets were widely used. Dissections of cadavers were restricted or outlawed, so those who practiced medicine were prevented from acquiring firsthand knowledge of the human body. Medical research came to a standstill.

It was very like what the historian Edward Gibbon described for the entire Eastern Empire, whose capital was Constantinople:

In the revolution of ten centuries, not a single discovery was made to exalt the dignity or promote the happiness of mankind. Not a single idea had been added to the speculative systems of antiquity, and a succession of patient disciples became in their turn the dogmatic teachers of the next servile generation.

Even at its best, pre-modern medical practice did not save many. Queen Anne was the last Stuart monarch of Great Britain. In the last 17 years of the seventeenth century, she was pregnant 18 times. Only five children were born alive. Only one of them survived infancy. He died before reaching adulthood, and before her coronation in 1702. There seems to be no evidence of some genetic disorder. She had the best medical care money could buy.

Diseases that once tragically carried off countless infants and children have been progressively mitigated and cured by science—through the discovery of the microbial world, via the insight that physicians and midwives should wash their hands and sterilize their instruments, through nutrition, public health and sanitation measures, antibiotics, drugs, vaccines, the uncovering of the molecular structure of DNA, molecular biology, and now gene therapy. In the developed world at least, parents today have an enormously better chance of seeing their children live to adulthood than did the heir to the throne of one of the most powerful nations on Earth in the late seventeenth century. Smallpox has been wiped out worldwide. The area of our planet infested with malaria-carrying mosquitoes has dramatically shrunk. The number of years a child diagnosed with leukemia can expect to live has been increasing progressively, year by year. Science permits the Earth to feed about a hundred times more humans, and under conditions much less grim, than it could a few thousand years ago.

We can pray over the cholera victim, or we can give her 500 milligrams of tetracycline every 12 hours. (There is still a religion, Christian Science, that denies the germ theory of disease; if prayer fails, the faithful would rather see their children die than give them antibiotics.) We can try nearly futile psychoanalytic talk therapy on the schizo-

phrenic patient, or we can give him 300 to 500 milligrams a day of clozapine. The scientific treatments are hundreds or thousands of times more effective than the alternatives. (And even when the alternatives seem to work, we don't actually know that they played any role: Spontaneous remissions, even of cholera and schizophrenia, can occur without prayer and without psychoanalysis.) Abandoning science means abandoning much more than air conditioning, CD players, hair dryers, and fast cars.

In hunter-gatherer, pre-agricultural times, the human life expectancy was about 20 to 30 years. That's also what it was in Western Europe in Late Roman and in Medieval times. It didn't rise to 40 years until around the year 1870. It reached 50 in 1915, 60 in 1930, 70 in 1955, and is today approaching 80 (a little more for women, a little less for men). The rest of the world is retracing the European increment in longevity. What is the cause of this stunning, unprecedented, humanitarian transition? The germ theory of disease, public health measures, medicines and medical technology. Longevity is perhaps the best single measure of the physical quality of life. (If you're dead, there's little you can do to be happy.) This is a precious offering from science to humanity—nothing less than the gift of life.

But microorganisms mutate. New diseases spread like wildfire. There is a constant battle between microbial measures and human countermeasures. We keep pace in this competition not just by designing new drugs and treatments, but by penetrating progressively more deeply toward an understanding of the nature of life—basic research.

If the world is to escape the direst consequences of global population growth and 10 or 12 billion people on the planet in the late twenty-first century, we must invent safe but more efficient means of growing food—with accompanying seed stocks, irrigation, fertilizers, pesticides, transportation and refrigeration systems. It will also take widely available and acceptable contraception, significant steps toward political equality of women, and improvements in the standards of living of the poorest people. How can all this be accomplished without science and technology?

I know that science and technology are not just cornucopias pouring gifts out into the world. Scientists not only conceived nuclear weapons; they also took political leaders by the lapels, arguing that

*their* nation—whichever it happened to be—had to have one first. Then they manufactured over 60,000 of them. During the Cold War, scientists in the United States, the Soviet Union, China and other nations were willing to expose their own fellow citizens to radiation—in most cases without their knowledge—to prepare for nuclear war. Physicians in Tuskegee, Alabama misled a group of veterans into thinking they were receiving medical treatment for their syphilis, when they were the untreated controls. The atrocious cruelties of Nazi doctors are well-known. Our technology has produced thalidomide, CFCs, Agent Orange, nerve gas, pollution of air and water, species extinctions, and industries so powerful they can ruin the climate of the planet. Roughly half the scientists on Earth work at least part-time for the military. While a few scientists are still perceived as outsiders, courageously criticizing the ills of society and providing early warnings of potential technological catastrophes, many are seen as compliant opportunists, or as the willing source of corporate profits and weapons of mass destruction—never mind the long-term consequences. The technological perils that science serves up, its implicit challenge to received wisdom, and its perceived difficulty, are all reasons for some people to mistrust and avoid it. There's a *reason* people are nervous about science and technology. And so the image of the mad scientist haunts our world—down to the white-coated loonies of Saturday morning children's TV and the plethora of Faustian bargains in popular culture, from the eponymous Dr. Faustus himself to *Dr. Frankenstein*, *Dr. Strangelove*, and *Jurassic Park*.

But we can't simply conclude that science puts too much power into the hands of morally feeble technologists or corrupt, power-crazed politicians and so decide to get rid of it. Advances in medicine and agriculture have saved vastly more lives than have been lost in all the wars in history.\* Advances in transportation, communication, and entertainment have transformed and unified the world. In opinion poll after opinion poll science is rated among the most admired and trusted occupations, despite the misgivings. The sword of science is double-

\* At a dinner table recently, I asked the assembled guests—ranging in age, I guess, from thirties to sixties—how many of them would be alive today if not for antibiotics, cardiac pacemakers, and the rest of the panoply of modern medicine. Only one hand went up. It was not mine.

edged. Its awesome power forces on all of us, including politicians, but of course especially on scientists, a new responsibility—more attention to the long-term consequences of technology, a global and transgenerational perspective, an incentive to avoid easy appeals to nationalism and chauvinism. Mistakes are becoming too expensive.

Do we care what's true? Does it matter?

... where ignorance is bliss,  
'Tis folly to be wise

wrote the poet Thomas Gray. But is it? Edmund Way Teale in his 1950 book *Circle of the Seasons* understood the dilemma better:

It is morally as bad not to care whether a thing is true or not, so long as it makes you feel good, as it is not to care how you got your money as long as you have got it.

It's disheartening to discover government corruption and incompetence, for example; but is it better *not* to know about it? Whose interest does ignorance serve? If we humans bear, say, hereditary propensities toward the hatred of strangers, isn't self-knowledge the only antidote? If we long to believe that the stars rise and set for us, that we are the reason there is a Universe, does science do us a disservice in deflating our conceits?

In *The Genealogy of Morals*, Friedrich Nietzsche, as so many before and after, decries the "unbroken progress in the self-belittling of man" brought about by the scientific revolution. Nietzsche mourns the loss of "man's belief in his dignity, his uniqueness, his irreplaceability in the scheme of existence." For me, it is far better to grasp the Universe as it really is than to persist in delusion, however satisfying and reassuring. Which attitude is better geared for our long-term survival? Which gives us more leverage on our future? And if our naïve self-confidence is a little undermined in the process, is that altogether such a loss? Is there not cause to welcome it as a maturing and character-building experience?

To discover that the Universe is some 8 to 15 billion and not 6 to 12

thousand years old\* improves our appreciation of its sweep and grandeur; to entertain the notion that we are a particularly complex arrangement of atoms, and not some breath of divinity, at the very least enhances our respect for atoms; to discover, as now seems probable, that our planet is one of billions of other worlds in the Milky Way Galaxy and that our galaxy is one of billions more, majestically expands the arena of what is possible; to find that our ancestors were also the ancestors of apes ties us to the rest of life and makes possible important—if occasionally rueful—reflections on human nature.

Plainly there is no way back. Like it or not, we are stuck with science. We had better make the best of it. When we finally come to terms with it and fully recognize its beauty and its power, we will find, in spiritual as well as in practical matters, that we have made a bargain strongly in our favor.

But superstition and pseudoscience keep getting in the way, distracting all the "Buckleys" among us, providing easy answers, dodging skeptical scrutiny, casually pressing our awe buttons and cheapening the experience, making us routine and comfortable practitioners as well as victims of credulity. Yes, the world *would* be a more interesting place if there were UFOs lurking in the deep waters off Bermuda and eating ships and planes, or if dead people could take control of our hands and write us messages. It would be fascinating if adolescents were able to make telephone handsets rocket off their cradles just by thinking at them, or if our dreams could, more often than can be explained by chance and our knowledge of the world, accurately foretell the future.

These are all instances of pseudoscience. They purport to use the methods and findings of science, while in fact they are faithless to its nature—often because they are based on insufficient evidence or because they ignore clues that point the other way. They ripple with gullibility. With the uninformed cooperation (and often the cynical connivance) of newspapers, magazines, book publishers, radio, television, movie producers, and the like, such ideas are easily and widely

\* "No thinking religious person believes this. Old hat," writes one of the referees of this book. But many "scientific creationists" not only believe it, but are making increasingly aggressive and successful efforts to have it taught in the schools, museums, zoos, and textbooks. Why? Because adding up the "begats," the ages of patriarchs and others in the Bible, gives such a figure, and the Bible is "inerrant."

available. Far more difficult to come upon, as I was reminded by my encounter with Mr. "Buckley," are the alternative, more challenging and even more dazzling findings of science.

Pseudoscience is easier to contrive than science, because distracting confrontations with reality—where we cannot control the outcome of the comparison—are more readily avoided. The standards of argument, what passes for evidence, are much more relaxed. In part for these same reasons, it is much easier to present pseudoscience to the general public than science. But this isn't enough to explain its popularity.

Naturally, people try various belief systems on for size, to see if they help. And, if we're desperate enough, we become all too willing to abandon what may be perceived as the heavy burden of skepticism. Pseudoscience speaks to powerful emotional needs that science often leaves unfulfilled. It caters to fantasies about personal powers we lack and long for (like those attributed to comic book superheroes today, and earlier, to the gods). In some of its manifestations, it offers satisfaction of spiritual hungers, cures for disease, promises that death is not the end. It reassures us of our cosmic centrality and importance. It vouchsafes that we are hooked up with, tied to, the Universe.\* Sometimes it's a kind of halfway house between old religion and new science, mistrusted by both.

At the heart of some pseudoscience (and some religion also, New Age and Old) is the idea that wishing makes it so. How satisfying it would be, as in folklore and children's stories, to fulfill our heart's desire just by wishing. How seductive this notion is, especially when compared with the hard work and good luck usually required to achieve our hopes. The enchanted fish or the genie from the lamp will grant us three wishes—anything we want except more wishes. Who has not pondered—just to be on the safe side, just in case we ever come upon and accidentally rub an old, squat brass oil lamp—what to ask for?

I remember, from childhood comic strips and books, a top-hatted,

\* Although it's hard for me to see a more profound cosmic connection than the astonishing findings of modern nuclear astrophysics: Except for hydrogen, all the atoms that make each of us up—the iron in our blood, the calcium in our bones, the carbon in our brains—were manufactured in red giant stars thousands of light-years away in space and billions of years ago in time. We are, as I like to say, starstuff.

mustachioed magician who brandished an ebony walking stick. His name was Zatarra. He could make anything happen, anything at all. How did he do it? Easy. He uttered his commands backwards. So if he wanted a million dollars, he would say "sralod noillim a em evig." That's all there was to it. It was something like prayer, but much surer of results.

I spent a lot of time at age eight experimenting in this vein, commanding stones to levitate: "esir, enots." It never worked. I blamed my pronunciation.

Pseudoscience is embraced, it might be argued, in exact proportion as real science is misunderstood—except that the language breaks down here. If you've never heard of science (to say nothing of how it works), you can hardly be aware you're embracing pseudoscience. You're simply thinking in one of the ways that humans always have. Religions are often the state-protected nurseries of pseudoscience, although there's no reason why religions have to play that role. In a way, it's an artifact from times long gone. In some countries nearly everyone believes in astrology and precognition, including government leaders. But this is not simply drummed into them by religion; it is drawn out of the enveloping culture in which everyone is comfortable with these practices, and affirming testimonials are everywhere.

Most of the case histories I will relate in this book are American—because these are the cases I know best, not because pseudoscience and mysticism are more prominent in the United States than elsewhere. But the psychic spoon bender and extraterrestrial channeler Uri Geller hails from Israel. As tensions rise between Algerian secularists and Moslem fundamentalists, more and more people are discreetly consulting the country's 10,000 soothsayers and clairvoyants (about half of whom operate with a license from the government). High French officials, including a former President of France, arranged for millions of dollars to be invested in a scam (the Elf-Aquitaine scandal) to find new petroleum reserves from the air. In Germany, there is concern about carcinogenic "Earth rays" undetectable by science; they can be sensed only by experienced dowzers brandishing forked sticks. "Psychic surgery" flourishes in the Philippines. Ghosts are something of a national obsession in Britain. Since



World War II, Japan has spawned enormous numbers of new religions featuring the supernatural. An estimated 100,000 fortune-tellers flourish in Japan; the clientele are mainly young women. Aum Shinrikyo, a sect thought to be involved in the release of the nerve gas sarin in the Tokyo subway system in March 1995, features levitation, faith healing and ESP among its main tenets. Followers, at a high price, drank the "miracle pond" water—from the bath of Asahara, their leader. In Thailand, diseases are treated with pills manufactured from pulverized sacred Scripture. "Witches" are today being burned in South Africa. Australian peace-keeping forces in Haiti rescue a woman tied to a tree; she is accused of flying from rooftop to rooftop, and sucking the blood of children. Astrology is rife in India, geomancy widespread in China.

Perhaps the most successful recent global pseudoscience—by many criteria, already a religion—is the Hindu doctrine of transcendental meditation (TM). The soporific homilies of its founder and spiritual leader, the Maharishi Mahesh Yogi, can be seen on television. Seated in the yogi position, his white hair here and there flecked with black, surrounded by garlands and floral offerings, he has a *look*. One day while channel surfing we came upon this visage. "You know who that is?" asked our four-year-old son. "God." The worldwide TM organization has an estimated valuation of \$3 billion. For a fee they promise through meditation to be able to walk you through walls, to make you invisible, to enable you to fly. By thinking in unison they have, they say, diminished the crime rate in Washington, D.C., and caused the collapse of the Soviet Union, among other secular miracles. Not one smattering of real evidence has been offered for any such claims. TM sells folk medicine, runs trading companies, medical clinics and "research" universities, and has unsuccessfully entered politics. In its oddly charismatic leader, its promise of community, and the offer of magical powers in exchange for money and fervent belief, it is typical of many pseudosciences marketed for sacerdotal export.

At each relinquishing of civil controls and scientific education another little spurt in pseudoscience occurs. Leon Trotsky described it for Germany on the eve of the Hitler takeover (but in a description that might equally have applied to the Soviet Union of 1933):

Not only in peasant homes, but also in city skyscrapers, there lives along side the twentieth century the thirteenth. A hundred mil-

lion people use electricity and still believe in the magic powers of signs and exorcisms. . . . Movie stars go to mediums. Aviators who pilot miraculous mechanisms created by man's genius wear amulets on their sweaters. What inexhaustible reserves they possess of darkness, ignorance and savagery!

Russia is an instructive case. Under the Tsars, religious superstition was encouraged, but scientific and skeptical thinking—except by a few tame scientists—was ruthlessly expunged. Under Communism, both religion and pseudoscience were systematically suppressed—except for the superstition of the state ideological religion. It was advertised as scientific, but fell as far short of this ideal as the most unselfcritical mystery cult. Critical thinking—except by scientists in hermetically sealed compartments of knowledge—was recognized as dangerous, was not taught in the schools, and was punished where expressed. As a result, post-Communism, many Russians view science with suspicion. When the lid was lifted, as was also true of virulent ethnic hatreds, what had all along been bubbling subsurface was exposed to view. The region is now awash in UFOs, poltergeists, faith healers, quack medicines, magic waters, and old-time superstition. A stunning decline in life expectancy, increasing infant mortality, rampant epidemic disease, subminimal medical standards, and ignorance of preventative medicine all work to raise the threshold at which skepticism is triggered in an increasingly desperate population. As I write, the electorally most popular member of the Duma, a leading supporter of the ultranationalist Vladimir Zhirinovskiy, is one Anatoly Kashpirovskiy—a faith healer who remotely cures diseases ranging from hernias to AIDS by glaring at you out of your television set. His face starts stopped clocks.

A somewhat analogous situation exists in China. After the death of Mao Zedong and the gradual emergence of a market economy, UFOs, channeling and other examples of Western pseudoscience emerged, along with such ancient Chinese practices as ancestor worship, astrology and fortune telling—especially that version that involves throwing yarrow sticks and working through the hoary hexagrams of the *I Ching*. The government newspaper lamented that "the superstition of feudal ideology is reviving in our countryside." It was (and remains) a rural, not primarily an urban, affliction.

Individuals with "special powers" gained enormous followings.

They could, they said, project Qi, the “energy field of the Universe,” out of their bodies to change the molecular structure of a chemical 2000 kilometers away, to communicate with aliens, to cure diseases. Some patients died under the ministrations of one of these “masters of Qi Gong” who was arrested and convicted in 1993. Wang Hongcheng, an amateur chemist, claimed to have synthesized a liquid, small amounts of which, when added to water, would convert it to gasoline or the equivalent. For a time he was funded by the army and the secret police, but when his invention was found to be a scam he was arrested and imprisoned. Naturally the story spread that his misfortune resulted not from fraud, but from his unwillingness to reveal his “secret formula” to the government. (Similar stories have circulated in America for decades, usually with the government role replaced by a major oil or auto company.) Asian rhinos are being driven to extinction because their horns, when pulverized, are said to prevent impotence; the market encompasses all of East Asia.

The government of China and the Chinese Communist Party were alarmed by certain of these developments. On December 5, 1994, they issued a joint proclamation that read in part:

[P]ublic education in science has been withering in recent years. At the same time, activities of superstition and ignorance have been growing, and antiscience and pseudoscience cases have become frequent. Therefore, effective measures must be applied as soon as possible to strengthen public education in science. The level of public education in science and technology is an important sign of the national scientific accomplishment. It is a matter of overall importance in economic development, scientific advance, and the progress of society. We must be attentive and implement such public education as part of the strategy to modernize our socialist country and to make our nation powerful and prosperous. Ignorance is never socialist, nor is poverty.

So pseudoscience in America is part of a global trend. Its causes, dangers, diagnosis and treatment are likely to be similar everywhere. Here, psychics ply their wares on extended television commercials, personally endorsed by entertainers. They have their own channel, the “Psychic Friends Network”; a million people a year sign on and use

such guidance in their everyday lives. For the CEOs of major corporations, for financial analysts, for lawyers and bankers there is a species of astrologer/soothsayer/psychic ready to advise on any matter. “If people knew how many people, especially the very rich and powerful ones, went to psychics, their jaws would drop through the floor,” says a psychic from Cleveland, Ohio. Royalty has traditionally been vulnerable to psychic frauds. In ancient China and Rome astrology was the exclusive property of the emperor; any private use of this potent art was considered a capital offense. Emerging from a particularly credulous Southern California culture, Nancy and Ronald Reagan relied on an astrologer in private and public matters—unknown to the voting public. Some portion of the decision-making that influences the future of our civilization is plainly in the hands of charlatans. If anything, the practice is comparatively muted in America; its venue is worldwide.

As amusing as some of pseudoscience may seem, as confident as we may be that we would never be so gullible as to be swept up by such a doctrine, we know it’s happening all around us. Transcendental Meditation and Aum Shinrikyo seem to have attracted a large number of accomplished people, some with advanced degrees in physics or engineering. These are not doctrines for nitwits. Something else is going on.

What’s more, no one interested in what religions are and how they begin can ignore them. While vast barriers may seem to stretch between a local, single-focus contention of pseudoscience and something like a world religion, the partitions are very thin. The world presents us with nearly insurmountable problems. A wide variety of solutions are offered, some of very limited worldview, some of portentous sweep. In the usual Darwinian natural selection of doctrines, some thrive for a time, while most quickly vanish. But a few—sometimes, as history has shown, the most scruffy and least prepossessing among them—may have the power to profoundly change the history of the world.

The continuum stretching from ill-practiced science, pseudoscience, and superstition (New Age or Old), all the way to respectable mystery religion, based on revelation, is indistinct. I try not to use the word “cult” in this book in its usual meaning of a religion the speaker

dislikes, but try to reach for the headstone of knowledge—do they really know what they claim to know? Everyone, it turns out, has relevant expertise.

In certain passages of this book I will be critical of the excesses of theology, because at the extremes it is difficult to distinguish pseudoscience from rigid, doctrinaire religion. Nevertheless, I want to acknowledge at the outset the prodigious diversity and complexity of religious thought and practice over the millennia; the growth of liberal religion and ecumenical fellowship during the last century; and the fact that—as in the Protestant Reformation, the rise of Reform Judaism, Vatican II, and the so-called higher criticism of the Bible—religion has fought (with varying degrees of success) its own excesses. But in parallel to the many scientists who seem reluctant to debate or even publicly discuss pseudoscience, many proponents of mainstream religions are reluctant to take on extreme conservatives and fundamentalists. If the trend continues, eventually the field is theirs; they can win the debate by default.

One religious leader writes to me of his longing for “disciplined integrity” in religion:

We have grown far too sentimental. . . . Devotionalism and cheap psychology on one side, and arrogance and dogmatic intolerance on the other distort authentic religious life almost beyond recognition. Sometimes I come close to despair, but then I live tenaciously and always with hope. . . . Honest religion, more familiar than its critics with the distortions and absurdities perpetrated in its name, has an active interest in encouraging a healthy skepticism for its own purposes. . . . There is the possibility for religion and science to forge a potent partnership against pseudo-science. Strangely, I think it would soon be engaged also in opposing pseudo-religion.

Pseudoscience differs from erroneous science. Science thrives on errors, cutting them away one by one. False conclusions are drawn all the time, but they are drawn tentatively. Hypotheses are framed so they are capable of being disproved. A succession of alternative hypotheses is confronted by experiment and observation. Science gropes and staggers toward improved understanding. Proprietary feelings are

of course offended when a scientific hypothesis is disproved, but such disproofs are recognized as central to the scientific enterprise.

Pseudoscience is just the opposite. Hypotheses are often framed precisely so they are invulnerable to any experiment that offers a prospect of disproof, so even in principle they cannot be invalidated. Practitioners are defensive and wary. Skeptical scrutiny is opposed. When the pseudoscientific hypothesis fails to catch fire with scientists, conspiracies to suppress it are deduced.

Motor ability in healthy people is almost perfect. We rarely stumble and fall, except in young and old age. We can learn tasks such as riding a bicycle or skating or skipping, jumping rope or driving a car, and retain that mastery for the rest of our lives. Even if we've gone a decade without doing it, it comes back to us effortlessly. The precision and retention of our motor skills may, however, give us a false sense of confidence in our other talents. Our perceptions are fallible. We sometimes see what isn't there. We are prey to optical illusions. Occasionally we hallucinate. We are error-prone. A most illuminating book called *How We Know What Isn't So: The Fallibility of Human Reason in Everyday Life*, by Thomas Gilovich, shows how people systematically err in understanding numbers, in rejecting unpleasant evidence, in being influenced by the opinions of others. We're good in some things, but not in everything. Wisdom lies in understanding our limitations. “For Man is a giddy thing,” teaches William Shakespeare. That's where the stuffy skeptical rigor of science comes in.

Perhaps the sharpest distinction between science and pseudoscience is that science has a far keener appreciation of human imperfections and fallibility than does pseudoscience (or “inerrant” revelation). If we resolutely refuse to acknowledge where we are liable to fall into error, then we can confidently expect that error—even serious error, profound mistakes—will be our companion forever. But if we are capable of a little courageous self-assessment, whatever rueful reflections they may engender, our chances improve enormously.

If we teach only the findings and products of science—no matter how useful and even inspiring they may be—without communicating its critical method, how can the average person possibly distinguish science from pseudoscience? Both then are presented as unsupported assertion. In Russia and China, it used to be easy. Authoritative science was what the authorities taught. The distinction between science

and pseudoscience was made *for you*. No perplexities needed to be muddled through. But when profound political changes occurred and strictures on free thought were loosened, a host of confident or charismatic claims—especially those that told us what we wanted to hear—gained a vast following. Every notion, however improbable, became authoritative.

It is a supreme challenge for the popularizer of science to make clear the actual, tortuous history of its great discoveries and the misapprehensions and occasional stubborn refusal by its practitioners to change course. Many, perhaps most, science textbooks for budding scientists tread lightly here. It is enormously easier to present in an appealing way the wisdom distilled from centuries of patient and collective interrogation of Nature than to detail the messy distillation apparatus. The method of science, as stodgy and grumpy as it may seem, is far more important than the findings of science.

## Chapter 2

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# SCIENCE AND HOPE